NSCA 2025

EXTENDED SUMMARY

14th National Symposium on Coastal Agriculture (NSCA 2025)
Harnessing Fragile Coastal Ecosystem for Food and Environmental Security

28 Feb - 3rd March, 2025

Organized by

Indian Society of Coastal Agricultural Research (ISCAR)
Canning Town, West Bengal, India

In Collaboration with

ICAR-CRIJAF, BARRACKPORE

ICAR-CIFRI, BARRACKPORE

ICAR-CSSRI, KARNAL

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Organizers

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Lead Lect-1T1D2

Living with medicinal and aromatic plants for livelihood and economy

MANISH DAS
Director
ICAR-Directorate of Medicinal and Aromatic Plants Research
Boriavi, Anand-387310, Gujarat
E-mail: manishdas50@gmail.com

Medicinal and aromatic plants (MAPs) grow naturally in the forest area and about 80-95% medicinal plants are collected from the wilder area. The process of collection is destructive because of the use of parts like roots (29.6%), leaves (25.8%), barks (13.5%), wood (2.8%), rhizome (4%), and whole plants (24.3%). The cultivation of such plants specifically for livelihood purposes has traditionally not been a common practice. The first initiative to cultivate medicinal plants as an income-generating activity took place in India during the Second World War, when an acute scarcity of drugs led to the cultivation of a good number of species. However, in response to growing demand by the drug manufacturing industry and also to reduce pressure on species collected from the natural wilderness, various government and industry initiatives to produce medicinal plants through cultivation were developed in different parts of the world including India.

Medicinal and aromatic plants (MAPs) based livelihood systems are often mediated by the market forces and/or related directly to employment and income of the poor people. Besides, primary producers consider high-yielding medicinal plants that are responsive to economies of scale, fast-growing and demanding less space as economically attractive. Further, cultivation will be particularly advantageous for community members where there are long-standing partnerships and contractual arrangements to supply manufacturers. Livelihoods are sustainable when they are resilient to shocks and stresses, independent of external support, maintain the productivity (and diversity) of natural stocks and do not adversely affect the livelihoods of others. In other words, builds on the strengths of people, their resources and knowledge systems, strengthens local institutional capacity, attempts to remove conditions causing poverty rather than poverty itself, and gives priority to improving policies, processes and institutions in developing and implementing programs.

DEFINITION OF MAPS

Plants used for medicinal purposes throughout the world are clubbed under the category of MPs. According to WHO, 'a medicinal plant is any plant which, in one or more of its organs, contains substances that can be used for therapeutic purposes, or which are precursors for chemo-pharmaceutical semi-synthesis'. Aromatic plants are essential oil yielding plants and have volatile, odoriferous oils in special cells, glands or ducts located in different parts of a plant, such as the leaves, barks, roots, flowers and fruits and sometimes in just one or two parts. The oils are usually present in very small amounts and comprise only a tiny fraction of the entire plant material. The oils are produced during some metabolic processes of the plant and are secreted or excreted as odoriferous by-products. The fragrant oils may not necessarily be present as such in the living plants but may occur as odourless compounds called glycosides.

MARKET CHAIN IN MAPS

Market chain to link products delivery is important for utilization and sustainable production of MAPs. This becomes further important when livelihood of major share of our population is involved in this sector. Several factors have been identified which are responsible for a poorly coordinated and obscure market chain, such as market access and transaction problems, information gaps, lack of reliable buyers, and discriminatory and unfair pricing. The tangible challenges faced by small-holder farmers in the upstream value chain relate to five specific areas: market information, capital and skills, volume, quality, and consistency of supply. In the Indian context, it is asserted that for farmers cultivating medicinal plants, there can be many obstacles inhibiting success. Obstacles could be lack of knowledge of cultivation and post-harvest techniques for some species and the lack of availability of good quality planting material as well constraints in this regard. The problems and challenges inherent in the medicinal plants value chain are versatile and multiple: poorly integrated, lack of market access, information and knowledge gaps, unfair pricing upstream, and lack of capacity at the producer level.

OVERHARVESTING OF MAPS AND ITS IMPACT

Harvesting is linked with production and production is linked with good agricultural practices. Hence harvesting should not be linked with quick and illegal delivery to the market. This results into

overharvesting or poorly harvesting. Over-harvesting of high-value medicinal plants in the wild has resulted from increased demand for herbals around the world. This rising threat to these MAPs will not only affect the living status of the farmers and communities but also jeopardize the health of the people in the region. Though medicinal plant cultivation is done on a modest scale, the World Bank has stated that measures should be taken to promote medicinal plant cultivation in order to reduce the hazards of unsustainable gathering from the wild and forests. Many countries are devising new policies that protect their natural resource base. The Biological Diversity (Amendment) Bill, 2021, was introduced in India's parliament on December 9, 2021, with one of its goals being to encourage the cultivation of medicinal plants. In this endeavour, ICAR-Directorate of Medicinal and Aromatic Plants Research (ICAR-DMAPR), Anand, Gujarat initiated several measures to bring MAPs into cultivation and encourage farmers to adopt technologies developed by it. However, R & D has been a continuous programme for all public sector Institutes like ICAR-DMAPR, CSIR-CIMAP, CSIR-NBRI, ICAR-IIHR and several other state agricultural universities (SAUs) and through ICAR-AICRP on Medicinal & Aromatic Plants and Betelvine.

MULTI-FACETED IMPORTANCE OF MAPS

The social perspective throughout and in particular India, the use of medicinal plants in meeting family's primary health care and nutrition needs is traditional and imbedded in all cultures, a practice dating back to at least four thousand years in many countries. There is acceptability regarding familiarity with the usage of plant products, methods of cultivation of many commonly grown plants and technologies required for processing into items of common household uses and value. Medicinal plants are socially acceptable employment avenues for women. Traditionally, women have been the mainstays of med-plants-based activities and micro-enterprises because the products and activities thereof easily fit within the average daily needs and work schedules of women. These typically include med-plants raw materials being collected, dried and transported to the market as well as training of women employed by herbal drug industry. Medicinal plants have also been used to develop family-based health and livelihood-oriented enterprises in rural areas. Many traditional healers have been running MAP-based health care system to earn their livelihoods. Arya Vaidya Sala (AVS), Kottakal in Kerala is an excellent example of business and traditional medicine service combined. Such industries not only strengthen the social fabric, but also help preserve the traditional medical knowledge, and provide easily adaptable enterprising opportunities for unemployed youth and rural poor who can learn the trade from their parents and peers and earn not only their livelihood but also contribute to the society.

GLOBAL AND INDIA SCENARIO

Worldwide sales of medicinal herbs are estimated at US$ 328 billion in 2023 and are forecasted to climb to US$ 555 billion by the end of 2033. Over the next ten years (2023 to 2033), the global medicinal herbs market is forecasted to expand steadily at 5.4% CAGR. Globally 72000-77000 (17-18%) of world flora is currently utilized for medicinal purposes. More than 200 therapies employed by different cultures to treat physical and psychological ailments employ medicinal plants as curative medicines. But there are positive signals also for us in the global market. India has 16 Agro-climatic zones, 10 vegetative zones, 15 biotic provinces, 426 biomes, 45000 different plant species and 15000 medicinal plants that include 7000 ayurveda, 700 in Unani medicine, 600 in Siddha medicine and 30 in modern medicine. This makes India one among 12 mega biodiverse countries of the world, which despite having only 2.5 % total land area, accounting for over 8 % of the recorded species of the world. The forecast is that the global market for herbal products is expected to be $5 Trillion by 2050. Herbal remedies would become increasingly important especially in developing countries. India, with its biodiversity has a tremendous potential and advantage in this emerging area. Acupuncture is one such therapy that has gained worldwide recognition.

STRENGTH OF MEDICINAL PLANTS CULTIVATION

A SWOT analysis of Indian medicinal plants has established that this sector has several strengths, such as enormous biodiversity, all types of soil and climate, a rich heritage of the Indian System of Medicine (ISM), a strong base of Research and Development laboratories, skilled manpower, lower production and manpower costs and a well-developed pharmaceutical industry, which is not in alignment with the perspective of farmers. There is a great demand for medicinal plants, as per the national survey conducted by NMPB; however, in this study, it was found that the majority of the participants were not aware of this Krusi Jagaran. Although there are several support schemes for medicinal plant cultivation from different Government sectors, most of the participants were not aware of them.

OPPORTUNITIES TO TRANSLATE

As per the farmers' perspective, there are major challenges in medicinal plant cultivation; such as a lack of profit, little or no buyers, little government support, little or no training or labour, financial problems and unfavourable climatic conditions. There is also a serious gap in availing government supporting schemes in medicinal plant cultivation by farmers, leading to limited success in productivity. Therefore, there is a great scope of work to be performed in this field in enhancing farmers' awareness of such available schemes, and by conducting various training programmes, which can provide an opportunity for the state to increase the production and productivity of medicinal plants substantially. Also, there is a need for effective legislative measures to enforce the contracts between the farmer and the buyer.

GOOD AGRICULTURAL PRACTICES

Good Agricultural Practice (GAP) is essential for sustainable agricultural development. It focuses on different curative and preventive measures, which are required for maintaining an agro-ecology and environment for quality food and nutrition. The Ministry of AYUSH and ICAR, from the government of India has issued guidelines for the cultivation, collection and processing of medicinal plants. Labor-intensive and low-input ecological organic agriculture having stringent on-farm resource management has been advocated for promising sustainable agricultural systems in India. There have been suggestions for the implementation of modern crop production, post-harvest and processing technologies to improve the quality and to make agriculture both a sustainable and profitable business. Indigenous technical knowledge and system for the management of natural ecology has helped in the survival of the people for a long time. Although, several good agricultural practices are in place in India such as controlling pests and diseases in organic farming preventive measures, these are widely used instead of curative measures; for example, whiteflies are diminished from crops via the use of taller, non-host border crops; such as like maize, sorghum and pearl millet. Also, mulch is used to cover soil surfaces around the plants to create congenial conditions for growth. Other practices may include temperature moderation, reduced salinity and weed control. For centuries, agriculture in India relied upon local resources; such as local indigenous varieties and knowledge, which was achieved through sustained interaction with nature. However, with reports about good agriculture practices in place concerning medicinal plants, India would stand sustainable and viable leading to more demand and export.

CONSERVATION STRATEGIES OF MEDICINAL PLANT RESOURCES

Medicinal plant resources are being harvested in increasing volumes, largely from wild populations. Indeed, demand for wild resources has increased by 8–15 % per year in Europe, North America, and Asia in recent decades. There is a threshold below which species reproductive capacity becomes irreversibly reduced. Various sets of recommendations relating to the conservation of medicinal plants have been developed, such as providing both *in situ* and *ex situ* conservation. Natural reserves and wild nurseries are typical examples to retain the medical efficacy of plants in their natural habitats, while botanic gardens and seed banks are important paradigms for *ex situ* conservation and future replanting. The geographic distribution and biological characteristics of medicinal plants must be known to guide conservation activities, e.g. to assess whether species conservation should take place in nature or in a nursery.

IMPLEMENTATION OF MAP-BASED LIVELIHOODS FRAMEWORK

Alleviating rural poverty will require efforts, which go well beyond the basic income yardstick. It has to include improved access to primary health and education services, the right to a sustainable means of livelihood, protection from external shocks, and the power to participate in decision-making that affects the lives of the poor and marginalized communities. Meeting all these challenges will require, in addition to enabling rural development-oriented policies, sustained income growth of rural people. The MAP sub-sector is an integral part of natural resource management (NRM), contributing to economic growth, environmental protection and trade. The potential contribution of MAP can be substantial in capital-poor but resource-rich countries if investment and efforts can be substantially increased in this sub-sector. The over-riding challenge for country like ours in the coming decades is to secure sustainable economic growth in the face of an increasing population and distribute the additional wealth created to reduce rural poverty and improve the quality of life, especially for poor, women and indigenous community who are most vulnerable to slip in and out of poverty trap. MAPs play an important role for such economy and well-being of human being and also for feeds and fodders.

Lead Lect-2T1D1

Promoting sustainability through hydroponic/ soilless cultivation for high value vegetable production in coastal areas

UMESH THAPA
Department of Vegetable Science, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya,
P.O. Krishi Viswavidyalaya, Mohanpur, Nadia -741252, West Bengal
E-mail: drumesh.thapa@gmail.com

INTRODUCTION

Agriculture in coastal regions faces numerous challenges, including salinity intrusion, poor soil fertility, waterlogging, and unpredictable climate conditions. Traditional soil-based farming struggles to sustain high yields under these stress conditions. In response, hydroponic and soilless farming have emerged as innovative and sustainable solutions, offering a controlled environment for vegetable cultivation without dependence on soil. These techniques enable efficient resource utilization, improve productivity, and ensure food security in coastal regions affected by environmental stress.

Vegetable crops are vital for food security and play a key role in both domestic and export markets. India's diverse climate supports a wide range of vegetable crops, yet many lesser-known varieties remain underutilized. Growing these rare vegetables in peri-urban areas can be highly profitable, as they command premium prices in metropolitan markets, luxury hotels, and tourist destinations.

In recent years, exotic vegetables like broccoli, Brussels sprouts, Chinese cabbage, red cabbage, lettuce, celery, and parsley have been introduced, with adaptation studies conducted across various regions. High-Value Crops (HVCs) provide significantly higher economic returns per unit of land and inputs compared to staple crops. With rising urbanization—expected to reach 45% by 2030—demand for HVCs is growing rapidly, influencing both urban and rural consumption patterns.

Soilless farming, a modern and sustainable technique, is gaining attention but requires specialized knowledge for effective adoption. Climate change, population growth, and shrinking cultivable land—from 0.50 hectares per capita in 1960 to 0.25 hectares today—pose major challenges for food production. Intensive farming has also degraded soil health, making it difficult to sustain supply through conventional methods. In this scenario, soilless cultivation offers a viable alternative to enhance productivity while conserving resources.

Hydroponics, a subset of soilless farming, involves growing plants in nutrient-rich water solutions, eliminating soil-related issues like salinity and pathogens. Other soilless methods, such as aeroponics and aquaponics, further enhance sustainability by optimizing nutrient delivery and water use. The adoption of these advanced techniques in coastal areas holds immense potential for increasing vegetable production while mitigating environmental degradation.

This paper explores the principles, benefits, and challenges of hydroponic and soilless farming in coastal regions, providing insights into their role in ensuring sustainable agricultural practices.

Research on soilless cultivation is being conducted at the Department of Vegetable Science, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur. The primary objective of this study is to enhance understanding and create awareness about high-value vegetable production under hydroponic and soilless culture systems. Additionally, the study aims to analyze the challenges farmers face in adopting these advanced cultivation techniques.

To achieve this objective, the following key areas of research have been identified:

- Awareness Assessment: Evaluating public awareness regarding the profitability and benefits of high-value vegetable cultivation through hydroponics and soilless technology.
- Crop Selection: Identifying suitable high-value vegetable crops that can be effectively cultivated using soilless culture systems.
- System Optimization: Standardizing different hydroponic and soilless culture modules for efficient and sustainable vegetable production.
- Growing Media and Nutrient Solutions: Determining the most suitable growing media and nutrient formulations for maximizing yield and quality in high-value vegetable production under soilless conditions.

Why these vegetables are gaining importance???

With the growth of new food chains like McDonald's, Pizza Hut ,Dominoz, KFC, Subway etc., the people are developing new taste buds for new food items. Preparation of these food items needs many exotic vegetables like Red cabbage, Broccoli, Colored bell pepper, Lettuce, Asparagus etc. Some of which are imported from other countries. So, these vegetable has more profitable market in metropolitan cities and small towns.If farmers grow these crops, they will be benefited. Exotic

vegetables are mainly grown for city markets and now a days they are in high demand in – shopping malls located in big cities, five Star hotels /International hotels, Multinational fast-food chains.

Hydroponic/Soilless:

The word hydroponics comes from hydro meaning water, and ponos meaning labour. Hydroponics thus, is the growing of crops in any medium containing nutrients, be it solid or even liquid but without soil. The medium can be anything from a mineral nutrient solution or some inert substrate such as gravel, sand, wool or perlite or even rice husks. The technology was first reported in scientific literature in 1600. The earliest published work on soilless culturewas the book Sylva Sylvarum published in 1627 by Francis Bacon, and after that water culturebecame a popular research technique. In India, Hydroponics was introduced in year 1946 by an English scientist, W. J ShaltoDuglas and he established a laboratory in Kalimpong area, West Bengal. He written a book on Hydroponics, named as Hydroponics the Bengal System.

Why Hydroponics/ Soilless?

Soilless culture is having more relevant option in the present days, to cope up with these challenges. Producing vegetable under soilless culture has shown promising results all over theworld. Whenever soil conditions are unfavourable soilless culture can be a good option to produce healthy and quality vegetables. Soilless technology is gaining popularities in recent days due to rapid urbanization and industrialization as well as due to impact of climate change.Soilless cultivation is ideal in urban areas where space is too limited for soil-based gardens.Soilless culture system (SCS) represents an innovative tool to improve the quality of produce at harvest, reducing microbial contamination and eliminating soil and chemical residue spoilage**.**

A very important aspect of establishing soilless culture is the selection of the proper growing media. The main criteria for selection of a particular substrate should be based on:-

- Agronomic characteristics of the substrates.
- Environmental conditions which can be provided (structure, controls and otherfacilities)
- Effect of substrates on crop susceptibility to diseases
- Economic situation of the farm businessBasic Forms of Growing Media

Growing media is usually available in four basic forms:

- Soil based(Field soil as a major component)
- Organic based(Coco peat, Peat, spaghnum moss , saw dust , wood chips, bark ,etc.)
- Inorganic based (Natural media- Vermiculite, Sand, Gravel, Rockwhool, Perlite, Pumic, zeolite, etc, and Synthetic media- Hydrogel, Foam mates, Oasis , etc)
- Hydroponics Soilless

Plants need water, mineral nutrients and oxygen to thrive. There are six hydroponic setups, based on different ways by which these requirements are fulfilled.

- Ebb and Flow System: It requires a medium such as perlite to give stability. Water and mineral solutions are periodically pumped into the tray containing plants. Plants absorb the solution and the remaining solution drains back to the reservoir. This methodis simple and used in home gardens. Herbs are grown by this method.
- Nutrient Film Technique (NFT): No medium is required. Hydroponic plants are keptin wooden channels having a slope. The mineral solution is pumped to the high end ofthe channel and slope down water is collected and reused. Plants with large roots are grown by this method.
- Drip Systems: It is similar to ebb and flow but here water goes through smaller tubes and drain on top of plants. Small plants having less developed root systems are grown using this method.
- Wick Systems: This is a medium based system where perlite or rockwool is used. Nylon rope is placed at the base of each root which extends to the reservoir. It takes upminerals and water and releases it in the medium which makes it available for plants. Itis an economical method of hydroponic farming because no pumps are required.
- Aeroponics: This is a water-based system similar to NFT and doesn't require amedium. The mineral solution is sprayed onto the plants in the form of mist. This is difficult to set up but is beneficial in the large commercial setting.
- Deep Water Culture (DWC**):** In a container, the plant's root is suspended in oxygenated water containing minerals. An air pump is used. This is an easy method andrequires low maintenance.

Research Trial conducted in the University studies on evaluation for adoption of high value crops under soilless culture

- To popularize soilless culture techniques for producing high value in semi-urban and urban areas.

- To find out the best growing medium with respect to growth and yield of sweet pepper,broccoli, red cabbage, Chinese cabbage, celery tomato, cherry tomato, Pakchoi etc under soilless culture.
- To standardize the ideal nutrient solution concentration influencing growth and yield of sweet pepper, tomato, cherry tomato, lettuce, spinach, under soilless culture.

CONCLUSIONS

Hydroponic farming is a revolutionary technology that holds immense potential for the future, especially in coastal areas where soil quality and water availability can be challenging. Hydroponics offers numerous advantages, making it a viable alternative to conventional farming. It ensures that plants receive a direct supply of nutrient-rich solutions, eliminating the need for them to expend energy searching for water and nutrients. As a result, plants achieve their best genetic potential, leading to higher yields and superior quality produce.

Hydroponically grown vegetables are rich in nutrients and free from harmful chemical fertilizers and pesticides, making them a healthier choice for consumers. Moreover, different types of hydroponic systems can be adopted based on the specific requirements of various crops. Given its sustainability, efficiency, and ability to produce high-nutrition crops, hydroponic farming is widely regarded as the future of agriculture. Its adoption in coastal regions can revolutionize food production, ensuring a consistent and high-quality yield despite environmental challenges.

Photographs shows different vegetables in Hydroponic/Soilless systems

Inv-01T1D1

Assessment of differential genes expression in distinct rice genotypes for salinity tolerant traits

S. V. SAWARDEKAR[1], S. K. MARASKOLI[2] and A. K. SINGH[3]
[1,2] Plant Biotechnology Centre, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Maharashtra
[3] ICAR-National Institute of Stress Management, Baramati
E-mail: svsawardekar@rediffmail.com

Key Words: *Gene Expression, Rice, Salinity Tolerance, Transcriptome Profiling*

INTRODUCTION

In rice the improvement of salt tolerance of sensitive genotypes at the seedling stage is an important breeding goal in many Asian countries, where seedlings must often establish in soils already contaminated by salt. The level and mechanism of salinity tolerance are established using a multivariate analytical technique based on numerous growths, qualitative, and physiological assessments to categorize genotypes depending on their level of salt tolerance through screening. The transcriptome data is primarily intended to be examined concurrently with the morpho-physiological data to identify the significantly expressed trait-specific genes throughout the rice genetic background represented by the genotypes utilized in this investigation. The main objective of the transcriptomic profiling is to identify the genotype-specific differentially expressed induced genes to build a model of gene expression in rice under salt stress based on the significantly induced genes of the tolerant and susceptible genotypes. This technique leads to the identification of many deferentially regulated transcripts due to cross-talks and overlapping pathways under particular stress /environmental situations (Soltani *et al*., 2014).

MATERIALS AND METHODS

The distinct genotypes were selected on the basis of their best salt tolerance performance and used as precious genetic resources, because they contain huge genetic variability which can be used to see the expression of genes governing salt tolerant trait and broaden the gene pool as a excellent sources of genes for novel alleles. For cDNA preparation, equal concentration of total RNA of normal and salt stressed plants was used. Single stranded cDNA was synthesized from DNase treated total RNA using ProtoScript II First strand cDNA synthesis Kit as per manufactures instructions. The cDNA of control and stress plants was used in quantitative Real Time PCR (qRT-PCR) CFX 96TM Real-Time system (Bio-Rad) to quantify expression of 15 genes in distinct rice genotypes for salinity tolerant traits . In the present investigation, we have studied salinity-related gene regulations such as *Saltol, OsNHX1, OsHKT1, OsHKT4, OsMYBS3, OsPDH45, OsCCC1, OsSKC1, OsMPK4, OsKCO1, OsTPC1, OsCDPK7, OsTIP1, OsCLC1* and *OsAKT1* genes in seedlings of selected desirable nine rice genotypes including six tolerant (Kala rata, CST 7-1, Damodar, FL 478, SR 3-9 and CSR 36) and three susceptible (Karjat 184, Karjat 4 and Ratnagiri 6) genotypes grown under salt treatment of 3 dSm^{-1}, 6 dSm^{-1} and 9 dSm-1. Genes in the *Saltol* genomic region and genes outside the *Saltol* region that interact with Saltol genes are anticipated to play a role in rice's ability to withstand salinity stress due to the physiological and genetic complexity of the plant response to salt stress. Data were tested for homogeneity and normality of the variance using Levene's and Shapiro-Wilk's tests, respectively, using SPSS 21 (Statistical Package for Social Sciences program, Chicago, IL, USA).

RESULTS AND DISCUSSION

To identify and understand the differential gene expression (DGE) pattern and the number of genes induced by salinity for 16 sets of samples, pair wise comparisons were made between genotypes with a combination of control and stress as, 1C vs 3C 4C 5C 6C, 1C vs 3S 4S 5S 6S, 1S vs 3S 4S 5S 6S, 2C vs 3S, 4S, 5S, 6S, 1C vs 3C, 1C vs 4C, 1C vs 5C, 1C vs 6C, 1C vs 3S, 1C vs 4S, 1C vs 5S, 1C vs 6S, 2C vs 3S, 2C vs 4S, 2C vs 5S, 2C vs 6S. A p-value < 0.01 threshold was set to retrieve the significant DEGs in FL 478, Karjat 4, CST 7-1, CSR 36, SR 3-9 and Karjat 184 before and after salt imposition in different sets of samples. Moreover, DEGs were screened based on log2fold change (log2FC) >1 or <−1. DEGs identified by p-value < 0.01 and log2FC >1 or <−1 were used as cut-offs for identifying up and down-regulated genes. We performed a hierarchical cluster analysis of our transcriptome data, which revealed that the identified DEGs could be classified into at least 5 distinct groups.

In the present study, significant upregulation in the expression of *Saltol* was observed in tolerant genotypes but not in sensitive genotypes under stress conditions. The *Saltol* gene increased in expression after the plants were subjected to salt stress in the tolerant cultivars than in susceptible cultivars compared to control plants. The data obtained in this study with the *Saltol* agree with those found by

Bundo *et al*. (2022). The *OsMPK4* significantly up-regulated in tolerant genotypes but not in sensitive genotypes under salt stress compared to control conditions. The data obtained in this study with the *OsMPK4* agree with those found by Hezaveh *et al*. (2019). The data obtained in the present research agree with those that Kumar and Dash (2019) found, which indicates that the *OsKCO1* gene plays a vital role in rice as K+ outward-rectifying channel. in the present research, we found that some salt-tolerant genotypes can up-regulate the expression of *OsAKT1*, and other genotypes showed down-regulate the expression under salt stress conditions. The data obtained in this study with the *OsAKT1* are in confirmation with Nieves-Cordones *et al*. (2010); Kumar and Dash (2019). The selected rice genotypes showed significant low, medium, to high levels of expression of *Saltol, OsNHX1, OsHKT1, OsHKT4, OsMYBS3, OsPDH45, OsCCC1, OsSKC1, OsMPK4, OsKCO1, OsTPC1, OsCDPK7, OsTIP1, OsCLC1* and *OsAKT1* at the seedling stage after the imposition of salt stress. A divergent expression pattern was observed depending on the level of salt treatment in rice genotypes where all the genes showed up-regulation in salt tolerant genotypes when exposed to salt stress of upto 9 dSm-1 except *OsTIP1* and *OsAKT1* were both up and down-regulates their expression according to genotypes under salt stress condition.

CONCLUSION

At the molecular level, identifying stress-responsive genes is an initial step toward understanding plant stress tolerance. The present study was undertaken to functionally identify salt-responsive genes of rice (*Oryza sativa* L.) with their up-regulation and down-regulation using a cDNA over expression or differential gene expression (qRT-PCR) strategy of transcriptome profiling.

REFERENCES

Bundó, M, Martín-Cardoso, H., Pesenti, M., Gómez-Ariza, J., Castillo, L., Frouin, J., Serrat, X., Nogués, S., Courtois, B., Grenier, C., Sacchi, G. A. and Segundo, S. B. (2022). Integrative Approach for Precise Genotyping and Transcriptomics of Salt Tolerant Introgression Rice Lines. Front. *Plant Sci.* 12:797141.

Hezaveh, T. A., Pourakbar, L., Rahmani, F. and Alipour, H. (2019). Interactive effects of salinity and ZnO nanoparticles on physiological and molecular parameters of rapeseed (*Brassica napus* L.). *Communications in Soil Science and Plant Analysis*, pp.1-18.

Kumar, A. and Dash, P. K. (2019). Transcriptome Analysis for Abiotic Stresses in Rice (*Oryza sativa* L.). *Transcriptome Analysis, IntechOpen*, pp.1-16.

Nieves-Cordones, M., Alemán, F., Martínez, V. and Rubio, F. (2010). The Arabidopsis thaliana HAK5 K+ transporter is required for plant growth and K+ acquisition from low K+ solutions under saline conditions. *Mol. Plant*, 3: 326–333.

Soltani, M., Kordenaeej, A. and Naji, A. (2014). The pattern of gene expression under water stress using cdna-aflp in wheat (Triticum aestivum L.). *International Journal of Plant, Animal and Environmental Science*, 4(3).

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High cash value horticultural crops: An effective approach to managing and utilizing challenging soils.

ANIL KUMAR DUBEY[1*], LAL CHAND[2] and H. VITTAL[3]

[1]ICAR-CSSRI, Regional Research Station, Lucknow, UP (India)

[2]ICAR- Central Institute of Arid Horticulture, Bikaner, Rajasthan (India)

[3]Division of Fruits and Horticultural Technology, ICAR-IARI, New Delhi

Email: anil.dubey1@icar.gov.in

INTRODUCTION

Soil salinization represents an increasingly serious threat to agronomic productivity throughout the world, as rising ion concentrations can interfere with the growth and development of plants, ultimately reducing crop yields and quality. 23% of the cultivated arable lands are saline over 100 countries in all continents. 20% (45 million ha) irrigated lands are human-induced salt-affected soils (secondary salinization) in the world (Zaman *et al.*, 2018). For instance, 2.6×107 hectares (ha) of the total land area are salt affected mainly in the north part and tidal coastal regions and 6.7 million ha lands of the irrigated areas are affected by secondary salinization in China. Salt stress damages plants both by imposing osmotic stress that reduces water availability while also inducing direct sodium- and chlorine-mediated toxicity that harms plant cells. About 6 million ha of irrigated land is lost each year due to drainage and salinization problems (Bohn *et al.*, 1985). Problems of soil salinity and sodicity occur primarily in arid areas where evapotranspiration exceeds rainfall. However, under certain conditions,

soil salinity problems exist in humid regions as well. It is thought that productivity enhancement of salt-affected lands in irrigated areas is one important method to provide more food, fruit, feed, and fiber to the expanding population worldwide (Qadir *et al.*, 2014).

Soil with an electrical conductivity (EC) of the saturated extract >4 $dS \cdot m^{-1}$ is considered saline, but some horticultural crops are negatively affected if salt concentrations in the rooting zone exceed 2 $dS\ m^{-1}$. Many horticultural crops are sensitive to the deterioration of soil physical properties associated with Na in soil and irrigation water. Economically viable management practices may simply involve a minor, inexpensive modification of cultural practices under conditions of low to moderate sodicity or a more costly reclamation under conditions of high Na. This lecture provides a short information on importance of horticulture, salinity tolerance of the main categories of horticultural crops, including some background information on advancement in management of sodic/saline soil through high values cash crops.

IMPORTANCE OF HORTICULTURE

Horticulture, with its broad adaptability, offers farmers a diverse selection of crops suited to various environments, soil types, and climatic conditions. Even marginal and degraded soils can support horticultural crops, providing farmers with degraded land the opportunity to cultivate suitable crops using effective practices. Many horticultural crops, such as potatoes, tubers, bananas, and vegetables, serve as essential food sources. Additionally, fruits and vegetables are increasingly used in natural health therapies, while many crops have medicinal properties. Therefore, a horticulture-based farming system should be embraced as a new paradigm to promote greening, environmental sustainability, and nutritious food production while enhancing farm profitability.

Horticultural crops can be categorized into three main groups: 1) landscape and ornamental plants, 2) vegetables, and 3) fruits and nuts. Enhancing and sustaining horticultural crop production presents a valuable opportunity to address global challenges related to human nutrition and economic development (Davis & Hariyadi, 2013; Davis *et al.*, 2017). The cultivation of horticultural crops offers key advantages: first, from a health and nutrition perspective, incorporating more fruits and vegetables into human diets is essential (FAO, 2003); second, horticultural crops typically generate higher economic returns per unit of land compared to agronomic crops, making them a promising avenue for economic growth.

GROUND RULES FOR SALINITY STUDIES IN HORTICULTURAL CROPS

Lunin et al. (1963) established key principles for salinity studies: (1) a crop's tolerance to salinity depends on the growth stage at which salinization begins and the final salinity level reached; and (2) salt tolerance assessments should consider the plant part intended for market. For instance, beet roots experience greater yield reductions due to salinity than their tops, while onion bulbs are less affected compared to their foliage. Additionally, salt tolerance genes interact with other genes that regulate quantitative traits and environmental responses. As a result, salt tolerance is a complex quantitative genetic trait governed by multiple genes (Shannon, 1996). Thus, salt tolerance can be adequately measured on the basis of two parameters: the threshold (EC_t), the electrical conductivity that is expected to cause the initial significant reduction in the maximum expected yield (Ymax) and the slope (s). Slope is simply the percentage of yield expected to be reduced for each unit of added salinity above the threshold value. Relative yield (Y) at any salinity exceeding ECt can be calculated:

Y =100 -s(EC_e EC_t) where *s* = the slope expressed in percent per dS/m; EC_t =the salinity threshold expressed in dS/m; and EC_e = the mean electrical conductivity of a saturated paste taken from the rootzone.

STRATEGIES FOR MANAGEMENT OF SODIC

Various strategies have been developed to manage problematic soils, categorized into:

1. Physical methods – These involve the use of organic amendments (such as manures), inorganic amendments (including gypsum, marine gypsum, and phospho-gypsum), and land modifications like integrated farming systems.
2. Biological methods – These include plant-based approaches, such as stress-tolerant crop varieties, and microbial solutions, such as bioformulations.

HIGH VALUE CROPS TOLERANT TO SODIC/SALINE SOIL

Fruit crops:

- Date palm (*Phoenix dactylifera*), Pomegranate (*Punica granatum*), Mulberry (Morus spp.), miswak *(Salvadora sps.)*, *Guava(Psidium guajava) fig (Ficus carica), dragon fruit Selenicereus undatus*, Kair *(Capparis decidua)*, Karonda (*Carissa carandas), bael (Aegle marmelos), Aonla (Emblica officinalis), Jamun (syzygium cumini), ber var apple ber (Zyziphus mauritiana).*

Vegetables:

Okra, Beets (*Beta vulgaris*), Spinach (*Spinacia oleracea*), Swiss chard (*Beta vulgaris* var. cicla), Broccoli, tomato, Mustard greens, Asparagus, Rhubarb

Flowers:

- Marigold (*Tagetes spp*.), Russian sage (*Perovskia atriplicifolia*), Gazania (*Gazania* spp.)

Table. *Fruit yield and optimum tolerance of some fruit trees when cultivated in alkali soil*

Common name	**Botanical name**	**Optimum pH of sodic tolerance**	**Fruit yield (t/ha)**
Aonla	*Emblica officinalis*	10	20.50
Karonda	*Carissa carandus*	10	5.20
Ber	*Ziziphus mauritiana*	9.5	15.50
Jamun	*Syzygium cuminii*	9.5	16.00
Phalsa	*Grewia asiatica*	9.2	6.00
Guava	*Psidium guajava*	9.0	12.50
Bael	*Aegle mamelos*	8.5	6.50
Grape	*Vitis venifera*	9.0	18.30

(Source Singh and Singh, 1990)

Grafting Improved Salinity Tolerance: Grafting can reduce the negative effects of salinity on tomato scions and thus provides an alternative way to enhance salt tolerance and maintain fruit yield and quality under salt stress The selection of salt-tolerant rootstocks is an important strategy for enhancing salt tolerance.

1. *Citrus rootstocks*:
   - **Cl^- excluders**-Rangpur lime (*C. limonia*), Cleopatra mandarin (*C. reshnii*)
   - **Na^+ excluders**-Trifoliate orange (*Poncirus trifoliata*) and its hybrids (X639)
   - **Na and Cl excluder**: sour orange, X-639, Attani, RxP
2. **Mango**
   - Kurukkan, ML-2, ML-6, Turpentine, 13/1, Gomera-1
   - Na excluder: Monoembryonic deshi type
   - Cl excluder: Olour
3. Grape:
   - The **V. champinii** species, along with the Fall grape and the **140 Ruggeri** and **1103 Paulsen** progenies of the **V. berlandieri × V. rupestris** cross, have been identified as salt-tolerant germplasms and are commonly used as rootstocks. Additionally, the **Dogridge** rootstock has demonstrated greater tolerance to salinity compared to other rootstocks studied.
4. Cucumber rootstock: Figleaf Gourd and Chaofeng Kangshengwang , pumpkin rootstock
5. Tomato rootstock: Wild relatives of tomato, Radja and Pera, X-238.

Table: *Relative tolerance of fruit/vegetable/ornamental crops species for soil sodicity*

pH2 (0-1.2m)	**Fruit species**
>10	Date palm
9.6 -10	*Carissa carandus, Psidum guajav, Zizyphus spp, Emblica officinalis*
9.1-9.5	*Prunica granatum, Archrus zapota, Tamrandus indica, Syszygium cumunii, Feronia limonia*
8.2-9.0	*Gravia asiatica, Eagle marmelos, Prunus persica, Morus alba, Ficus spp, vitis vinifera*

Advanced production technology to mitigate negative effect of salt Use special planting techniques: Pit making with auger holes machine in alkali soil to pierce hard pan ($CaCO_3$ layer) for planting tree sapling

ALTERNATE PIT PLANTING

Alternate pit planting is a strategic orchard management technique designed to enhance the lifespan and productivity of perennial fruit crops, particularly in high-textured sodic soils. This method optimizes resource utilization and promotes better feeder root penetration by directing root growth into the adjacent unplanted pits rather than straight down. As a result, it improves nutrient and water use efficiency, leading to higher overall productivity. The technique involves planting fruit trees in designated pits while leaving alternate pits (typically 10 in size) unplanted but filled with the same medium as the main pits. These unplanted pits serve as reservoirs for water and nutrients, promoting

better absorption and growth for the adjacent trees as root of tree entered in this pit. This approach is particularly beneficial in partially reclaimed high-textured, sodic soils characterized by a hard calcium carbonate ($CaCO_3$) pan. To maximize effectiveness, the distance between the main and subsidiary pits should be no more than 10 cm, with both pits maintaining a consistent depth of 60 cm.

MULTIPLE AUGER PLANTING TECHNIQUE

In this system, five auger holes are dug at each planting site: one central hole with a diameter of 30 cm, surrounded by four peripheral holes each 10 cm in diameter. Initially, three holes are created, and then the direction of the tractor is rotated 90 degrees to form three additional holes in two passes, overlapping the central hole. These pits should be filled with a well-prepared medium consisting of soil, sand, and farmyard manure (FYM), supplemented with 2 kg of gypsum per pit. This preparation provides an ideal environment for planting high-value fruit crops. The planting should be carried out during the monsoon or spring season to ensure optimal growth in sodic soils. This system is highly suitable for apple ber cultivation under partially reclaimed sodic soils.

RAISED BEDS PLANTATION WITH DRIP IRRIGATION

In this system, planting of high value fruit and vegetable is done on raised beds with provision of drip irrigation. In this system water stagnation around the tree trunk can be avoided which leads facilitate better aeration in root zones. Bunding is thus considered a low-cost technique with dual benefits of soil/water conservation and sustainable production of high value crops.

OPEN FIELD HYDROPONICS PLANTING IN FRUIT CROPS

The integration of substrate bags into fields represents a significant advancement in maintaining roots within a controlled environment (Rubio-Asensio et al., 2018). This system is classified as near soilless, as the growing tree also utilizes the surrounding soil to some extent. By concentrating active roots within substrate bags, the influence of sodic soil as a medium for water and nutrient storage is minimized. The success of the OFH system in orchards largely depends on the proportion of the tree's root system that colonizes the substrate relative to its total root volume. Similar to other hydroponic systems, OFH aims to concentrate as many active roots as possible into the substrate bags, ensuring these roots are immersed in a balanced nutrient solution after each irrigation. This approach enhances the tree's water and nutrient use efficiency. Shallow-rooted, high-value fruit crops can be successfully cultivated in high-textured sodic soils using the OFH system, making it an ideal solution for challenging growing conditions. Following crops can be used for OFH system under high textured sodic soils. Citrus {Sweet orange (PR and PS), lemon (Pusa lemon-1), acid lime Pusa Abhinav, Pusa Udit, Balaji), grapefruit (Redblush and Marsh Seedless), Pummelo (Pusa Arun), Papaya (Red Lady), Strawberry (Chandler, Sweet Charlie), Dragon fruit (Both red and white flesh), Apple ber, Pomegranate (Bhagwa).

CONCLUSION

Extensive research across different regions has provided critical insights into the salinity tolerance of various horticultural crops. Moreover, advancements in genetics, along with the selection of salt-tolerant rootstocks for fruit and nut trees and the implementation of innovative technologies, offer promising solutions to enhance salinity resilience. While some data exist on the salt tolerance of common vegetables, there is surprisingly little quantitative research on most vegetable species. In particular, quantitative salt tolerance data remain limited for several major crucifers, including cauliflower, kale, Brussels sprouts, kohlrabi, cress, watercress, and rutabaga. Additionally, minor crucifers such as horseradish and sea kale have also received minimal attention in salt tolerance studies. Additionally, grafting in fruit and vegetable crops as a strategy to mitigate the negative effects of salinity should be explored more thoroughly.

REFERENCE

Qadir, M., Quillérou, E., Nangia, V., Murtaza, G., Singh, M., Thomas, R. J., et al. (2014). Economics of salt-induced land degradation and restoration. *Natural Resources. Forum* 38 (4), 282–295. doi: 10.1111/1477-8947.12054.

Zaman, M., Shahid, S. A., Heng, L., Shahid, S. A., Zaman, M., Heng, L. (2018). "Soil salinity: Historical perspectives and a world overview of the problem," in Guideline for Salinity Assessment, Mitigation and Adaptation Using Nuclear and Related Techniques. (Cham: Springer Nature), 43–53.

Shannon, M.C. and Noble, C.L., 1990. Genetic approaches for developing economic salt-tolerant crops. In: Tanji, K. (Ed.), Agricultural Salinity Assessment and Management. ASCE Manuals and Reports on Engineering No. 71, ASCE, New York, pp. 161-185

Shannon, M.C., 1996. New insights in plant breeding efforts for improved salt tolerance. *HortTechnology* 6, 96-99.

Davis T. D. and Hariyadi P. (2013). Horticultural research and education opportunities in Indonesia. *HortScience*, 48: 292-295.

Davis T. D. and Bost E. M., Byce C. N. (2017). Emerging horticultural research and education opportunities in Myanmar. *HortScience*, 52:1141-1144.

Lunin, J., Gallatin, M.H. and Batchelder, A.R. (1963). Saline irrigation of several vegetable crops at various growth stages I. Effect on yields. *Agronomy Journal*. 55, 107±114.

Smolders, E. and McLaughlin, M.J. (1996). Effects of Cl on Cd uptake by Swiss chard in nutrient solutions. *Plant and Soil*, 179, 57-64.

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Scope, status, challenges, and thrust areas for Coastal Horticulture

V. KANTHASWAMY, U. BAGAVATHI AMMAL, M. S. MARICHAMY, J. SHERLY, B. BAVITHRA and N. BAVYA

Department of Horticulture, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Affiliated to Pondicherry Central University, Karaikal-609603. U.T. of Pondicherry, India

E-mail: v.kanthaswamy@gmail.com

***Key Words**: Challenges, Coastal horticulture, Scope, Status, Thrust areas*

INTRODUCTION

India has got extensive coastline of about 8413 km covering 5778 km of mainland and 2635 km of island territories. India has a coastal line length of 8413 km is shared by 9 states (West Bengal, Orissa, Andhra Pradesh, Tamil Nadu, Kerala, Karnataka, Maharashtra, Goa and Gujarat) and 2 union territories *viz*., Puducherry and Daman and Diu and 2 groups of islands *viz*., Andaman-Nicobar and Lakshadweep-Minicoy group of islands and 3 megacities viz., Mumbai, Kolkata and Chennai. Coastal India with diverse soil and climate provide ample opportunity to grow a variety of horticultural crops which forms a significant part of total agricultural production in the country. Therefore, coastal horticulture, in addition to benefiting from favourable environmental conditions with generally good land, also benefits from sea communications for trade and for development of industry and tourism, which may provide markets for horticulture products.

MATERIALS AND METHODS

The coastal ecosystem offers vast scope for commercial use not only for a wide variety of fruit and vegetable crops, but also plantation crops, spices and medicinal plants. Plantation crops, like coconut, areca nut, oil palm, cashew, coco, spices ginger, turmeric, and seed spices like pepper, cumin, coriander, fennel, fenugreek are high-value commercial crops and coastal regions have a great scope to cultivate commercially for all those crops. Around 400 species contribute to global vegetable crop diversity (Arora, 2003). Medicinal and aromatic plants play important role in Indian traditional medicines. Development of multiple stress tolerant (salinity, submergence and mineral toxicity) varieties in horticultural crops for coastal saline areas should be the focus.

RESULTS AND DISCUSSION

Following are some points that make horticulture a suitable choice for coastal Agriculture

1. Horticulture for nutritional and livelihood security: Horticultural crops, particularly, fruits and vegetables are not only the source of vitamins, minerals, fat, proteins, carbohydrates, and dietary fibers, but eating them reduces the risk of diseases. Low intake of fruits and vegetables has been recognized as a top risk factor for global mortality by the World Health Organization. The people in the coastal agriculture system suffer significant micronutrient and protein deficiencies because of imbalanced dietary habits.
2. Wide crop selection choices: Horticulture with diverse group of crops offers a range of crop choices to the farmers for crop diversification in coastal agriculture. Availability of moisture throughout the year with excellent soil and climatic conditions facilitates cultivation of horticultural crops.
3. Broader adaptability: Many horticultural crops are hardy and well adapted to the adverse edaphic and climatic conditions where cereals and other crops fail to produce economic yields. Most of the coastal areas have problematic soils, *viz.*, saline, alkaline, acid sulphate, marshy, and waterlogged soils.
4. High profit: Horticultural crops are high-value low volume crops and provide good returns per unit area over other crops. Fruits and vegetables give 4-10 times the return than from other crop groups, namely, cereals, pulses, and oilseeds.
5. Employment generation: Cultivation of horticultural crop is labour intensive activity, hence, provides assured employment opportunities to the inhabitants of the coastal region.

Fruit production requires on an average 860 man-days per hectare per annum as against the employment generation of 143 man-days by cereal crops.

6. Income level of farmers from horticulture: India's horticultural production has surpassed that of all other agricultural sub-sectors, India is the second largest producer of fruits and vegetables globally.

7. Better foreign exchange: Horticultural crops fetch more foreign exchange per unit area than cereal crops due to high yields and higher prices available in the international market. Fruits & plantation crops earn 20-30 times more foreign exchange than cereal crops.

8. Complete utilization of natural resources: Diverse features of horticultural crops, *viz.*, growth habit, canopy pattern, root depth, and crop duration allows scope for multi-tier cropping system, which ensures efficient utilization of natural resources and gives better returns per unit area, per unit time, and per unit input over the monocropping.

9. Change in dietary habit of people: The food preference and the consumption pattern of Indians are shifting towards fruits and vegetables from a cereal based diet in the wake of urbanization, growing income, and health awareness. Total horticultural crop production during the year 2024 was 353.18 m. t from an area of 289.83 mha with a productivity of 12.19 t/ha (india.stat).

TECHNOLOGIES FOR PROMOTION OF COASTAL HORTICULTURE

1. Grafting for mitigating the salinity stress in vegetables
2. Hybrid technology for high productivity and quality in annual horticultural crop
3. Salinity resistant rootstocks for perennial horticultural crops
4. Quality planting material and seed production, advanced vegetative propagation in fruit crops
5. High density planting, hi-tech horticulture, protected cultivation
6. Use of digital science for transforming coastal horticulture, artificial Intelligence (AI)

CONCLUSIONS

Coastal region offers plenty of scope for horticulture. Generating new technologies and innovations to meet the emerging challenges by the public and private sectors needs to be encouraged through commensurate policies. Professionals, farmer producer organizations (FPOs), farmer producer companies (FPCs), self-help groups (SHGs), cooperatives and NGOs are to be effectively involved in scaling innovations with easy access to technology, policy, financial support and hand-holding from the research institutions. The application of digital technologies (Gill *et al*., 2017). which include remote sensing (satellites and drones), wireless sensors, internet of things are expected in providing newer solutions to the problems faced by the farmers in future.

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REFERENCES

Arora R.K. (2003) Genetic resources of underutilized vegetables and their regions of diversity. *Vegetable Science*. 30 (1): 1-9.

Gill, S. S., Chana, I., and Buyya, R. (2017). IoT based agriculture as a cloud and big data service: the beginning of digital India. *Journal of Organizational and End User Computing*. 29 (4) :1-23. https://www.indiastat.com/data/agriculture/horticulture

Nayar ER, Pandey A, Venkateswaran K, Gupta R, Dhillon BS (2003) Crop plants of India- checklist of scientific names. *National Bureau of Plant Genetic Resources*, New Delhi.

Ouillon S. (2018). Why and How Do We Study Sediment Transport Focus on Coastal Zones and Ongoing Methods. *Water*, 10, 390; doi:10.3390/w10040390 *Ministry of Statistics and Programme Implementation*, 2020. https://www.mospi.gov.in

Vision 2050: ICAR-Vision-2050 document of ICAR-Central Coastal Agricultural Research Institute (CCARI), Goa (2015). Published by ICAR, New Delhi.

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Agri-diversification and farming system approach for coastal and waterlogged ecosystems

K.G. MANDAL, SANJOY SAHA, A. SHAMNA, D. DATTA and G. KAR
Division of Crop Production, ICAR-Central Research Institute for Jute and Allied Fibres (CRIJAF), Barrackpore, West Bengal
E-mail: kgmandal@gmail.com, krishna.mandal@icar.gov.in

Abstract

India has a total land area of about 10.78 million ha which is under coastal ecosystems. Coastal areas belong to 84 districts in nine states and Union Territories including the islands. There is a large human population and faming households with a majority of small and marginal land holdings. Natural resource management in coastal ecosystems is very challenging because of multiple factors *viz*. rise of seas water level due to the impact of climate change, frequent occurrence of extreme weather conditions like storm surge, catastrophic flooding and waterlogging, water congestion, damage of crops and agricultural lands, seawater intrusion, the problem of soil salinity, scarcity of good quality water for irrigation during dry season cropping etc. Including coastal areas, as per reliable estimate, India is particularly prone to floods and the major flood-prone area is about 40 million ha, which is about 12.15% of 329 million ha of the geographic area, and waterlogged ecosystems of 11.5 million ha. It is a misery to about 113 million people i.e., about 9% of the population in India, Soils of those areas undergo cyclic anaerobic and aerobic conditions. Although soil is fertile and potentially productive in many areas of coastal ecosystems and waterlogged areas, average agricultural productivity is low. There is ample scope for improving the overall farm productivity and farmers' income in coastal areas. The strategic approaches in land management, water management, and cropping system intensification would enable diversification and eco-regional farming and the adoption of situation-specific farming systems. It is necessary finding appropriate crop planning, crop intensification and better crop management. Monitoring of soil organic carbon stocks, at least once in 3 years, reveals the status of soil health and sustainability of cropping. There are evidence-based technology options suitable for coastal areas and waterlogged ecosystems: i) land shaping- alternate raised and sunken bed technology for medium and low lands; this would enable crop diversification, especially in rice-based systems, and fostering intensification of cropping, thereby increasing both crop and water productivity, ii) farm pond-based crop intensification and integrated farming where fresh water can be harvested and stored in the ponds, pond water can be utilized for multiple purposes viz. irrigation to dry season crops, on-dyke horticulture, and fish culture in ponds; it is required to excavate new ponds in suitable sites and rejuvenation of existing farm ponds, then interlinking to reduce spatial variability in the availability of irrigation water, iii) development of auxiliary water storage tanks/ ponds in canal irrigated commands even in coastal areas to enable storage of rainwater, excess canal water delivered and intensification of cropping and/ or farming in the command areas, iv) suitable planting techniques for dry season crops for saving of irrigation water and thereby increasing area under irrigation. Likewise, to address the problem of water congestion in waterlogged areas, there is a need for a holistic approach integrating crop husbandry, horticulture, agroforestry, dairy and poultry farming, fish culture etc. For this, agri-diversification and integrated farming solution is the potentially suitable option.

Key Words: *Agri-diversification, Integrated farming, Coastal and waterlogged ecosystems*

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Silicon nutrition of rice in the coastal saline soils

SUKANTA KUMAR SARANGI[1], ASHISH KUMAR SRIVASTAVA[2], SUDHANSHU SINGH[2], HANUMAN SAHAY JAT[3] and PARBODH CHANDER SHARMA[4]
ICAR-Central Soil Salinity Research Institute, Regional Research Station, Canning Town, West Bengal – 743 329, India
[1]ICAR-Central Institute for Women in Agriculture, Bhubaneswar, Odisha, India,
[2]International Rice Research Institute, South Asia Regional Centre Varanasi, Uttar Pradesh-221106, India
[3]ICAR-Indian Institute of Maize Research, Ludhiana, Punjab, India;
[4]ICAR-Central Soil Salinity Research Institute, Karnal, Haryana, India
E-mail: S.Sarangi@icar.gov.in

Key Words: *Silicon, Susceptibility, Salinity*

INTRODUCTION

Silicon (Si) is a beneficial nutrient for rice as rice plants need Si to overcome abiotic and biotic stresses (Thakral *et al*., 2021). In the salt-affected, natural calamity prone coastal areas, the role of Si has been more prominent. Si nutrition reduces the rice plant's susceptibility to fungal (blast, brown spot) and bacterial diseases, insect (stem borers, plant hoppers) and mite pests. The soil of the Indo-Gangetic plain is rich in Si, but due to interaction with soil cation and anions, maximum Si gets converted into the insoluble salts.

MATERIALS AND METHODS

Field experiment on Si nutrition of rice was conducted in the coastal flood-prone and salinity affected region of West Bengal, India at ICAR-Central Soil Salinity Research Institute, Regional Research Station, Canning Town. The experiment consisted of *Kharif* followed by *Boro* rice in cycle for three *Kharif* (2019, 2020 and 2021) and two *Boro* (2019-20 and 2020-21) seasons. *Boro* rice was grown with the use of ground water irrigation and in all the crops, about 40% paddy straw was recycled in the soil in each treatment. The initial soil samples were having Si concentration of 28 – 33 mg Si per kg soil. The treatments during the *Kharif* Season were main plot with two varieties (V1: Tolerant: Amal-Mana, V2: Susceptible: Sabita). The sub plot had application methods, 100% basal with the recommended dose of fertilizers (RDF), 75% basal with RDF + 25% foliar at maximum tillering and 50% foliar spray during 10-12 days after waterlogging + 50% foliar spray before panicle initiation. The sub-subplot included Si fertilizer doses, 0 kg ha^{-1} (no Si), 105 kg sodium metasilicate ha^{-1} (24.20 kg Si ha^{-1}), 180 kg sodium metasilicate ha^{-1} (41.05 kg Si ha^{-1}), 220 kg sodium metasilicate ha^{-1} (50.06 kg Si ha^{-1}) and 270 kg sodium metasilicate ha^{-1} (62.10 kg Si ha^{-1}). The treatments for rabi season was two varieties (tolerant: Canning 7 and susceptible: IR 29) in main plot; application methods: 100% basal with the recommended dose of fertilizers (RDF), 75% basal with RDF + 25% foliar at maximum tillering and 50% foliar spray during 10-12 days after waterlogging + 50% foliar spray before panicle initiation in sub plot. Sub-subplot consisted Si fertilizer doses 0 kg ha^{-1}, 75 kg sodium metasilicate ha^{-1}, 105 kg sodium metasilicate ha^{-1}, 170 kg sodium metasilicate ha^{-1} and 230 kg sodium metasilicate ha^{-1}. Experimental design was split-split plot with three replications; source of Si was sodium metasilicate (23% Si) for both *Kharif* and *Rabi* seasons. During the *Boro* season of 2020-21, on-farm trial was conducted to study the response of *Boro* rice varieties to Si application. The study was conducted in five farmers' fields in South 24 Parganas district of West Bengal. Silicon in the form of sodium meta silicate was provided to the farmers for use in the field trials. Four high yielding rice varieties viz. Hy 22/64, WGL 20471, Hy 555 and Banshkati were used in the study.

RESULTS AND DISCUSSION

During the *Kharif* 2019, the grain and straw yields were significantly affected by the silicon dose. Due to the application of silicon fertilizer the grain and straw yield were increased from 11-24% and 8-16%, respectively. However, the grain yield response was upto 50 kg Si ha^{-1}. During *Kharif* 2020, highest grain yield of 6.02 t ha^{-1} was observed with application of highest dose of 62 kg Si ha^{-1}. Observation on lodging tolerance was recorded by a prostate tester at maturity. The lodging tolerance of Amal-Mana was 0.31 kg cm^{-1}, which was higher than Sabita (0.21 kg cm^{-1}). However, the lodging tolerance was at par (0.27 kg cm^{-1}) with 50 and 62 kg Si ha^{-1}. During *Kharif* 2021, the lodging tolerance of Amal-Mana was 0.37 kg cm^{-1}, which was higher than Sabita (0.22 kg cm^{-1}). The lodging tolerance of rice increased with increasing dose of silicon fertilizer. However, the lodging tolerance was at par (0.32 kg cm^{-1}) with 50 and 62 kg Si ha^{-1}. The effect of Si doses on third year (fifth season) rice crop was found

non-significant. This may be due to gradual buildup of Si in the soil due to retention of crop residues (paddy straw) and use of ground water as irrigation sources for *Boro* rice cultivation. Si concentration in the control plots was found more than 40 mg Si per kg soil. During the *Boro* season 2019-2020, out of the two varieties, Canning 7 produced grain yield of 6.26 t ha^{-1}, significantly higher than IR 29 (4.19 t ha^{-1}). The difference in grain yield due to methods of application of silicon was non-significant. Application of Si through all foliar spray, basal+foliar spray and all basal resulted in 5.25, 5.20 and 5.23 t ha^{-1} grain yield respectively. The grain yield of IR 29 increased from 3.69 t ha^{-1} without Si application to 4.87 t ha^{-1} with application of 53 kg Si ha^{-1}. In Canning 7, the grain yield increased from 5.46 t ha^{-1} without Si application to 7.00 t ha^{-1} with application of 53 kg Si ha^{-1}. The mean grain yield response due to 0, 17, 24, 39 and 53 kg Si ha^{-1} was 4.58, 5.00, 5.07, 5.54 and 5.94 t ha^{-1} respectively. During the *Boro* season of 2020-21, the average grain yield of rice ranged from 6.20 – 7.25 t ha^{-1} in control plots, whereas in Si applied plots the grain yield ranged from 7.12 – 8.62 t ha^{-1}. There was about 18.9% increase in yield of *Boro* rice due to application of 150 kg sodium metasilicate per hectare. It was found that application of 34.5 kg Si ha^{-1} could efficiently minimize the soil salinity effect and result 12-24% higher grain yield over the control plot (without Si fertilizer application).

CONCLUSION

The response to Si application was pronounced during the *Boro* season, when salinity is a problem and higher doses of N fertilizer is required to be applied for high yielding and hybrid rice grown during this season. Continues rice straw (40% or more) recycling for four seasons and ground water irrigation during *Boro* season resulted in non-significant difference between silicon dose treatments. Therefore, in Si deficient soils during the initial years, Si fertilizer application may be recommended along with paddy straw recycling. Ground water irrigation for *Boro* rice cultivation also adds Si to soil and Si fertilizer application may be discontinued after four seasons.

REFERENCE

Thakral, V., Bhat, J.A., Kumar, N., Myaka, B., Sudhakaran, S., Patil, G., Sonah, H., Shivaraj, S.M. and Deshmukh, R. (2021). Role of silicon under contrasting biotic and abiotic stress conditions provides benefits for climate smart cropping. *Environmental and Experimental Botany*, Volume 189, 104545, https://doi.org/10.1016/j.envexpbot.2021.104545.

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Challenges and opportunities of crop intensification in rice – fallow system under coastal agro-ecosystem

HIRAK BANERJEE

Regional Research Station (Coastal Saline Zone), Bidhan Chandra Krishi Viswavidyalaya, Akshaynagar, Kakdwip, South 24 Parganas, West Bengal-743347, India

E-mail: banerjee.hirak@bckv.edu.in

Key Words: *Coastal Area, Crop Production, Mono-Cropping, Salt Deposition, Soil Variability*

INTRODUCTION

Rice-fallow is a monocropped rice–based production system where *kharif* paddy grown areas are kept fallow in *rabi* season. In India 82% of these area is concentrated in the eastern states including Chhattisgarh, Jharkhand, upper Assam, Bihar, eastern UP, Odisha and West Bengal.

BIO-PHYSICAL CONSTRAINTS

Soil variability is the major concern in coastal areas of India. Existence of different types of soil is found in different corners of coastal belt, that includes saline soil, saline-alkali soil, non-saline alkali soil and degraded saline soils. Characteristically they are quite different from each other, as depicted by pH range of 4.5 to 9.0 and EC of 2.5 to 20.0. Temporal variability of soil salinity in coastal region is also very common which poses great problem in crop cultivation, particularly during *rabi* season. Furthermore, cultivation of field crops is also constrained by biophysical factors like deep water-logging and drainage congestion, poor physical condition of top soil due to puddling in *kharif* season, higher runoff and low soil moisture storage capacity and salt deposition in upper layer of soil in dry season.

IMPACT OF CLIMATE CHANGE

Impact of climate changes in coastal area has become quite prominent in recent times. Consequent to this, sea level rising (SLR) would lead the salt water intrusion in coastal areas impacting agriculture and degrading ground water quality. It has been proved that 1.0 m rise in sea level will displace > 5000 square km of land. Storm surges are also the major cause of coastal flooding and it is more vulnerable in east coast India due to higher frequency and magnitude of tropical cyclone.

PRODUCTION AND SOCIO-ECONOMIC CONSTRAINTS

The production of crops is limited due to many reasons like cultivation of traditional (tall, photoperiod sensitive, late maturing) *kharif* rice varieties, lack of suitable quality seeds of short-duration varieties of pulses/oilseeds for rice–fallows, delay in sowing during dry season, poor plant stand due to poor soil-seed contact in relay sowing, higher disease pest incident like lentil rust and chickpea wilt, severe weed infestation in dry season including parasitic weeds, and finally, moisture stress and terminal drought. The key socio-economic constraints include resource-scarcity at farmer's end, lack of credit and market infrastructure, non-availability of critical input, migration of human labours and lack of farm-mechanization.

TECHNOGICAL INTERVENTIONS

In order the intensify cropping pattern in coastal areas, the only option left with us is to adopt improved field-based technologies. These include cultivation of suitable high yielding varieties of rice and pulses, adoption of appropriate water harvesting and irrigation management practices, rice stubble retention for conserving soil moisture, adopting relay cropping system, use of bio-fertilizer *viz. Rhizobium,* PSB and bio-stimulant (Seaweed extract), seed treatment with VAM and seed priming materials, foliar spray of 2% urea/DAP at pre-flowering stage for enhancing seed yield, crop diversification with non-rice crops and nutri-cereals, adoption of farm mechanization and strategic climate resilient agricultural practices. Strategic water management in coastal area is also need of the hour, which may include construction of farm pond/ community water reservoirs, in-situ water harvesting in farmland, leaching off surface salt into deeper soil profile, ground water recharge and life-saving irrigation to the succeeding crops. In rice-fallows, efficient conservation practices can mitigate moisture-related stress, terminal drought and enhanced productivity and soil quality. In this context, improved land management practices related to zero tillage, crop residue incorporation, reduce/minimum tillage and soil surface covering/mulching can be adopted. Crop diversification shows lot of promise in alleviating the constrains in rice fallow areas through withstanding weather aberrations, ensuring balanced food supply and conserving natural resources. Introduction of pulse and oilseeds in cropping systems is urgently needed not only for proper utilization of residual soil moisture of rice-fallow but also for food and nutritional security. Adoption of relay cropping/ inter cropping in rice-fallow system can be profitable. Impact of different land shaping models on cropping pattern in selected clusters of villages under coastal saline environment has already been proved effective. Adoption of INM is the key for maintenance or adjustment of soil fertility and plant nutrient supply through optimization of the benefits from all possible sources of plant nutrient in an integrated manner. Finally, climate-resilient contingency measure for coastal region of India must have to be adopted to intensification of rice – fallow system.

CONCLUSION

Besides technological interventions, government initiatives have also to be popularized through supply of critical inputs and capacity buildings of farmers for implementation of rice-fallow intensification programmes.

REFERENCE

Banerjee, H., Ray, K., Alipatra, A., Nayak, J., Pahari, A. and Banik, A. (2023). Crop selection and management strategies to combat weather related vagaries in coastal Bengal. *SATSA Mukhapatra – Annual Technical Issue* 27: 134-144.

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Impact potassium and calcium application on groundnut yield under moisture stress

K.V. NAGA MADHURI [1], CH. BHARGAVA RAMI REDDY[1], P. LATHA[2], K. JOHN[3], M. MADHAN MOHAN[1] and G.P. LEELVATHI [1]

[1]Department of Soil Science, Acharya N.G. Ranga Agricultural University, Regional Agricultural Research Station, Tirupati.,

[2]Crop Physiology, RARS, Tirupati,

[3]Plant Breeding, RARS, Tirupati

E-mail: kv.nagamadhuri@angrau.ac.in

Key Words: *Groundnut, Moisture Stress, Potassium And Gypsum Application, Yield*

INTRODUCTION

Groundnut yields are limited during drought in Southern region of Andhra Pradesh. There is a dire need to re-visit fertilizer recommendations during water stress condition. Potassium has been found to influence water status in crops and also effect uptake of other major, secondary and micro nutrients.

Studies in India to determine dosage of K under drought conditions are less and hence the present research was under taken to fix the optimum dose, time of application of both potassium as well as gypsum on yield of groundnut. It should be noted that K application has improved yields under water stress condition in wheat, rice and other crops.

MATERIALS AND METHOD

The present experiment was conducted in three replications with spli plot design comprising gypsum and no gypsum as main plots and K doses and time of application as sub plots. Sub plots comprised of seven treatments viz., T1: 100 % Recommended K, T2: 125% Recom. K, T3: 150% Recom. K, T4: 50% Recom.K as basal + 50% at 30 DAS, T5: 100% Recom. K as basal + 25% at 30 DAS, T6: 100% Recom. K as basal + 50% at 30DAS, T7: No potassium. All the treatments were maintained both under irrigated and moisture stress situation. Moisture stress was given for 40 days form 40 days after sowing. The test variety used in the present study was K6. The crop was harvested at maturity and pod yield was recorded after proper drying and expressed as kg ha^{-1}.

RESULTS AND DISCUSSION

The pod yield was significantly influenced by the treatments imposed to the crop. The moisture stress imposed for 40 days from 40 DAS to 80 DAS significantly reduced the pod yield of groundnut. The higher pod yiled was recorded under irrigated conditions (2536 kg ha^{-1}) as compared to stress condition (1570 kg ha^{-1}). However, application of gypsum did not show any influence on pod yield either under irrigated or moisture stress. Much research has been carried out on groundnut fertilization in India leading to a recommendation of 80-100 kg of K for optimal yields. Some studies also focused on timing of fertilizer application and demonstrated that split application of K significantly improved yields when compared with single basal application (Chitdeshwari *et al.,* 2007; Borah *et al.,* 2017). Umar et al. (1999) suggested foliar application of potassium as 1 % KCl on groundnut increased nutrient uptake and yield.

Basal K application is necessary for groundnut as it complements N and P uptake about each stage of crop development. Also, it promotes root proliferation, thus extending plant water acquisition from the soil. Never the less, the capacity of the young crop to to take up the whole seasonal K dose is very limited. Therefore, most of the K dose, if basally applied, may be lost through leaching or fixation, and will not be available to the crop at later developmental stages, when K demands surge. Pod yield was influenced by all K fertilization treatments as compared to control. However, the high K rates did not have any influence on improving the pod yield under both irrigated and moisture stress conditions. The split application of potassium viz., 50 % as basal and 50% K at 30 DAS, however, resulted in significant increase in pod yield (2189 kg ha^{-1}) as compared to no application of K (1714 kg ha^{-1}). Splitting K dose into two applications, basal and upon bloom, provides the groundnut crop with more appropriate K quantities throughout the season, precisely when required. The advantages of split K application, which was demonstrated in several previous studies, has therefore also been confirmed in the present experiment; the split K application gave rise to greater pod numbers and yields, and to higher kernel eight. More recent studies on groundnut crops in India (Borah *et al*., 2017; Sanadi *et al*., 2018. Patra *et al.*, 2018) also support these results.

CONCLUSION

Under both irrigated as well as moisture stress at the recommended K dose, particularly under split K application, brought about a significant increase in yield of 30%. Hence, split application of K *viz.*, 50% as basal and 50% at 30 DAS can be given as general recommendation to the farmers.

REFERENCES

Chitdeshwari, T., P.K. Selvaraj, and P.M. Shanmugam. 2007. Influence of Levels and Split Application of Fertilizers on the Yield and Nutrient Uptake by Groundnut. *Agricultural Science Digest* 27(2):91-94.

Borah, B., D.S. Patil, and Pawar, R.B. 2017. Enhancing Kharif Groundnut (Arachis hypogaea L.) Y ield a nd Q uality i n Entisol through Potassic Fertilizer Management. *Int. J. Curr. Microbiol. App. Sci. 6*(11):4068-4074. doi: https://doi. org/10.20546/ijcmas.2017.611.476.

Patro, H.K., G. Sahoo, B. Behera, A.K. Senapati, N.K. Awasthi, S.K. Bansal, S.N. Jena (, N. Prusty, and A. Panda. 2018. Effects of Potassium Application Regime on Productivity and Drought Tolerance Parameters of Groundnut (Arachis hypogaea L.) in Odisha, India *Resarch findings*, IIP, 25-35

Sanadi, U., K.K. Math, B.I. Bidari, and B.S. Yenagi. 2018. Effect of Potassium Nutrition on Yield, Quality and Economics in Groundnut (Arachis hpogaea L.) in a Vertisol. *J. Pharmacognosy and Phytochemistry* 7(2):220- 222.

Umar, S., and Moinuddin. 2002. Genotypic Differences in Yield and Quality of Groundnut as Affected by Potassium Nutrition under Erratic Rainfall Conditions. *J. Plant Nutr.* 25:1549-1562.

Table 1: *Effect of Potassium and Calcium on pod yield of groundnut*

Treatments	**Pod Yield (kg ha^{-1})**		
Main plots/Subplots	**Irrigated**	**Stress**	**Mean**
No Gypsum	2525	1560	2042
Gypsum	2546	1579	2062
Mean	**2536**	**1570**	
Main plots	*Sig		
Sub plots	NS		
K levels (Sub-sub plots)			
T1:100% Recommended K	2549	1597	2073
T2: 125% Recom. K	2567	1511	2039
T3: 150% Recom. K	2468	1595	2032
T4: 50% Recom K as basal + 50% at 30DAS	2685	1693	2189
T5: 100% Recom. K as basal + 25% at 30DAS	2657	1615	2136
T6: 100% Recom. K as basal + 50% at 30DAS	2715	1658	2187
T7: No potassium	2107	1320	1714
Mean	**2535**	**1570**	
Sub-Sub	*Sig	*Sig	
MxSxSS	*Sig		

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Securing food systems in the Ganges delta through improved technological interventions

D. BURMAN[1*], T.D. LAMA[1], U.K. MANDAL[1], R.N. BHUTIA[1], P. BHARTI[2], S. MALLICK[1], DEVIKA S[1]., N. KAWARAZUKA[3], S. CHAUDHARI[3] and N.R. PRAKASH[4]

[1]ICAR-CSSRI, RRS, Canning Town- 743329, West Bengal, India

[2]International Rice Research Institute, Bhubaneswar - 751007, Odisha, India

[3]International Potato Center, Hanoi, Vietnam

[4]ICAR-CSSRI, Karnal- 743329, Haryana, India

E-mail: burman.d@gmail.com

Key Words: *Cropping System Intensification, Food Security, Resource Conservation, Ganges Delta*

INTRODUCTION

The Ganges Delta is highly fragile and vulnerable to climatic hazards and environmental degradation due to its geographical setting and anthropogenic activities. Salinization and waterlogging are the predominant land degradation processes affecting this region (Burman et al., 2015). These challenges, combined with adverse climatic conditions, contribute to poor livelihood security and low agricultural productivity. Enhancing rural livelihoods through sustainable, agriculture-based solutions in these marginal areas is, therefore, a utmost priority. There are significant opportunities for cropping system intensification through efficient water management, optimized crop calendars, and improved agronomic practices (Mandal et al., 2019). This study focuses on the Indian Ganges Delta, aiming to develop improved agricultural practices through farming system intensification, tailored to local contexts for increased climate resilience.

MATERIALS AND METHODS

The study was conducted from 2023 to 2024 across six clusters, three in the Hasnabad block of North 24 Parganas District and three in the Basanti block of South 24 Parganas District, covering one to two villages per cluster. The interventions focused on promoting salt-tolerant and improved varieties of rice, jute, and mustard, along with zero-tillage potato cultivation using paddy straw mulching. Additionally, innovative land-shaping techniques were implemented for soil and water management.

Improved homestead production systems (HPS) were introduced, integrating vegetable cultivation and scientific aquaculture. To enhance the capacity of small and marginal farmers, training programs on advanced agricultural and aquaculture practices were conducted.

RESULTS AND DISCUSSION

Field trials were conducted in farmers' fields across different locations in South and North 24 Parganas districts to assess the performance of improved varieties of rice (Pratikshya, Super Shyamali, CR-1017, Mali-4), jute (JROG 1, CO 58, JRO 204, S 19), and mustard (CS 60, CS 5). Results indicated a significant yield advantage with improved varieties. The adoption of improved varieties and better crop management practices in the rice-mustard-jute cropping system resulted in a 30.1% increase in Rice Equivalent Yield (REY) in the salt-affected coastal regions of the Ganges Delta.

Participatory Varietal Selection (PVS) trials were conducted to identify the most preferred rice varieties for the Ganges Delta region. Farmers evaluated different genotypes based on key traits such as long panicles, lodging resistance, high yield, a greater number of grains per panicle, lower incidence of pests and diseases, and good grain quality. Based on preference scores, Mali-4, CR-506, CR-508, and Santoshi emerged as the most favored varieties. Conversely, the genotypes Ambika, SR26B, CR-409, and Gitanjali were identified as low-performing based on farmer preferences.

Zero-tillage (ZT) potato cultivation with paddy straw mulch, introduced to 467 households, has demonstrated significant advantages over conventional tillage (CT). ZT reduced labor by 42%, cut synthetic fertilizer use by 50%, and lowered irrigation water demand by 46% while maintaining comparable yields (ZT: 29.98 t ha, CT: 29.13 t ha). Additionally, adopting ZT enables earlier planting and harvesting of potatoes, creating an opportunity for triple cropping. This allows farmers to cultivate a third crop, such as green gram, within the same growing season, further enhancing land productivity and income.

The intensification of the homestead production system (HPS) was achieved through the introduction of improved vegetable crops and scientific aquaculture practices in two villages of the Ganges Delta. This intensification led to an increase in gross farm income, ranging from Rs. 10,592 to Rs. 35,900 per household, with an average income of Rs. 21,018. Farmers earned between Rs. 4,710 and Rs. 24,180 from the marketable surplus, with an average income of Rs. 11,904. The homestead farm diversity index varied from 0.32 to 0.99 (mean: 0.56), while commercialization diversity index ranged from 0.03 to 0.85 (mean: 0.59), reflecting differences in the extent of market-oriented farming among households.

The performance of three fish culture systems in homestead ponds: (T1) 100% Indian Major Carps (IMC), (T2) 50% IMC and 50% monosex tilapia, and (T3) 100% monosex tilapia were assessed. IMC showed higher absolute growth, specific growth rate % and performance index value when cultured with tilapia, while tilapia performed best in monoculture. The highest production was in T1 (925.02 kg/ha), followed by T2 (801.76 kg/ha) and T3 (720.05 kg/ha). Polyculture of IMC (T1) was the most profitable (₹64,000 net return, BC ratio 3.24). Water quality parameters remained optimal across treatments, supporting freshwater species. These results highlight the economic and ecological benefits of IMC polyculture.

Innovative climate-resilient land-shaping technology has been successfully implemented to transform lowland rice landscapes. This approach enhances water availability by harvesting rainwater, mitigates salinity (by 40-60%), and reduces drainage congestion. By enabling integrated year-round farming, land shaping significantly boosts farm income (by 6-9 times) for small and marginal farmers, ensuring greater sustainability and resilience against climate variability.

Capacity development programs were organized for small and marginal farmers to enhance their knowledge of good agronomic practices and scientific aquaculture techniques. These initiatives aimed to strengthen their ability to adopt climate-resilient technologies, ensuring sustainable food systems in the Ganges Delta.

CONCLUSIONS

The study demonstrates that technological interventions, such as high-yielding crop varieties, resource conservation technologies, and improved homestead production systems, significantly enhance income and food security for farming communities in the climatologically vulnerable Ganges Delta. Diversifying cropping systems not only ensures food, nutrition, and income security but also mitigates risks from climatic adversities, contributing to farm income stabilization.

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REFERENCES

Burman, D., Mandal, S., Bandopadhyay, B.K., Maji, B., Sharma, D.K., Mahanta, K.K., Sarangi, S.K., Mandal, U.K., Patra, S., De, S., Mandal, B., Maitra, N.J., Ghosal, T.K. and Velmurugan, A. 2015. Unlocking production potential of degraded coastal land through innovative land management practices: a synthesis. *Journal of Soil Salinity and Water Quality* 7(1): 12-18.

Mandal, U.K., Burman, D., Bhardwaj, A.K., Nayak, D.B., Samui, A., Mullick, S., Mahanta K.K., Lama, T.D., Maji, B., Mandal, S., Raut, S. and Sarangi, S.K. 2019. Waterlogging and coastal salinity management through land shaping and cropping intensification in climatically vulnerable Indian Sundarbans. *Agricultural Water Management*. 216: 12-26.

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Improvement for multiple abiotic stress tolerance in rice under changing climatic scenario in coastal ecological perspective

K. CHATTOPADHYAY*, PREETHI B., K. CHAKRABORTY

ICAR-Central Rice Research Institute

Cuttack, Odisha- 753006

E-mail: k.chattopadhyay@icar.gov.in, krishnenducrri@gmail.com

Key Words: *Salinity Stress, Stagnant Flooding, Combined Abiotic Stress Tolerance, Coastal Agriculture*

INTRODUCTION

Abiotic stresses, such as drought, salinity, heat, and cold, are major limiting factors affecting crop production both qualitatively and quantitatively (Bashir et al., 2019). These threats are likely to become even more significant under climate change. The Indian Network for Climate change Assessment projected the climate scenario for 2030s that the magnitude of increase in annual minimum and maximum temperature along the eastern and western coastal regions was estimated to be 2.0 - 4.5^{0}C and 1.0 - 3.5^{0}C respectively. This will lead to erratic rainfall, in consequence to that rice crop in the same season would experience drought, submergence, stagnant flooding apart from salinity stress in coastal areas. Rice is grown in coastal areas in West Bengal, Odisha, Andhra Pradesh, Tamil Nadu, Puducherry, Kerala, Karnataka, Goa, Maharastra and Gujarat. Apart from salinity, rice frequently faces the other abiotic stresses such as submergence, stagnant flooding, cyclonic condition and also drought (Chattopadhyay et al. 2021). Intensity of crop damages sometimes goes high due to multiple abiotic stresses which occur in isolation or in combination. The frequency of occurrence of multiple stresses is also increasing at a higher rate under the changing climatic scenario. Cultivation of multiple stress tolerant rice varieties is become inevitable for maintaining sustainability in the coastal ecology in India.

GERMPLASM AND VARIETIES WITH MULTIPLE STRESS TOLERANCE

To identify multiple stress tolerant germplasm a diverse set of germplasm were evaluated by Chakraborty et al (2023) to identify multiple abiotic stress-tolerant donors for rice improvement. The experiment was conducted during 2018–21 at ICAR-National Rice Research Institute, Cuttack, Odisha A few lines were detected in that study (Table 1). A number of other investigations were also conducted by researchers in recent past and a few germplasm were identified with multiple abiotic stress tolerance.

COMBINED STRESS TOLERANCE FOR COASTAL ECOLOGY

Submergence with saline water:

Gas films impart submergence tolerance both under saline and non-saline floodwater conditions. Sarkar and Ray (2016) observed no difference between saline (12 dS m^{-1}) and non-saline (0.17 dS m^{-1}) floods; FR13A, tolerant to submergence but susceptible to salinity showed similar survival under both the situations. *Sub1*-mediated quiescence strategy complemented by higher tissue tolerance ability could be more suitable mechanistic acclimation than ion exclusion under saline water submergence in rice.

Stagnant flooding with saline water:

Combined submergence and salinity stress, common in coastal regions, presents a compounded challenge. The dual stresses impact seed germination, plant biomass, and chlorophyll content more severely than each stress alone. A land race Rashpanjar was found tolerant to saline water under partial submerged condition. Well-developed constitutive aerenchyma in Rashpanjar provided an adaptive advantage during partial submergence due to saline water flooding in rice (Chakraborty *et al.,* 2021).

DEVELOPMENT OF MULTIPLE STRESS TOLERANT VARITIES FOR COASTAL ECOLOGY

CR Dhan 412 (NICRA Dhan: Luna Ambiki) was released and notified for Odisha in 2020-21 for cultivation in coastal saline areas. It was derived from Gayatri/ SR 26B cross. CR Dhan 412 was also found tolerant to moderate salinity stress (EC 4-7 dS m^{-1}) and also moderately tolerant to stagnant

flooding. CR Dhan 414 (IET 27051) has been released and notified for cultivation in coastal areas of Odisha, West Bengal and Andhra Pradesh. It has multiple stress tolerance. It was found tolerant to moderate salinity stress (EC 4-7 dS m^{-1}) and also moderately tolerant to stagnant flooding and osmotic stress. The mean grain yield was found around 4.5 t/ha.

CONCLUSION

Understanding the physiological and molecular mechanisms underlying tolerance to submergence and salinity is crucial for effective breeding. By integrating physiological insights with advanced breeding techniques, it is possible to accelerate the development of rice varieties capable of thriving under the combined stresses of complete and partial submergence and salinity, ensuring sustainable rice production in the face of climate change.

Table 1. *List of germplasm with multiple abiotic stress tolerance*

Combination of stress	Promising genotypes
Drought + Submergence	IC-516366, Gurjari, AC-38209, AC-35678, Mahulata, IC-516008, IET- 18727, EC-305939, IC-516149 and IET-18208
Drought + Anaerobic germination	IET-18716, PAU-9, Khandagiri, IC-516149, Arnnapurna and Sahabhagi dhan
Drought + Submergence + Anaerobic germination	IC-516 149

REFERENCES

Bashir, K., Matsui, A., Rasheed, S., Seki, M. (2019). Recent Advances in the Characterization of Plant Transcriptomes in Response to Drought, Salinity, Heat, and Cold Stress. *F1000 Research* 8:658. doi: 10.12688/f1000research.18424.1.

Chakraborty, K., Ray, S., Vijayan, J., Molla, K.A., Nagar, R., Jena, P. et al. (2021). Preformed aerenchyma determines the differential tolerance response under partial submergence imposed by fresh and saline water flooding in rice. *Physiologia Plantarum*, 1–19. https://doi.org/10.1111/ppl.13536

Chakraborty, K., Roy, S., Jena, P., Dash, G.K., Barik, M., Behera, M., Sar, P., Senapaty, J., Baig, M.J., Swain, P. (2023). Identification of multiple abiotic stress tolerant donors for climate-resilient rice (*Oryza sativa*) development. *Indian Journal of Agricultural Sciences* 93 (3): 258–262, https://doi.org/10.56093/ijas.v93i3.132345.

Chattopadhyay, K., Marndi, B.C., Chakraborty, K., Bose, L.K., Poonam, A., Molla, K., Jakkeral, S.A., Vighneswaran, V., Manohara, K.K., Thirumeni, S., Rao, K.R., Sarkar, K.R. (2021). Challenges in rice improvement for the coastal ecosystems of India under changing climatic scenario. In Advances in Rice Breeding: Stress Tolerance, Climate Resilience, Quality & High Yield (eds. Pradhan et al.), ICAR-National Rice Research Institute, Cuttack, Odisha, India, pp. 128-143.

Sarkar, R.K., Ray, A. (2016). Submergence-tolerant rice withstands complete submergence even in saline water: Probing through chlorophyll a fluorescence induction O-J-I-P transients. *Photosynthetica* 54: 275–287.

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Advances in the management of agriculture for abiotic stress in the coastal acid saline soils of Kerala

A. K. SREELATHA*, VEENA VIGHNESWARAN, DEEPA THOMAS, S.J SREEJA and DEEPTHY ANTONY

Rice Research Station, Kerala Agricultural University, Vyttila P.O, Kochi-682019, Kerala, India

E-mail: seelatha.ak@kau.in

Key Words: *Pokkali, Acid Saline, Rice, Prawn, IFS, Abiotic Stress*

INTRODUCTION

The long coastline of about 580 km in the state has sixteen backwaters linked to the sea covering an area of 650 km^2. Most of the coastal lands, deltaic areas at river mouths and reclaimed backwaters are either at sea level or 1.0 to 1.5 m below Mean Sea Level (MSL). As a result, sea water intrudes up to a distance of 10 to 20 km upstream during high tides. The special zone for problem areas lies on the coastal line covering an area of 4,28,540 ha. The saline soils of Kerala occur in this periodically saline water inundated lands, Saline hydromorphic soils are usually seen within the coastal tracts of the districts of Ernakulam, Alappuzha, Thrissur and Kannur covering an area of the origin, genesis and development of these soils have been under peculiar physiographic conditions. They are, therefore, not comparable with the saline soils occurring in other parts of the country or the globe. *Pokkali* lands are known after

the *Pokkali* type of cultivation and are located in Ernakulam, Thrissur and Alappuzha districts. Kaipad tract is seen spread in the north Malabar districts of Kerala, India, in Kozhikode, Kannur, and Kasargod districts near to Arabian Sea. The traditional organic rice cultivation and shrimp farming (rainfed rice-saline fish/prawn system) practised in the wetlands of Ernakulam, Alappuzha Thrissur districts (Pokkali), and Kannur (Kaipad) is one of the most eco-friendly farming practices in the world. The area under Pokkali farming is decreasing at an alarming rate due to the non-availability of farm workers, high labour wages, climate change, non-availability of quality seeds of high-yielding or potential multi-stress tolerant varieties, etc. Development of abiotic stress tolerant rice varieties, management of salinity and acidity with agronomic practices, integrated farming system *etc.* will boost the production and productivity.

MATERIALS AND METHODS

Research interventions to revive the organic Pokkali cultivation include crop improvement for abiotic stress, management of salinity and acidity with suitable ameliorants, development of saline tolerant PGPR, mechanization, an integrated farming system with new enterprises, etc.Salinity, acidity and submergence are the complex abiotic stress problems faced in the Pokkali ecosystem. Biotic stresses like pest and disease attacks are below the threshold level in Pokkali. Advanced molecular breeding research like marker-assisted breeding in rice and introgression of the Saltol gene is being conducted. This study of the underlying mechanisms in the different valuable Pokkali landraces and the pyramiding of these different mechanisms into a single rice variety is also envisaged. The search for new saline-tolerant genes/QTLs of their existing landraces in the germplasm is another area of research.

RESULTS AND DISCUSSION

Rice Research Station, Vyttila of Kerala Agricultural University, took up concerted efforts and developed 11 abiotic stress-tolerant varieties for this ecosystem. Introgression of abiotic stress-tolerant genes/QTLs like Saltol and Sub1 genes into three popular rice varieties, viz., Uma, Jyothi, and Jaya, was done. The abiotic stress-tolerant QTL introgressed lines are intended to be cultivated in all saline-prone areas of Kerala including salt-intruded areas of Kuttanad and Kole lands. A scientific investigation conducted at the Rice Research Station, Vyttila, revealed that the Pokkali bran was nutritionally rich in bran oil and antioxidants like oryzanol (202.9 mg 100 g^{-1} bran), tocopherol (2.26 mg 100 g^{-1}bran), tocotrienols (5.13 mg 100 g^{-1}1 bran) etc. as compared to the most popular varieties like Jyothi and Uma in the region Sreelatha and Shylaraj,2017). Mechanization in Pokkali farming has so far remained confined to threshing since the unfavourable soil physical conditions restrict the use of normal machinery. Forming ridges instead of the traditional mounds for sowing the seeds not only saves labour costs but gives almost equal yield. It has been brought out that 30 cm high-ridge constructed 40 cm apart are equally good as the traditional mounds with garden tillers. Pokkali farming avoids the use of chemical inputs to maintain its organic integrity and to prevent adverse effects on succeeding prawn farming, there is an urgent need to explore eco-friendly alternatives for restoring and enhancing soil fertility. The use of plant growth-promoting rhizobacteria offers a promising solution, as these microbes can improve nutrient availability, counteract the effects of salinity, and boost plant growth naturally. A saline-tolerant microbial consortia specific to Pokkali soils has been developed to mitigate the adverse effects of salinity while promoting sustainable agricultural practices in these regions. Integrated farming systems with new enterprises like duck in floating duck cages and vegetable cultivation with drip fertigation in the raised bunds of Pokkali fields have been developed. Integrated farming system models developed for the Pokkali ecosystem will help in sustainable income and improved food security. Integrated farming systems such as paddy-fish-based rotational ecosystems have been identified as effective means for ensuring the resilience of extremely climate-vulnerable fragile regions such as coastal wetlands (Ramachandran *et al.*, 2023).

CONCLUSIONS

Pokkali, a natural organic farming system in the coastal areas of Ernakulam, Thrissur and Alappuzha, is facing severe threats due to the unavailability of farm workers, especially for harvesting, high labour wages, low income from rice and intensive aquaculture activities. The 11 saline-tolerant varieties developed by Kerala Agricultural University with higher yields are supposed to revive Pokkali cultivation. The mechanisation of Pokkali cultivation, especially harvest, will attract more farmers to pursue rice cultivation followed by prawn farming. Adoption of the integrated farming system with multiple enterprises will revive the *Pokkali* farming.

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REFERENCES

Ramachandran, C., Shinoj, P., Gills, R., Anuja, A.R., Padua, S., Ratheesh Kumar, R. and Rajesh, N., 2023. Ecosystem services of coastal wetlands for climate change mitigation: an economic analysis of Pokkali and Kaipad-based rotational paddy farming systems in India. *Current Science*, 125(5), pp.156-164.

Sreelatha, A.K., Shylaraj, K.S., 2017. Pokkali rice cultivation in India: A technique for multi-stress management. In: Gupta, S.K., Goyal, M.R. (Eds.), Soil

Salinity Management in Agriculture: Technological Advances and Applications. Apple Academic Press Inc, Waretown, New Jersey, pp. 317–335.

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Genetic dissection of sodicity tolerance in rice

RAVIKIRAN K.T.[1,2*], SUMIT K SATPATHY[2], NITISH RANJAN PRAKASH[3] and LOKESHKUMAR B.M.[3]

[1]ICAR-Central Soil Salinity Research Institute, Regional Research Station, Lucknow – 226 002, Uttar Pradesh, India

[2]ICAR-Indian Agricultural Research Institute, Lucknow – 226 002, Uttar Pradesh, India

[3]ICAR-Central Soil Salinity Research Institute, Karnal – 132 001, Haryana, India

E-mail: Ravi.KT@icar.gov.in

Key Words: *Genes, Marker Trait Associations, Rice, Sodicity*

INTRODUCTION

Sodic soils, characterized by high levels of exchangeable sodium, pose a significant challenge to global agriculture, impacting millions of hectares worldwide. These soils exhibit an elevated pH of over and above 8.6, exchangeable sodium percentage exceeding 15, poor soil structure, and restricted water and nutrient availability, severely limiting crop productivity. Rice, a staple food crop for a large portion of the global population, is particularly susceptible to sodicity stress at all stages of growth. Breeding for sodicity tolerance in rice is crucial to ensure food security in affected regions. By elucidating the genetic determinants of this trait, we can accelerate the development of sodicity-tolerant rice varieties through marker-assisted selection, thereby enhancing crop resilience and improving agricultural sustainability. Hence, this study aims to identify marker-trait associations and pinpoint candidate genes that govern sodicity tolerance in a diverse panel of rice genotypes.

MATERIALS AND METHODS

This study utilized a subset of 196 rice genotypes from the 3,000 Rice Genomes Project (IRRI, 2014). Genotypes were evaluated for sodicity tolerance (initial soil pH 9.7-9.9) in field conditions at ICAR-CSSRI, Lucknow, India, during the 2024 monsoon season. Seedlings were raised in a nursery with normal soil (pH ~ 7.5) and transplanted at 30 days into a sodic field using an Augmented Randomized Block Design with four checks. Vigor was scored at 25 and 45 DAT using a 1-9 scale (1: highly tolerant; 9: highly susceptible. The fresh weight of root and shoot samples was measured at 90 DAT. Then samples were oven-dried for dry weight determination. Following this, shoot samples were digested with nitric and perchloric acid (10:2 v/v) to measure sodium (Na^+) and potassium (K^+) concentrations in ppm using a flame photometer. 80,871 SNPs from Rice SNP-Seek (https://snp-seek.irri.org/) were used for GWAS using the 'Genome Association and Prediction Integrated Tool (GAPIT)' (Wang et al., 2021) implementing a multilocus model, 'Bayesian-information and Linkage-disequilibrium Iteratively Nested Keyway (BLINK)', after filtering rice genotypes (n=196) for missing data and minor allele frequencies. Significant MTAs ($-\log10(P) \geq 5$) were identified and surrounding genomic regions were investigated for candidate genes using Rice Genome Annotation Project database.

RESULTS AND DISCUSSION

Genotypes planted in a sodic field showed a significant delay in early growth after transplanting, with leaf chlorosis and the death of sensitive genotypes occurring as early as 15-20 days after transplanting. Consequently, the vigor score was recorded at 25 DAT, revealing that 21 genotypes had a score of 3 (tolerant), 71 genotypes scored 5 (moderately tolerant), 89 genotypes scored 7 (sensitive), and 34 genotypes scored 9 (highly sensitive). By 45 DAT, changes in genotype performance were observed, as reflected by updated SES scores: 19 genotypes were classified as tolerant (score 3), 68 as moderately tolerant (score 5), 75 as sensitive (score 7), and 53 as highly sensitive (score 9). The average vigor score was 6.469, ranging from 3 to 9. The average root fresh weight was 28.49 g, with values ranging from 2.9 to 122.03 g. The mean shoot fresh weight was 38.53 g, which varied from 5.08 to

178.23 g. The average root dry weight was 4.332 g, with a range from 0.9 to 20.37 g. The shoot dry weight had a mean of 5.997 g, ranging from 0.9 to 31.52 grams. The analysis of shoot samples for N^+ revealed concentrations ranging from 9252.5 to 31905 ppm, with a mean concentration of 19234.27 ppm. K^+ concentrations were observed to range from 1425 to 5475 ppm, with a mean concentration of 3031.01 ppm. GWAS analysis identified several significant marker-trait associations for phenotypic traits, along with putative candidate genes associated with these traits (Table).

Table 1. *Candidate Genes for Various Traits, Showing MTA Distribution Across Chromosomes.*

Trait	No. of MTAs & Chromosome number	Putative Candidate genes
Vigor score	6 (2, 4, 9 ,11)	DEAD-box ATP-dependent RNA helicase (LOC_Os11g38670) & zinc finger, C3HC4-type domain-containing protein (LOC_Os02g55520)
Root fresh weight	2 (12)	Nascent polypeptide-associated complex subunit alpha-like protein 3 (LOC_Os01g71230.1)
Shoot fresh weight	8(3, 11, 12)	OsMADS31 - MADS-box family gene with MIKCc type-box (LOC_Os04g52410.2)
Root dry weight	1 (5)	Nuclear transport factor (LOC_Os08g42000.1)
Shoot dry weight	7 (8, 12)	Erythronate-4-phosphate dehydrogenase (LOC_Os11g26850.2)
Na^+ of shoot	2 (1, 3)	WD domain containing protein, putative (LOC_Os01g22390.2)
K^+ of shoot	2 (5, 6)	phox domain-containing protein, putative (LOC_Os05g27920.1)

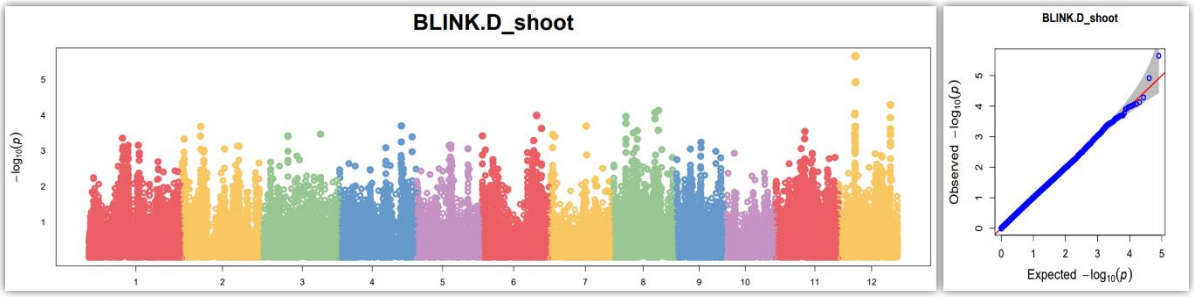

Fig 1. *Representative Manhattan plots (for shoot dryweight) depicting the locations of SNPs on 12 rice chromosomes on X-axis and -log10(p) values on Y-axis & QQ plot with Expected -log_{10} (p) on X-axis and Observed -log_{10} (p) on Y-axis.*

CONCLUSIONS

The present study identified 19 rice genotypes that are tolerant to sodicity, which could serve as valuable donors in future breeding programs after further confirmation. Several putative candidate genes were found near significant marker-trait associations (MTAs) that may play a role in rice's response to sodic stress, as indicated in previous reports. If validated in future studies, these genes could be important for marker-assisted selection aimed at improving sodicity tolerance in rice.

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Discerning gene(s) to deliver varieties for Indian coast: leveraging single gene manipulation, MQTL-analysis and genomic selection in rice

N.R. PRAKASH[1*], S. DEVIKA[2], K.T. RAVIKIRAN[3], S.K. SARANGI[2,4], S.L. KRISHNAMURTHY[1,5], B.M. LOKESHKUMAR[1], KRISHANU[1], A. MANN[1], S.K. SANWAL[1], S. SNEHI[6], R.P. SAH[7], P.K. SINGH[6], S. KOTA[5], R.K. YADAV[1]

[1]ICAR-Central Soil Salinity Research Institute, Karnal - 132001, Haryana, India
[2]ICAR-Central Soil Salinity Research Institute, RRS, Canning Town - 743329, W.B., India
[3]ICAR-Central Soil Salinity Research Institute, RRS, Lucknow - 226002, U.P., India
[4]ICAR - Central Institute for Women in Agriculture, Bhubaneswar - 751003, Odisha, India
[5]ICAR-Indian Institute of Rice Research, Hyderabad - 500030, Telangana, India
[6]Institute of Agricultural Sciences, BHU, Varanasi - 221005, U.P., India
[7]ICAR-National Rice Research Institute, Cuttack, Odisha – 753006
E-mail: nitishranjan240@gmail.com

Abstract

Identifying gene(s) and its follow-up in the breeding pipeline is the foremost consideration, deciphered with complex genetic architecture, sophisticated physiological phenomena, and redundant selection approaches, jeopardizing the breeder's decision-making ability. In recent years, the advancement in genomic tools, easy-to-access phenotyping approaches, and robust data analysis, have helped breeders. At ICAR-CSSRI, we follow a simplified but robust breeding approach including genetics dissection of traits governing salt and submergence tolerance, identification of candidate gene(s), meta-analysis of genomic information, and novel breeding approaches such as marker-assisted selection and gene editing. The present topic delves into our results from these approaches and future endeavours.

Key Words: *Genes, Salinity Tolerance, Meta-QTL Analysis, Gene Editing*

INTRODUCTION

Indian coastal regions, particularly in states such as West Bengal, Odisha, Andhra Pradesh, Tamil Nadu, and Gujarat, face significant challenges due to salinity intrusion and frequent submergence. These environmental stressors are caused by tidal waves, cyclones, storm surges, and heavy monsoons, leading to considerable reductions in rice yield and endangering food security. Millions of people in these regions rely on rice cultivation, making it imperative to develop climate-resilient rice varieties that can withstand such abiotic stresses. Some traditional rice landraces such as Pokkali, Nona Bokra, and Kalarata have evolved mechanisms to tolerate salinity, but their productivity remains much lower than that of high-yielding modern cultivars (Prakash *et al*. 2024). Submergence stress, along with salinity, severely aggravates yield loss in coastal rice-growing areas, especially during the monsoon season. Traditional breeding methods for salt and submergence tolerance have focused on incorporating tolerant genes from landraces and wild rice relatives. The introduction of major quantitative trait loci (QTLs) such as *SUB1* for submergence tolerance and *Saltol* for salinity tolerance into high-yielding rice varieties has been a significant achievement (Snehi *et al.* 2025a). However, given the complex polygenic nature of salinity and submergence tolerance, more advanced breeding strategies are required. Riding on new genomic approaches, viz., single-gene manipulation, Meta-QTL analysis, and gene editing are becoming instrumental in breeding rice for climate resilience in coastal agroecosystems.

LANDRACES OF THE INDIAN COAST

The Regional Research Station (RRS) at Canning, West Bengal, has been actively involved in identifying and characterizing rice landraces adapted to coastal stress conditions. Landraces such as Lakkansal, Latika, Mayna, Dudheswar, Sitapi, Kakua, Okhadjama, Khaskal, Lathisal, Sonalu, Gilijite, Adanshilpa, Baduma, Khandagiri, Paaru, Kalajeera, Black, R.J.N., Sainthia, Radhuni Pagal, Kanakchur, Siuli, Hormanona, Talmugur, Sundari, Kuzhiadichan exhibit significant tolerance to high salinity at seedling as well as reproductive stage and had been limitedly used in breeding program. This is making them valuable unexplored genetic resources for rice breeding programs. Genetic characterization using molecular markers has revealed unique stress-tolerant alleles present in these landraces, which can be utilized for breeding resilient varieties and is in progress.

UNDERSTANDING GENETICS OF SALT AND SUBMERGENCE TOLERANCE IN RICE

Monitoring a large-effect QTL in genomics-assisted breeding is a pretty simple process. The application of these QTLs in breeding programs may be restricted by the very broad confidence interval that has been anticipated in a number of QTL mapping investigations. As a result, we need to use a methodology to find a consensus region and identify Meta-QTLs that control salt tolerance during the

seedling and reproductive stages. Breeders have so far been successful in using *SALTOL* QTL. There is not much detailed research on the meta-QTL analysis influencing rice's ability to withstand salinity as well as submergence during germination. In order to identify genomic regions harboring consensus QTLs governing salinity tolerance and for anaerobic germination, studies were carried out by our team. For predicting meta-QTLs for anaerobic germination in rice, the consensus rice genetic map was projected with 240 reported QTLs associated with anaerobic germination from 26 research. 46 Meta-QTLs, spread across all chromosomes but not on chromosome 12, were predicted by the study. The predicted MQTL ranged in weight from 0.06 to 0.46 and in confidence interval from 0.01 to 16.41. Moreover, gene ontology (GO) analysis was carried out after extracting all of the annotated genes found in MQTL regions from the IRGSP site. Significant results were obtained for a number of GO keywords, including protein serine/threonine kinase activity (GO:0004674) and lipid transport (GO:0006869). Afterward, a whole-transcriptomic expression dataset from NCBI for AG susceptible (IR42 and IR64) and tolerant (MR, KHO, Kharsu 80A, and Nanhi) genotypes was obtained, and 56 differentially expressed common genes (Tolerant vs. Susceptible) related to 21 MQTLs were found (Snehi *et al.* 2025b).

For predicting meta-QTLs for salt tolerance in rice, 34 QTL mapping studies with 696 unique QTLs on rice salinity tolerance at the seedling stage and 11 research with 219 unique QTLs on rice salinity tolerance at the reproductive stage are included. All twelve rice chromosomes had a total of 65 projected Meta-QTLs for the seedling stage and 49 for the reproductive stage. For validation, a set of 36 extremely important Meta-QTLs for the seedling stage and 25 for the reproductive stage were chosen, and microsatellite markers were employed to link them. Eight extreme genotypes were chosen out of thirty-two genotypes that were assessed for salinity tolerance at the seedling stage in hydroponics (EC = 10.0 dSm^{-1}). Validation was performed on the seedling stage Meta-QTL MSQTL4.2 (~295.43kb), which is located on chromosome 4 (Chr4:20680856-20986280) close to marker "RM5635." Based on functional annotation and previously published expression data, the candidate gene analysis has suggested that it is a protein that binds to the FAD binding domain of monooxygenase (*Os04g0423100*). It is anticipated that this gene plays a role in the synthesis and conversion of ubiquinone, coenzyme transport metabolism, and energy. This Meta-QTL's underlying characteristics included leaf chlorophyll content, the concentration of sodium and potassium in roots and shoots, etc (Prakash *et al.* 2022).

BREEDING APPROACHES

Advancements in molecular breeding techniques have greatly improved the ability to manipulate single genes for stress tolerance in rice. Marker-assisted backcross breeding (MABB) has been successfully used to introgress major QTLs like *Saltol* and *SUB1* into elite rice varieties while minimizing undesirable genetic linkages (Kumar *et al.* 2024). At our institute, one MABB derived varieties CSR101 (Pusa 44 having *Saltol* + *xa13* + *Xa21*) had been released recently. However, we are exploring novel breeding approaches for developing salt and submergence-tolerant varieties. The haplotype-based selection allows breeders to identify beneficial gene variants and accelerate the breeding process by selecting plants with favorable haplotypes. We have identified suitable haplotypic variations for candidate genes governing submergence tolerance during germination and are in a process to imply the selection approach. Gene-editing technologies, particularly CRISPR/Cas9, have opened new possibilities for precise genetic modifications. At our institute, we are targeting *OsARF18* gene to mutate and enhance seedling stage salinity tolerance in rice.

REFERENCES

Kumar, R., Das, S.P., Choudhury, B.U., Kumar, A., Prakash, N.R., Verma, R., Chakraborti, M., Devi, A.G., Bhattacharjee, B., Das, R., Das, B., Devi, H.L., Das, B., Rawat, S. and Mishra, V.K. (2024). Advances in genomic tools for plant breeding: harnessing DNA molecular markers, genomic selection, and genome editing. *Biological Research* 57(1): 80.

Prakash, N.R., Lokeshkumar, B.M., Rathor, S., Warraich, A.S., Yadav, S., Vinaykumar, N.M., Dushynthkumar, B.M., Krishnamurthy, S.L. and Sharma, P.C. (2022) Meta-analysis and validation of genomic loci governing seedling and reproductive stage salinity tolerance in rice. *Physiologia Plantarum* 174(1): e13629.

Prakash, N.R., Lokeshkumar, B.M., Rathor, S., Warriach, A.S., Yadav, S., Vinaykumar, N.M., Krishnamurthy, S.L. and Sharma, P.C. (2024). Mechanisms of Saline and Submergence Tolerance in Rice for Coastal Ecology. In: Singh, R.K., Prakash, M., Gautam, R.K., Krishnamurthy, S.L., Thirumeni, S. (eds) Genetic Improvement of Rice for Salt Tolerance. Springer, Singapore. https://doi.org/10.1007/978-981-99-3830-8_13

Snehi, S., Ravi Kiran, K.T., Rathi, S., Upadhyay, S., Kota, S., Sanwal, S.K., Lokeshkumar, B.M., Arun, B., Prakash, N.R., Singh, P.K. (2025a). Discerning Genes to Deliver Varieties: Enhancing

Vegetative and Reproductive Stage Flooding Tolerance in Rice. *Rice Science* 32. https://doi.org/10.1016/j.rsci.2025.01.002

Snehi, S., Singh, P.K., Beena, R., Kota, S., Sanwal, S.K., Kiran, K.R., Anilkumar, C., Chattopadhyay, K., Prakash, N.R., & Sah, R.P. (2025b). QTL-Meta-analysis and Candidate Gene (s) for Anaerobic Germination Potential in Rice. *Journal of Plant Growth Regulation* 1-14. https://doi.org/10.1007/s00344-024-11618-y

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Deciphering genetic factors underlying sodicity tolerance in rice development

BAYRAGONDLU M. LOKESHKUMAR [1*], VISHVJEET S. PATIL [1], SARASWATHIPURA L. KRISHNAMURTHY [2], SUMAN RATHOR [1], ARVINDER S. WARRAICH[1] and NITISH RANJAN PRAKASH[1]

[1]Division of Crop Improvement, Central Soil Salinity Research Institute, Indian Council of Agricultural Research (ICAR), Karnal 132001, India

[2] ICAR-Indian Rice Research Institute Hyderabad 500030

E-mail: lokeshbm8050@gmail.com

Key Words: *Sodicity Tolerance, Reproductive Stage, Candidate Gene, QTL*

INTRODUCTION

Rice is a staple food for over 3.5 billion people worldwide and is cultivated in 114 countries (FAO, 2014). The combination of a growing population and rapid urbanization poses significant threats to food security and contributes to global climate change by increasing temperatures and reducing cultivable land. Among the abiotic stresses, salt stress (including salinity and sodicity) is one of the most critical factors limiting crop productivity. More than 6% (900 Mha) of the world's soil is affected by salt intrusion (FAO 2014). In the course of climate change land salinization is expected to affect the crop production from the 50 percent of the present cultivated area. Under salt stress, crops experience ion imbalances, ion toxicity, and reduced water potential, which disrupt normal plant metabolism and lower crop yields (Krishnamurthy *et al.*, 2016). Numerous studies have reported the impact of sodic soils on rice growth and development. However, information on the molecular mechanisms underlying sodicity tolerance remains limited. Rice being a susceptible crop to salt stress at early seedling and reproductive stage, it is mandatory to investigate genomic regions that govern salt stress tolerance to sustain rice cultivation and food security.

MATERIALS AND METHODS

In the present study, 244 rice genotypes obtained from the International Rice Research Institute (IRRI), Philippines, were evaluated for grain yield under sodic conditions using sodic microplots (6 × 3 m²) at ICAR-CSSRI, Karnal. Thirty-two-day-old seedlings were transplanted into soil with a pH of 9.5 using an alpha lattice design with two replications, with a row length of 3.0 m and a row-to-plant spacing of 20 × 15 cm. The desired pH of the soil (pH ~9.5) was created on 14 DAS using sodium bicarbonate (NaHCO3) and sodium carbonate (Na2CO3) solution. The micro plot pH was measured and maintained at 9.5 throughout the crop growth period. Grain yield was recorded from five randomly selected plants at maturity and used to calculate grain yield per plant (g). Marker-trait associations (MTAs) were estimated using Bayesian-information and Linkage-disequilibrium Iteratively Nested Keyway (BLINK) through the Genomic Association and Prediction Integrated Tool (GAPIT). The SNP positions associated with traits of interest were considered candidate genes. These QTLs will be validated in the 244 IRRI materials.

RESULTS AND DISCUSSION

The average grain yield (kg/ha) was found 2207.45 whereas, maximum grain yield was recorded for the genotype IR 96080-25-3-2-2 (5366 kg/ha) and genotype IR 132084-B-26-1-5-B-8 expressed the lowest grain yield (266.66 kg/ha). The grain yield distribution of genotypes was presented in graphical form in Figure 1.

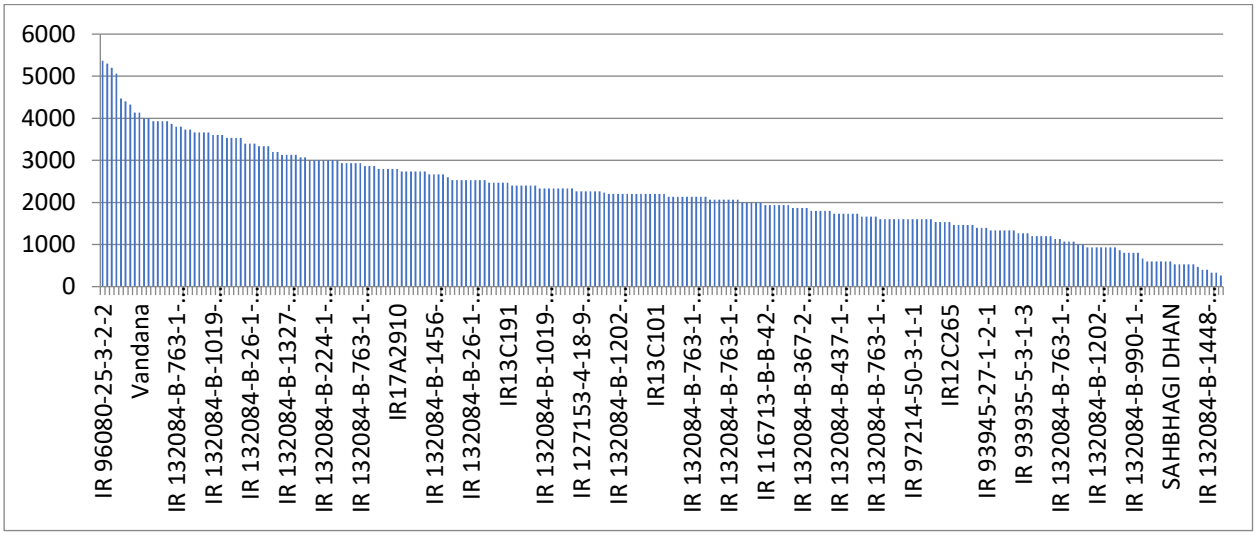

Fig 1: *Grain yield distribution of 244 rice genotypes under sodic stress condition (pH~9.5)*

The genotypes IR 96080-25-3-2-2, IR 96067-14-2-1-3, IR 116709-B-B-53-3-B-B and IR 97432-36-3-2-2 with grain yield more than 5000 kg/ha. The top performing genotypes under sodic conditions were presented in Figure 2.

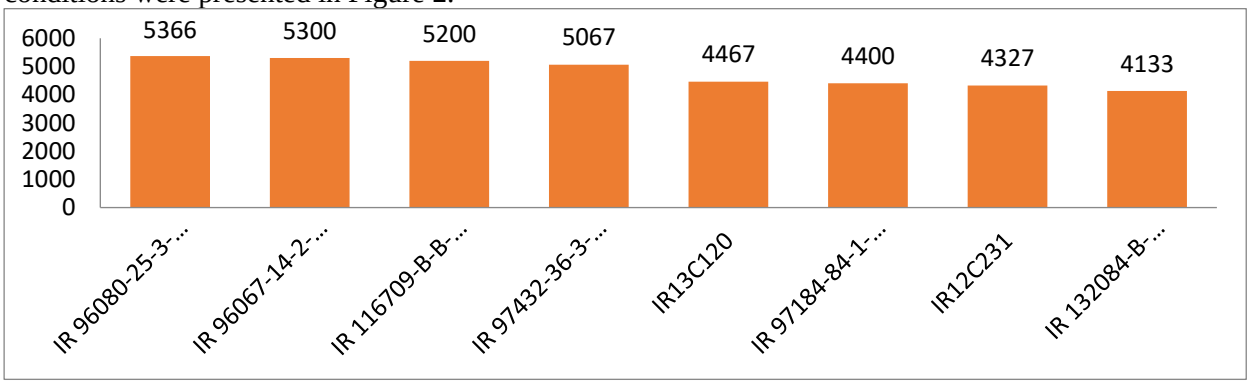

Fig 4: *Graphical representation of top performing genotypes under Sodic stress condition (pH ~ 9.5)*

We identified key QTLs for seedling stage explained approximately 32.02%, 20.65%, and 9.83% of the characteristics K^+/Na^+ homeostasis, shoot magnesium content (Mg^{2+}), and shoot calcium (Ca^{2+}), respectively. Significant relationships were found between the three candidate genes LOC_Os02g48290, LOC_Os02g48340, LOC_Os02g48350 for Sod K/Na.1, and LOC_Os08g15020 for Sod_Ca.1. In the QTL *Sod_K/Na.1* responsible for K+/Na+ homeostasis, we observed six peak SNP markers tracked between the 289 kb region from 29.313 to 29.602 Mb. The peak SNP positions in *Sod_K/Na.1* were lying in the regions of *LOC_Os02g48290*, *LOC_Os02g48340*, and *LOC_Os02g48350* (*OsDGAT*), which encodes thioredoxin reductase, (DGATs), respectively. RNA recognition motif containing (RRM) protein and diacylglycerol O-acyltransferase (Ojeda *et al.* 2017; Valerio *et al.* 2017 and Thormahlen, *et al.*, 2015) . The haplotype analyses for candidate genes linked to seedling stage sodicity tolerance suggested that three genes (*LOC_Os10g36690*, *LOC_Os01g41770*, and *LOC_Os10g31040*) show significant haplotypes associated with QTLs Sod_SL.1, Sod_Na.1, and Sod_Mg.1, respectively. Sod_SL.1 (LOC_Os10g36690) for shoot length, Sod_Na.1 (LOC_Os01g41770) for sodium content, and Sod_Mg.1 (LOC_Os10g31040) for magnesium content. The newly discovered unique SNPs are promising candidates for functional characterization, which would add to our knowledge of the genetic composition of rice's sodicity stress tolerance. To improve rice's resistance to salt, the tolerant lines might be employed in subsequent breeding initiatives.

CONCLUSIONS

We identified thirteen SNPs associated with eight QTL regions responsible for sodicity tolerance. We detected major QTLs for the traits K^+/Na^+ homeostasis, shoot magnesium content (Mg2+), shoot calcium (Ca2+), and shoot length. We found three significant candidate gene haplotypes associated with the QTLs for shoot length (LOC_Os10g36690), shoot sodium content

(LOC_Os01g41770), and shoot magnesium content Sod_Mg.1 (LOC_Os10g31040). The identified QTL regions and candidate genes play significant roles in sodic stress tolerance, which can be further

investigated. The identified SNPs will be validated in IRRI lines under both seedling and reproductive stage. The top performing genotypes IR 96080-25-3-2-2, IR 96067-14-2-1-3, IR 116709-B-B-53-3-B-B and IR 97432-36-3-2-2 can be nominated to AICRP Trails.

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REFERENCES

FAO. Extent of Salt Affected Soils. 2014. Available online: http://www.fao.org/soils-portal/soil-management/management-ofsomeproblem- soils/salt-affected-soils/more-information-on-saltaffected-soils/en/ (accessed on 3 December 2014).

Krishnamurthy, S.L., Gautam, R., Sharma, P., Sharma, D. (2016). Effect of different salt stresses on agro-morphological traits and utilisation of salt stress indices for reproductive stage salt tolerance in rice. *Field Crop. Res* 190, 26–33.

Ojeda, V., Pérez-Ruiz, J.M., González, M., Nájera, V.A., Sahrawy, M., Serrato, A.J., Geigenberger, P., Cejudo, F.J. (2017). NADPH ThioredoxinReductase C and Thioredoxins Act Concertedly in Seedling Development. *Plant Physiol* 174, 1436–1448.

Thormahlen, I., Meitzel, T., Groysman, J., Ochsner, A.B., von Roepenack-Lahaye, E., Naranjo, B., Cejudo, F.J., Geigenberger, P. (2015). Thioredoxin f1 and NADPH-Dependent ThioredoxinReductase C Have Overlapping Functions in Regulating Photosynthetic Metabolism and Plant Growth in Response to Varying Light Conditions. *Plant Physiol* 169, 1766–1786.

Valerio, C., Costa, A., Marri, L., Issakidis-Bourguet, E., Pupillo, P., Trost, P., Sparla, F. (2011). Thioredoxin-regulated beta-amylase (BAM1) triggers diurnal starch degradation in guard cells, and in mesophyll cells under osmotic stress. *J. Exp. Bot.* 62, 545–555.

Inv-07T1D2

Soil quality and ecosystem services in jute (*Corchorus olitorius* l.) based cropping systems under conservation agriculture (CA) practice: A real myth

R SAHA[1], ALKA PASWAN, B. MAJUMDAR, S.P. MAZUMDAR, D. BARMAN, DEVIKA T.M. and G. KAR

ICAR-Central Research Institute for Jute and Allied Fibers, Barrackpore, Kolkata, West Bengal 700 121

E-mail: saharitesh74@rediffmail.com

***Key Words**: Ecosystem Service, Indo-Gangetic Plains, Jute-Based Cropping, No Tillage, Residue Management, Soil Quality*

INTRODUCTION

Shrinking resources of prime lands, deforestation and accelerated erosion, deterioration of soil physical environment, lower efficiency of inputs such as water, fertilizers and agrochemicals, environmental degradation has aggravated the current agricultural practices. Conservation agriculture (CA) technologies involve paradigm shift from traditional agriculture and includes minimum soil disturbance, permanent soil cover through crop residues and crop diversifications for achieving sustained productivity and making rational use of resources. The study was undertaken to evaluate the soil quality and ecosystem services of jute based cropping systems under conservation agricultural practices so as to recommend an alternative crop management practice for resource poor farmers' adoption and livelihood security.

MATERIALS AND METHODS

Two tillage systems viz., conventional tillage (CT) and no tillage with crop residue (NT+R) as main plot and three cropping systems viz. viz., Jute-rice-wheat (J-R-W), Jute-rice-lentil (J-R-L) and Jute-rice-mustard (J-R-M) in sub plot were tested in split plot design. Additional crop residues were applied as *Sesbania* spp. during sowing of jute @ 2 t/ha. After completion of 6th year continuous experimentation, the soil physico-chemical properties were analysed based on standard methodology.

RESULTS AND DISCUSSION

The nutrient balance sheet showed that there was a positive nutrient balance in all the tillage treatments with highest positive balance in NT+R (N: 195.89; P: 28.02 and K: 134.17 kg ha^{-1},

respectively). The soil organic carbon (SOC) density and SOC stock, indices for estimating the SOC accumulation/status in the soil system varied significantly under various treatments from an initial SOC density of 234.24 g m^{-2}. Among the tillage treatments, SOC density varied in between 242.17 – 330.03 g m^{-2} whereas it is ranging from 273.92 to 303.43 g m^{-2} under cropping systems treatments. NT+R contributed the highest SOC stock (3.30 Mg C ha^{-1}) followed by NT (2.94 Mg C ha^{-1}), and CT (2.42 Mg C ha^{-1}). NT+R contributed the highest SOC stock (3.30 Mg C ha^{-1}) followed by NT (2.94 Mg C ha^{-1}), and CT (2.42 Mg C ha^{-1}). Evaluation of soil quality using soil quality index (SQI) showed that soil quality was better in Jute-rice-lentil (range: 0.42-0.62) under NT+R as compared to the other systems. Economic value of the ecosystem services was highest in NT+R (Rs. 71,224 ha^{-1}) followed by NT (Rs. 68,533 ha^{-1}), lowest being in CT (Rs. 59,086 ha^{-1}). Green income from conventionally tilled jute based cropping systems was Rs. 28,545 ha^{-1}, which increased to Rs. 41,528 ha^{-1} in NT and to Rs. 45,407 ha^{-1} in NT+R. Higher green income in the NT and NT+R treatments was due to the higher value of ecosystem services along with lower pollution cost and lower input cost.

CONCLUSION

Thus, no tillage with residue incorporation (NT+R) under Jute-rice-lentil system is highly beneficial in maintaining sustainability and improving soil quality status in Lower Indo-Gangetic plains. The study also highlighted the significance of conservation agricultural practices with better ecosystem services for long-term sustainability of agricultural systems.

REFERENCES

Saha, R., Paswan, Alka, Mazumdar, S.P. Barman, D., Majumdar, B., Behera, M.S. and Saha, A.R. (2022) Improvement in soil quality through tillage and residue management in Jute (Corchorus spp.) based cropping systems of Indo-Gangetic plains. *Carbon Management*. DOI:10.1080/17583004.2022.2068453

Saha, R., Paswan, Alka, Majumdar, B., Barman, D., Behera, M.S., Mazumdar, S.P. and Sarkar, S. (2018) Soil Quality under Tillage and Residue Management in Jute (*Corchorus* spp.) based Cropping Systems of Indo-Gangetic Plains. *International Journal of Current Microbiology and Applied Sciences*. 7(11): 133-140. https://doi.org/10.20546/ijcmas.2018.711.xx

Datta, Debarati, Saha, R. and Ghorai, A.K. (2020) Conservation agriculture and resource management under Jute (*Corchorus* spp.) based cropping systems in eastern India. *Current Science*. 119(6): 926-933. doi: 10.18520/cs/v119/i6/926-933.

Saha, R., Barman, D., Behera, M.S. and Kar, G. (Eds.) 2021. Conservation Agriculture and Climate Change: Impacts and Adaptations. NIPA Genx Electronic Resources & Solutions P. Ltd., New Delhi. pp. 496.

Inv-08T1D2

Integration of herbicidal and mechanical methods for efficient weed management in jute

SITANGSHU SARKAR*, RANJAN KUMAR NAIK, BIJAN MAJUMDAR and DEBARATI DATTA

ICAR-Central Research Institute for Jute and Allied Fibres, Barrackpore, Kolkata-700121

E-mail: sarkaragro@gmail.com

Field experiment was conducted for two consecutive years (2021-22 and 2022-23) at ICAR-Central Research Institute for Jute and Allied Fibres, Nilganj, Barrackpore, West Bengal to find best weed management practice for olitorius jute (cv. JRO 204) using mechanical weeders (nail weeder and single wheel jute weeder) and comparatively new herbicide (ipfencarbazone) along with other weed management methods. The highest tossa jute (cv. JRO 204) plant height (PH) at harvest (120 DAS) was recoded with two manual weeding treatments (357.5 cm). Among the herbicidal and mechanical weed management treatments, it was observed that, ipfencarbazone @ 90 g/ha (PE) + nail weeder at 14 DAS produced the tallest jute pants (336.4 cm) closely followed by and at par with the plant height (PH) obtained with ipfencarbazone @ 90 g/ha (PE) + single wheel jute weeder at 21 DAS (334.4 cm). Like PH, similar trends were observed in case of jute basal diameter (BD) at harvest. The highest jute fibre yield was obtained with two manual weeding (37.9 q/ha). Among the herbicidal and mechanical weed management methods considered, application of ipfencarbazone @ 90 g/ha (PE) + single wheel jute weeder at 21 DAS produced higher fibre yield (35.5 q/ha) closely followed by and at par with the fibre yield recorded with application of ipfencarbazone @ 90 g/ha (PE) + nail weeder at 14 DAS (35.4 q/ha).

In both the efficacious combination treatments (herbicide and mechanical weeder), the fibre yield reduction, due to competition from surviving weeds (i.e., Weed Index), was only 6.5 and 6.7%, respectively, as compared to the fibre yield obtained in manual weeding treatment. The stick yield of jute also followed the same pattern of fibre yield with the different weed management treatments. The jute fibre quality did not differ significantly with the different weed management treatments considered. In general, the obtained fibre was very good in terms of colour, strength and fineness.

Inv-09T1D2

Soil sulphur application for preventive management of jute yellow mite

S. SATPATHY, V. RAMESH BABU, SONALI PAUL MAZUMDAR and S. K. ROY*
ICAR-Central Research Institute for Jute and Allied Fibres, Barrackpore
ICAR-National Bureau of Plant Genetic Resources, New Delhi

The jute crop has witnessed dynamic changes in the pattern of infestation of early season sucking pests which is mostly associated with erratic climatic pattern. The infestation of yellow mite, Polyphagotarsonemus latus is regular and severe even raised to the status of outbreaks. Development of preventive control measures is very important against these sucking pests. Elevation in the level of desirable plant metabolites through application of certain micro-nutrients builds up resilience to prevent the damage due to mite infestation.The role of soil application of sulphur on yellow mite infestation in jute demonstrated significant effect of sulphur applied @ 30 - 60 kg/ha on mite population density, infestation and plant growth characteristics of jute (Cv JRO 8432) indicated that higher dose of soil applied sulphur could reduce the mite population build up. Soil-applied sulphur manifested significant variation in mite population (adult and egg) density on jute plants. The population density of mite in the plants grown on sulphur-applied soil was significantly less compared to the plants grown in soil without sulphur. Similarly, the damage grade was also significantly reduced due to the enhanced nutritional effect because of sulphur application. Other yield attributing parameters like plant height, basal diameter, chlorophyll content and plant dry weight were significantly more due sulphur application in soil.The dry weight and chlorophyll content of the plants grown in higher level of sulphur was significantly higher compared to the control plants. The mite density and plant damage (%) was significantly reduced in higher S level. The sulphur content in the leaves of jute varieties grown in S-treated plots was significantly higher i.e., 0.57% and 0.53% at 60 kg/ha and 30 kg/ha soil applied S respectively compared to 0.40% in control. Soil-applied sulphur has definite role to subside the mite infestation as well as compensating the mite damage caused by desaping the plants.

Inv-10T1D2

Livelihood and environmental security of an agro-ecosystem through resilient agricultural technologies with special reference to jute crop

S. K. JHA*, S. KUMAR, SHAMNA A, S. SAHA and T. SAMAJDAR
[1]ICAR-CRIJAF, Barrackpore, Kolkata - 700121
E-mail: sunitikumarjha@gmail.com

Key Words: *Climate-Smart Agronomic Practices, Economic Benefits, Livelihood Security, Resilient Agricultural Technologies,*

INTRODUCTION

Agricultural development in coastal regions is significantly constrained by multiple environmental and agronomic challenges, including waterlogging during the wet season, soil salinity in dry conditions, poor soil fertility, and short winter seasons. These factors collectively threaten farmers' livelihoods, necessitating strategies to manage agricultural and environmental risks effectively. Developing suitable policies that ensure the efficient use of resources while safeguarding the interests of multiple stakeholders is critical. Technological, administrative, and socio-economic barriers further complicate sustainable agriculture in these areas. Resilient agricultural technologies play a pivotal role in stabilizing income sources, improving resource efficiency, and maintaining ecological balance. Jute, a valuable cash crop with substantial economic and environmental advantages, presents an opportunity to enhance agricultural resilience and sustainability. This paper explores the impact of resilient agricultural technologies on livelihood security and environmental sustainability in jute-based agro-ecosystems.

MATERIALS AND METHODS

This study examines various resilient agricultural technologies and their role in improving economic security and environmental sustainability in jute-based farming systems. The study employs

a multidisciplinary approach, incorporating agronomic trials, socio-economic surveys, and impact assessments. The frontline demonstrations were conducted in consultation with the scientists of ICAR-CRIJAF. Care was taken to organize interpersonal discussion, group interactions, field visits, farmers' day and scientist-farmer interactions for effective sharing / dissemination of information and solving their problems related with the jute cultivation. The data on yield and economic performance were collected from demonstration plots as well as control plots to work out the fibre yield economics. Data were collected from farming communities for analysis of cost-effective and sustainable solutions for enhancing crop productivity. Collection of qualitative and quantitative data through questionnaires were done to assess the economic and social impacts of jute-based resilient agricultural practices. The extension gap, technology gap and technology index were calculated using the formula as suggested by Samui et al. (2000).

Technology gap (q / ha) = Potential yield – Demonstration yield

Extension gap (q / ha) = Demonstration yield– Farmer's conventional practice yield

Technology index (per cent) = [Potential yield – Demonstration yield / Potential yield] x 100

RESULTS AND DISCUSSION

The findings indicate that the adoption of resilient agricultural technologies significantly enhances both economic security and environmental sustainability. It is evident from results that under the demonstrated plot, yield performance of jute was sustainably higher than that in the control plot following local traditional practices in all the years of the study (2021-24). The results are in close conformity with the research results of Chapke (2012,2013) , Kumar et al., (2015), Mitra and Samajdar (2013) and Jha et al., (2008) who reported higher net return and B: C ratio through improved technologies as compared to the farmer's practices. Yield in demonstration plots and potential yield of the crop was compared for estimating yield gaps. These gaps were further categorized as technology and extension gaps. The discussion underscores the importance of policy support and financial incentives in promoting these technologies. Government interventions should focus on subsidizing resilient seed varieties, encouraging farmer cooperatives, and expanding market access for jute products. Furthermore, extension services must be strengthened to educate farmers on climate-smart agricultural practices.

CONCLUSIONS

Jute-based agro-ecosystems, when integrated with resilient agricultural technologies, offer a viable solution for achieving both livelihood security and environmental sustainability. By overcoming climate-induced challenges and improving income stability, these systems contribute to sustainable resource management. Policy-driven support, technological advancements, and community participation are crucial for the widespread adoption of these practices. Ensuring long-term sustainability requires a holistic approach that combines scientific innovations with effective governance and farmer engagement.

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REFERENCES

Chapke, R.R. (2012). Impact of frontline demonstration on jute (*Corchorus olitorious*). *J. of Human Ecol.*, 38 (1): 37-41

Jha, S.K.; Ghoari, D.K.; Rahman, F.H.; Sinha, M.K. and Mahapatra, B.S. (2008). Towards food and economic security through enterprise diversification, Bulletin No.23/2008, CRIJAF, Barrackpore.

Kumar, S.; Shamna, A.; Jha, S.K. and Ghorai, A.K. (2015). CRIJAF Nail weeder an innovative tool for weed management: Farmer's experience. Proceedings. Volume II (oral papers). 25th Asian -Pacifi c Weed Science Society Conference, Hyderabad, India. *Indian society of Weed Science*, Jabalpur.155p.

Samui, S.K.; Maitra, S.; Roy, D.K.; Mondal, A.K. and Saha, D. (2000). Evaluation of front line demonstration on groundnut (*Arachis hypogea* L.) in Sundarbans. *J. of Indian Society of Coastal Agri. Res.*, 18(2): 180-183.ICAR-CRIJAF (2021,2022,2023). Annual Reports., https://crijaf.icar.gov.in/SideLinks/Publications/AnnualReports.php

Oral V1TID1

Agronomic management of potato (*Solanum tuberosum* L.) for seed tuber production under new alluvial zone of West Bengal

S. K. DAS[1], A. SARKAR[1], J. K. TARAFDAR[2] and A. CHAKRABORTY[1]
[1]AICRP on Potato, [2] AICRP on Tuber Crops, Directorate of Research, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur- 741252, Nadia, West Bengal, India
E-mail: sanjibag@gmail.com

Key Words: *Fertilizer Management, Haulm Cutting Dates, Indexing of Viruses, Intra Row Spacing, Potato, Seed Tuber*

INTRODUCTION

Seed tuber is the single most important factor in potato cultivation, which accounts for nearly 40-50% of the total investment for raising the crop, and if the seed is not of good quality, then optimum production could not be achieved. Unavailability of good quality seed, high price and untimely supply of seed at the village level are the main limiting factors for profitability and increase of potato production. With the expansion of potato cultivation in the Indo-Gangetic plains (IGP), it became evident that seed production in the Indian hills cannot cope with the increasing demand of good quality seed. The objective was to determine the effects of spacing, time of dehaulming and fertility levels on quality seed tuber production of potato following seed plot technique.

MATERIALS AND METHODS

Field experiments were conducted during *rabi* seasons of 2016-17, 2017-18, 2018-19 and 2019-20 at BCKV, Kalyani, WB, India. The experiment was laid out in a split split plot design with three replications having twelve treatment combinations viz. Main plot: Spacing- 2 levels (60cm X 20cm and 60cm X 15cm), sub plot: Date of haulm cutting- 2 levels (65 and 75 DAP) and Sub sub plot: fertility -3 levels (100%, 75% and 50% RDF of N-P-K). ELISA test for virus profiling of potato leaves, supplied breeder seed and produced seed tubers were conducted for the samples using Immuno-strip (Agdia Incorporation, USA) specific to Potato Virus Y; Molecular method- Reverse Transcription-Polymerase Chain Reaction (RT-PCR) of PVY, PVX, PVS, PVM and Leaf roll Virus (PLRV). In all the detection time positive and negative control were maintained to cross check the infection and required primers were used. The economic parameters (cost of cultivation, gross return and net returns) were worked out. Analysis of variance of the data in the experimental design and comparison of means at $p \leq 0.05$ were carried out, using MSTAT-C software.

RESULTS AND DISCUSSION

The results revealed that with decrease in intra row spacing from 20cm to 15cm, dehaulming at 65 DAP and decrease in fertility levels from 100% RDF of NPK to 50% RDF of NPK seed grade size (< 75g) tuber yield and numbers and total tuber numbers were significantly increased but marketable grade (> 75 g) tuber yield and numbers were significantly reduced. Both spacing and fertilizer dose had a marked effect on disease incidence and severity. Dehaulming at 65 DAP was found to be safer so far as infestation and chances of viral disease transmission by the sucking pests were concerned. It was found from the indexing of the viruses in the tubers of Kufri Himalini (breeder seed and produced seed tuber) the seeds were free from PVY, PVX, PVS, PVM and PVLRV. The highest net return and B : C ratio (4.08) was recorded with 15 cm intra row spacing, dehaulming at 65 DAP and 50% RDF of NPK followed by B : C ratio (3.99) with 15 cm intra row spacing, dehaulming at 75 DAP and 50% of RDF of NPK.

Table 1: *Effects of spacing, haulm cutting dates and fertilizer management on grade wise and total tuber yield of potato (Pooled data of four years)*

Treatment	Grade-wise yield of tubers (t ha^{-1})					Yield on dry weight basis (t ha^{-1})	
	0-25g	25-50g	50-75g	>75g	Total	Tuber	Haulm
Levels of spacing							
S1	2.97	6.47	7.11	13.46	30.02	5.76	3.45
S2	3.80	7.18	8.80	13.24	33.02	5.81	3.49
SEm (±)	0.15	0.11	0.11	0.13	0.27	0.08	0.05
LSD (0.05)	NS	0.66	0.66	NS	1.64	NS	NS
Levels of dates of haulm cutting							
H1	3.67	6.84	7.89	12.28	30.69	5.70	3.42

H2	3.09	6.81	8.02	14.42	32.34	5.87	3.52
SEm (±)	0.06	0.08	0.18	0.21	0.28	0.06	0.03
LSD (0.05)	0.22	NS	NS	0.82	1.11	NS	NS
Levels of fertility							
F1	2.87	6.42	7.09	19.22	35.60	6.41	3.85
F2	3.19	6.75	8.22	13.04	31.20	5.68	3.41
F3	4.09	7.31	8.56	7.79	27.76	5.26	3.16
SEm (±)	0.13	0.19	0.31	0.30	0.53	0.11	0.07
LSD (0.05)	0.39	0.56	0.92	0.91	1.60	0.33	0.21

CONCLUSION

Thus, from the present study it can be concluded that, for quality virus free seed grade potato tuber production use of 60cm X 15cm spacing along with dehaulming at 65 days after planting, when planting is done on first week of November and grown with 50% RDF of NPK i.e. 100:75:75 kg $N:P_2O_5:K_2O$ ha^{-1} + 0.1% boric acid as foliar application at 40, 50 and 60 DAP, was found best under lower Indo-Gangetic plains of India to get higher numbers of virus free quality potato seed tubers.

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REFERENCES

Dua, V.K., Jaiswal, R.C., Khurana, S.C., Kumar, D., Nandekar, D.N., Raghav, M., Rawal, S., Sasani, G.V., Trehan, S.P., Trivedi, S.K., Jatav, M.K., Lal, S.S., Thakur, K.C., Pandey, S.K. and Naik, P.S. (2008). Manipulation of agronomic practices for tuber-size distribution in potato (*Solanum tuberosum*) seed crop. *Indian Journal of Agronomy*. 53(3): 217-223.

Garg V.K., Deshraj and Sarjeet, S. (1999). Influence of dates of planting and haulms cutting on the yield of seed sized tubers in Shimla Hills. *Journal of Indian Potato Association.* 26: 7-13.

Das, S.K., Sarkar, A., and Chakraborty, A. (2016). Effect of spacing, dates of haulm cutting and fertility levels on quality seed grade tuber production of potato (Solanum tuberosum L.). Indian Agriculturist. 60(3 &4): 225-236.

Das, S.K.,. Sarkar, A., Tarafdar, JK and Chakraborty, A (2020). Potato (*Solanum tuberosum* L.) seed tuber production as influenced by intra-row spacing, dehaulming time and nutrient management in lower Indo-Gangetic plains of India. *Journal of Crop and Weed*. 16(1): 30-38.

Oral V2TID1

Studies on population fluctuation and effect of abiotic stresses on the population of *Myzus persicae* (Sulz.) infesting potato in the Gangetic basin of West Bengal

A. SARKAR and A.K. NAYAK

Department of Agricultural Entomology, AICRP on Potato, Directorate of Research,
Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal

E-mail : asarkar1920@gmail.com

Key Words: *Potato, Aphid, Population Dynamics, Abiotic Factors*

INTRODUCTION

India is the second largest producer of potato next to China (45.3 million tonnes) in the world with an average yield of 22.8 t/ ha [Mandol *et. al*, 2015]. West Bengal ranks second among all potato growing states in India with a production of 12.0 million tonnes from an area 0.48 million ha, while the productivity was 29.7 t/ ha during 2013-14 [www.agricoop.nic.in]. Among the important insect pest aphids *Myzus persicae* (Sulz.) and *Aphis gossypii* (Glov.) is an important one [Moschetti, 2003]; as a pest of potato, aphids can damage the crop directly and cause yield loses and indirectly when they act as vector and spread diseases like Potato virus X and potato virus Y [Raj, 1991]. Keeping in view the importance of the crop and the losses caused by the aphids, this present investigation was initiated to find out the population fluctuation of the aphid species during the crop growth period so that proper management can be applied to avoid crop loss.

MATERIALS AND METHODS

Field experiment was carried out at District Seed Farm–C Unit, Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India (22_580 N latitude, 88_250 E longitude, 9 m above mean sea level) in rabi season 2018–19 and 2019–20 to study the population dynamics of aphids on potato as well as the effect of different abiotic stresses on the population buildup of this pest. The seed tubers of variety

Kufri Jyoti were grown following recommended agronomic practices. Aphid population was recorded on randomly selected 34 plants starting from plant emergence till maturity as per the standard technique prescribed by the Central Potato Research Institute (CPRI), Shimla.

RESULTS AND DISCUSSION

The population of *Myzus persicae* was ranged from 01 to 408 nymphs and adults in season I (2018-19) and 05 to 346 in season II (2019-20) per hundred (100) compound leaves. It first appeared on the crop during the 2nd week of January in season I. Thereafter, the density of aphid increased gradually with a peak of 408 aphids per 100 compound leaves in the second week of February. Similarly, in second season aphid first appeared two weeks earlier i.e during the last week of December and then their density increased slowly as compared to season I and reached to its peak of 346 aphids per 100 compound leaves in third week of February

During the first year (2018-19) data pertaining to the correlation study revealed that there was a significant positive correlation with maximum temperature ($r = 0.554$, $p \leq 0.05$) and significant negative correlation with the morning ($r = -0.636$, $p \leq 0.05$), evening ($r = -0.583$, $p \leq 0.05$) and average ($r = -0.609$, $p \leq 0.05$) relative humidity (Table 1).

During second year (2019-20) significant positive correlation was found between aphid number and maximum temperature ($r = 0.561$, $p \leq 0.05$) (Table 2). There was a significant negative correlation between aphid population and morning ($r = -0.664$, $p \leq 0.05$) and evening ($r = -0.625$, $p \leq 0.05$) relative humidity. These findings are in agreement with [Konar and Sing, 2009] who found that the maximum temperature varied between 21.1 °C and 30.3 °C, the minimum temperature ranged from 10.0 °C to 16.6 °C, the maximum relative humidity varied from 73 to 100% and minimum relative humidity ranged from 35 to 56% during the crop growth period.

Table. 1: *Correlation between aphids and weather parameters in the year 2018-19 and 2019-20*

Environmental factors		Correlation co-efficient (r)		Co-efficient of determination (R^2)	
		2018-19	2019-20	2018-19	2019-20
Temperature (°C)	Maximum	0.554*	0.561*	$R^2 = 0.6133$	$R^2 = 0.5244$
	Minimum	0.342	0.172	$R^2 = 0.2027$	$R^2 = 0.0452$
	Average	0.469	0.390	$R^2 = 0.4238$	$R^2 = 0.2479$
Relative Humidity (%)	Morning	(-)0.636*	(-) 0.664*	$R^2 = 0.5508$	$R^2 = 0.5508$
	Evening	(-)0.583*	(-) 0.625*	$R^2 = 0.4985$	$R^2 = 0.7844$
	Average	(-)0.609*	(-) 0.577	$R^2 = 0.5343$	$R^2 = 0.7738$
Bright sun shine(hr.)	Duration	0.218	0.532	$R^2 = 0.0673$	$R^2 = 0.2295$

*Significant at 5% level of significance.

CONCLUSION

From the study it can be concluded that the peak population of aphid was observed in the second and third week of Frebruary during first and second season respectively though the initiation of the population was observed little bit earlier in second season than first season. Among the different weather parameters maximum temperature had a significant positive correlation in both the year whereas relative humidity (max., min. and average) had a significant negative correlation with that of aphid population in the first year.

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REFERENCES

Horticulture Statistics Division. Department of Agriculture & Cooperation, Government of India. Accessed August 01, 2014; http://www.agricoop.nic.in/Admin_Agricoop/Uploaded_File/ICAR_5.pdf.

Konar A, Singh NJ (2009). Occurrence of aphids on various potato germplasms in eastern 36angetic plains of West Bengal. *Journal of Pant Protection Sciences*; 1(1):21-24.

Mondal SS, Patra BC and Banerjee H (2015). Micronutrient management. In Advances in potato cultivation technology. New Delhi, India: Kalyani Publishers, 115-21.

Moschetti R (2003). Biological control using beneficial insects. Biological Control Bulletin. IPM of Alaska.

Raj BT (1991). Seasonal variations of Aphis gossypii Glover. Infesting potatoes in Deccan Plateau. *Journal of Aphidology*. 3(1, 2):98-101.

Oral V3TID1

Tossa jute genetic goldmine: Establishing a breeding core collection

THRIBHUVAN R[1*], J. K. MEENA[1], K. N. CHOURASIA[1], RAKESH BHOWMICK[1], P. SATYA[1], C. S. KAR[1], AMIT BERA[1] and JIBAN MITRA[1]

[1]ICAR – Central Research Institute for Jute and Allied Fibres, Barrackpore– 700121, WB, India

E-mail: thribhuvan.r@icar.gov.in

Key Words: *Core Collection, Germplasm, Tossa Jute*

INTRODUCTION

Jute, a member of the Malvaceae family, is a versatile and environmentally sustainable bast fibre crop known as "golden fibres." It has been used for centuries and recently gained scientific interest for its industrial applications and role in sustainable development (Majumder et al., 2020). However, jute's genetic diversity is underutilized, threatening its sustainability and productivity. Germplasm collections, which include a wide array of genetic material, are crucial for breeding programs and conservation efforts. Yet, existing collections often suffer from redundancy and inadequate genetic diversity representation. Developing a core collection—a subset of accessions capturing maximum genetic diversity with minimal redundancy—is essential. This core collection would streamline research, facilitate efficient genetic resource utilization, and enhance breeding programs to improve tossa jute's resilience and productivity. This study aims to establish a robust core collection of tossa jute germplasm, ensuring its long-term conservation and optimal use in breeding and research.

MATERIALS AND METHODS

A total of 1,830 accessions of *Corchorus olitorius* were evaluated in this study. The assessment focused on 24 traits, comprising ten qualitative and fourteen quantitative characteristics. The core collection was developed using PowerCore, a tool employing a modified heuristic algorithm to maximize genetic diversity while retaining all qualitative traits and classes for quantitative ones (Kim et al., 2007). The origin of each accession was also considered as a qualitative trait to ensure representation from each centre of origin or collection. This approach was particularly important given the initially low number of accessions in the core collection, as it aimed to capture a broad spectrum of genetic diversity.

RESULTS AND DISCUSSION

The evaluation revealed moderate variability in traits such as stem, leaf, stipule, and petiole color among the 1,830 accessions of *Corchorus olitorius*. The majority of accessions exhibited lanceolate and ovate-lanceolate leaf shapes, with red stems being the most common. Descriptive statistics for the accessions and for the core collection are presented in Table 1. The core collection exhibited means and ranges for traits that were comparable to those of the primary collection but demonstrated a higher degree of variability.

Two distinct core collections were developed: one comprising 76 accessions (4.15% of the total) using the M-strategy, and another consisting of 92 accessions (5.02%) developed through a random search algorithm. Notably, 45 accessions were common to both sets. The core collections displayed similar means and ranges for the evaluated traits but exhibited greater variability than the primary collection, as illustrated in Figure 1. The coincidence rate between the core collection and the entire collection was determined to be 96.16% (using the M-strategy), indicating a high degree of resemblance between the core and the entire collection.

Table 1. *Descriptive statistics of the 1,830 Olitorius accessions and 76 core collection accessions (M-strategy)*

Statistic	Green weight (g/plant)	Plant height (cm)	Basal Diameter (cm)	Number of nodes	Stick weight (g/plant)	Fibre weight (g/plant)	1000 seed weight (g)
1,830 Olitorius Accessions							
Mean	217.58	331.72	1.35	72.06	33.63	13.51	1.97
S.D.	68.90	40.48	0.20	11.21	12.08	4.71	0.46
Maximum	559	460	2.28	117	99.8	44.4	3.32
Minimum	49	121	0.51	31	3.2	2	0.8
76 Core Collection Accessions (M-strategy)							
Mean	236.3	324.5	1.4	72.1	36.7	15.2	1.8

S.D.	117.8	68.7	0.3	16.8	20.6	8.0	0.5
Maximum	555	440	2.28	117	99.8	44.4	3.23
Minimum	60	121	0.51	33	3.2	2	0.75

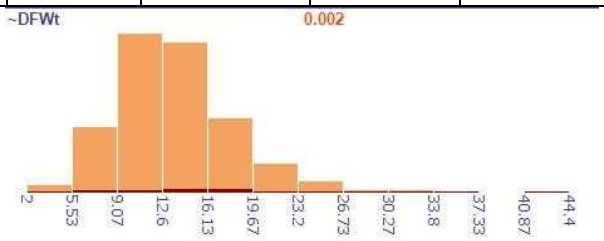

Fig. 1. *Histogram exhibiting variability in dry fibre weight (g/plant) of the primary collection and the core collection*

CONCLUSION

The increased variability in the core collection highlights its potential for discovering new traits and expanding the genetic base of tossa jute. This study provides a solid foundation for future research and breeding programs, ensuring the sustainability and productivity of Corchorus olitorius. The thorough assessment of the germplasm emphasizes the importance of genetic diversity and the benefits of strategic sampling methods to develop representative and efficient core collections. These efforts aim to enhance tossa jute's resilience, adaptability, and overall genetic improvement.

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REFERENCES

Kim, K.W., Chung, H.K., Cho, G.T., Ma, K.H., Chandrabalan, D., Gwag, J.G., Kim, T.S., Cho, E.G. and Park, Y.J., 2007. PowerCore: a program applying the advanced M strategy with a heuristic search for establishing core sets. *Bioinformatics*, 23(16), pp.2155-2162.

Majumder S, Saha P, Datta K, Datta SK. Fiber crop, jute improvement by using genomics and genetic engineering. Advancement in crop improvement techniques. 2020 Jan 1:363-83.

Oral V4T1D1

Stem infection by *Macrophomina phaseolina* disrupts the physiology of jute plants

K. MANDAL, D. BARMAN, S. NANDY, S. SARKAR and D. BANIK

ICAR-Central Research Institute for Jute & Allied Fibres, Barrackpore, Kollkata-700121

E-mail: mandal_kunal@yahoo.co.in

Key Words: *Stem-Rot, Stress-Physiology, Wilt*

INTRODUCTION

Jute is an important natural fibre crop grown in Southeast Asia, with India being a major producer. The stem-rot disease, mainly caused by *Macrophomina phaseolina*, is a major impediment to successful jute cultivation. The disease results in ~10% yield loss which often reaches 35–40% in case of severe attack. The present study is taken up as understanding the physiology of a diseased plant can lead to a better understanding of disease development and help in devising effective management strategies.

MATERIALS AND METHODS

Two susceptible cultivars, one each representing white (*C. capsularis*, cv. JRC-412) and tossa (*C. olitorius*, cv. JRO-524) jute were selected for the experiments. At 70 days after sowing uniform plants were dug out with a minimum injury to the roots and grown under hydroponic conditions. Inoculation was done after three days and observations were noted till seven days after inoculation (DAI). Each plant was inoculated with a virulent isolate of *M. phaseolina* (CJMR-17) at the mid-length of the stem following a stem-tape technique (Mandal et al., 2021). Inoculation was done in a staggered manner so that at the time of data recording plants were at 0, 2, 4 and 7 DAI. One leaf (3^{rd} to 5^{th} leaf from top) from each plant was harvested at the designated time for determination of relative water content (RWC), membrane stability index (MSI) and chlorophyll content following standard protocols (Dwivedi et al., 2018).

RESULTS AND DISCUSSION

Inoculated plants gradually developed stem lesions. The lesion originated from the site of inoculation and spread further (Fig. 1A). Initially it was a water-soaked lesion expanding from the centre. As the lesion size increased in size, the older portion of the lesion turned necrotic while the growing fronts maintained a water-soaked appearance. Lesion length was significantly larger in JRC-412 compared with those of JRO-524. As the lesion length increased, the plants expressed symptoms more akin to distress associated with water deficit. The most striking symptoms were gradual drooping of the leaves on the inoculated plants (Fig. 1B). With the progress of the disease, the leaves rolled, dried, withered and turned yellowish, often with necrotic spots and many leaves fell (Fig. 1C). At 7 DAI, both the species were wilted. Some of the plants were broken at the site inoculation.

RWC was the maximum at 0 DAI and it decreased gradually thereafter. However, foliar RWC at 2 DAI was marginally lower than that of 0 DAI. In both the genotypes, a drastic reduction of RWC was observed from 4 DAI onwards.

With the progress of lesion length and concomitant expression of water-stress symptoms, leaf MSI was also affected. The lowest MSI was recorded at 7 DAI in both genotypes.

Leaf chlorophyll content decreased in the infected plants over time. However, the difference in chlorophyll concentrations in samples collected between the 0 and 2 DAI was nonsignificant. In the case of white jute (JRC-412), chlorophyll a, chlorophyll b and total chlorophyll content in leaves from the infected plants at 2, 4 and 7 DAI varied between 78.3–83.9%, 57.7–84.5% and 77.6–85.7% of the control, respectively. However, for JRO-524, two distinct groups were formed based on the foliar chlorophyll contents.

Fig. 1. *Gradual symptoms development following stem inoculation of JRC-412 (upper panel) and JRO-524 (lower panel) with Macrophomina phaseolina*

CONCLUSIONS

Our study suggests that infection by stem-rot fungus in jute induces water-stress-related symptoms. It disrupts leaf water balance and affects cell membrane stability, thereby disrupting cellular organization. Leaf chlorophyll content was also affected which explains possible reasons for yield reduction by this disease.

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REFERENCES

Dwivedi, S.K., Arora, A., Singh, V.P. and Singh, G.P. (2018). Induction of water deficit tolerance in wheat due to exogenous application of plant growth regulators: membrane stability, water relations and photosynthesis. *Photosynthetica***56** (2): 478-486.

Mandal, K., Anil Kumar, A., Ghosh, D. (2021). Development of screening techniques to evaluate response of jute (*Corchorus olitorius*) to *Macrophomina phaseolina*. Australasian Plant Pathology 50: 621-630.

Oral V4T1D1

Insecticide resistance monitoring and assessment in major lepidopteran pests infesting jute

V. RAMESH BABU, S. SATPATHY and CHINMAY BISWAS
Crop Protection Division, ICAR-Central Research Institute for Jute and Allied Fibres, Barrackpore, Kolkata, West Bengal-700121
E-mail: veegalaramesh@gmail.com

Leaf dip bioassays were carried out with the third instar larvae of second filial generation (F_2) of the major lepidopteran pests viz, hairy caterpillar *Spilosoma obliqua*; indigo caterpillar *Spodoptera litura* and jute semilooper, *Anomis sabulifera* infesting jute against the conventional organophosphorus insecticide, profenophos. The LC_{50} values deduced at 24HAT were 279.3 ppm, 1218.7 ppm and 114.6 ppm for *S. obliqua*; *S. litura* and *A. sabulifera* respectively and depicted 10.63- and 2.43- folds resistance ratio in *S. litura* and *S. obliqua* over *A. sabulifera*. The qualitative and quantitative changes of enzymes viz., carboxylesterase, Glutathione -S-Transferases (GST's) and acetylcholine esterase (AchE) extracted from midguts *S. obliqua*, *S. litura* and *A. sabulifera* revealed that carboxylesterase titres in *S. obliqua*; *S. litura* and *A. sabulifera* were 355.21 µmols $min^{-1}mg^{-1}$ protein, 879.14 µmols $min^{-1}mg^{-1}$ protein and 114.39 µmols $min^{-1}mg^{-1}$ protein respectively depicting a 3.11- folds and 7.68- folds greater carboxylesterase in *S. obliqua* and *S. litura* over *A. sabulifera*. The GST's titre in *S. obliqua*; *S. litura* and *A. sabulifera* were 12.59 µmols $min^{-1}mg^{-1}$ protein, 91.27 µmols $min^{-1}mg^{-1}$ protein and 3.65 µmols $min^{-1}mg^{-1}$ protein respectively and revealed 3.44- folds and 25.01- folds greater GST's titres in *S. obliqua* and *S. litura* over *A. sabulifera* midgut extracts. The acetylcholine esterase (AchE) titre in *S. obliqua*; *S. litura* and *A. sabulifera* were found to be 266.45 µmols $min^{-1}mg^{-1}$ protein, 779.23 µmols $min^{-1}mg^{-1}$ protein and 56.19 µmols $min^{-1}mg^{-1}$ protein respectively and showed 4.74- folds and 13.86- folds greater AchE titres over the *A. sabulifera* midgut homogenates.

Oral V1T1D2

Customized multi-nutrient formulation for boosting rice productivity in the acid-saline soils of sandy plains of Kerala

MINI V.* and A.B. VIJAY
ORARS, Kayamkulam, 690502, Kerela, India.
E-mail: mini.vilas@kau.in

Key Words: *Acid Saline, Customized, Multinutrient, Rice, Soil Fertility*

INTRODUCTION

Acid saline soils of the sandy plains of Kerala, are susceptible to periodic sea water inundation and are known as Orumundakan soils. This is a potential rice cultivation area that is now poorly utilized due to soil fertility constraints and the long duration of the varieties used for cultivation. The possibility of growing medium-duration rice varieties suitable to acid saline soils of Kaipad and Pokkali and acid sulphate soils of Kuttanad can be explored in Orumundakan lands along with customized nutrient management strategies for profitable rice production in this area. Hence the present study has been undertaken to develop and evaluate a customized multi-nutrient formulation for boosting rice productivity in the acid-saline soils of the sandy plains of Kerala by integrating varietal tolerance and nutrition.

MATERIALS AND METHODS

A customised multi nutrient formulation was prepared after analysing the data on the weighted average values Anju (2019) of soil fertility of Orumundakan tract and crop requirement. A multi-nutrient mixture having a composition of (N-1.65%, P-0.10%, K-1.35%, Ca-1.9%, Mg-2.4%, Cu- 0.5%, Zn-1.2%, Mn-0.18%, B-3.74%,) was developed. A field experiment was conducted with three varieties *viz.*, Pournami (V-1) of Kuttanad, Ezhome -2 (V-2) of Kaipad and Vyttila -6 (V-3) of Pokkali with nine treatments, and the treatments were T1 (Recommended dose of fertilizer and lime, T2 (Soil test-based N, P, K+ lime), T3 (Soil test-based N, P, K, Mg + Fine silica @ 100 kg ha-1 + 0.5% Borax), T4 (Soil test-based N+ Double dose of soil test- based P and K+ lime + 0.5% Borax), T5 (Soil test based N, P, K+ lime+ K2SiO3@ 0.5% + 0.5% Borax), T6 (Soil test based N, P, K+ lime + customized foliar spray 0.5%.), T7 (Soil test based N, P, K+ lime+ customized foliar spray 1.0%), T8 (Soil test based N, P, K+ 13-0-46 @ 1 % + 0.5% Borax) and T9 (Absolute control).

RESULTS AND DISCUSSION

Application of customised nutrient formulation in T7 (Soil test -based N, P, K+ lime+ Customized foliar spray 1.0%) resulted in better growth, yield and yield attributes in rice varieties selected for the study. The highest grain and straw yield of 4.23 and 6.56 t ha^{-1} (Table 1) was obtained from plots supplied with T7 (soil test-based N, P, K+ lime+ customized foliar spray 1.0% at maximum and panicle initiation stage). Vyttila-6 (V-3) surpassed other varieties and the treatment plots supplied with supplementary foliar sprays have given higher grain and straw yields. The higher grain yield may be due to the application of sufficient nutrients in combination. Multi-micronutrient formulations enable the delivery of a wide range of plant nutrients in the amount required by crops, improving nutrient usage efficiency and crop yield. Foliar application promotes nutrient absorption and has been identified as the best alternative for compensating nutrient deficit in a shorter amount of time Wassaya *et al.*(2017).
Visual symptoms of iron toxicity were scored using a standard evaluation system for rice developed by IIRI at panicle initiation stage (Fig.1). Absolute control plots showed highest incidence of toxicity symptoms. Varietal difference was observed as Vytila-6 recorded the lowest score in all the treatments. However, no iron toxicity symptoms were observed in plots supplied with multi-nutrient formulation treatments. Rice plants could resist the toxic effects of increased Fe^{2+} in lowlands better when fertilized with N, P, K, S, and Zn, although symptoms were not eliminated Reddy *et al*. (2009).

Table 1. *Effect of customized multi-nutrient formulation on grain and straw yield (t ha^{-1})*

Grain yield (t ha^{-1})					Straw yield ((t ha^{-1})				
Treatments	V1	V2	V3	Mean	Treatments	V1	V2	V3	Mean
T1	2.91	2.68	2.96	2.85f	T1	4.64	4.24	4.50	4.46g
T2	2.61	2.56	2.84	2.67g	T2	4.53	4.10	4.10	4.24h
T3	3.11	2.92	3.21	3.08e	T3	4.85	4.42	4.84	4.70f
T4	3.31	3.12	3.34	3.26e	T4	5.24	4.72	5.08	5.01e
T5	3.61	3.4	3.72	3.58c	T5	5.52	5.15	5.45	5.37c
T6	4.11	3.86	4.22	4.06b	T6	6.20	5.86	6.32	6.13b
T7	4.36	4.12	4.46	4.31a	T7	6.64	6.22	6.86	6.57a
T8	3.48	3.34	3.56	3.46d	T8	5.25	4.90	5.52	5.22d
T9	1.48	1.25	1.28	1.34h	T9	2.32	1.96	1.96	2.08 i
Mean	3.22b	3.03c	3.29a		Mean	5.02a	4.62c	4.96b	
SEm±	m0.017	s0.02	mxs0.049		SEm±	m0.030	s0.032	mxs0.071	
CD(0.05)	m0.054	s0.061	mxs0.136		CD(0.05)	m0.099	s0.089	mxs0.199	

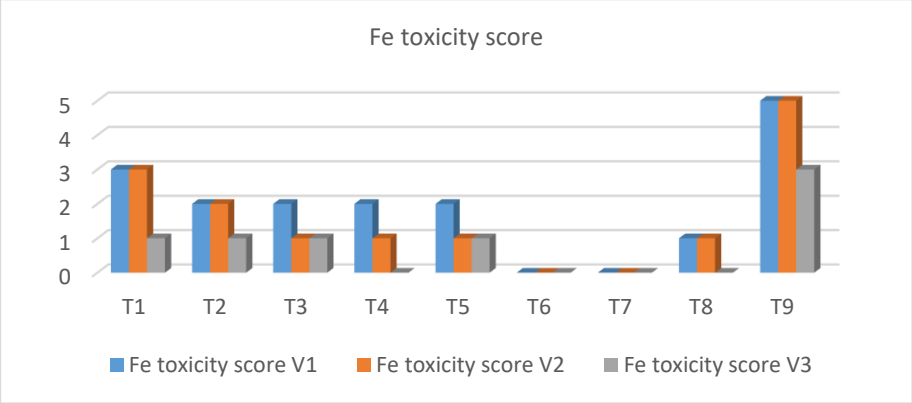

Fig. 1. *Fe toxicity score of three varieties under different treatments*

The highest B: C ratio of 1.86 was obtained for T7 Soil test-based N, P, K+ lime+ customized foliar spray 1.0%) which might be due to the balanced application of nutrient after identifying the limiting nutrients.

CONCLUSIONS

Orumundakan soils are very strongly acidic with low nutrient status. Soil test-based N, P, K+ lime+ customized foliar spray 1.0% at maximum and panicle initiation stage was found to be effective for management the fertility constraints of Orumundakan tract which resulted in the highest yield and B: C ratio. Vytila -6 was found to be the best suitable medium duration variety to this tract followed by Ezhome -2. Profitable rice cultivation in this tract is possible through the integration of acid-saline tolerant rice variety and soil test based NPK+ lime with multi nutrient foliar application at critical growth stages.

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REFERENCES

Anju, P.S. (2019). Development of customized fertilizer formulations for the cultivation of elephant foot yam [*Amorphophallus paeoniifolius* (Dennst.) Nicolson] in Kerala for better farm income and improved tuber and soil quality. *Field Crops Research.* 47: 1-12.

Reddy, F., Simonnot, O.M., and Morel, J. (2014). Short-term effects of biochar on soil heavy metal mobility are controlled by intra-particle diffusion and soil pH increase. *Eurasian Journal of Soil Science.* 65 (2): 149-161.

Wassaya, A., Shabir, M.S., Hussain, M., Ansar, M., Aziz, A., Hassan, W., and Ahmad, I. (2017). Foliar application of zinc and boron improved the productivity and net returns of maize grown under rainfed conditions of Pothwar plateau. Soil Sci. *Plant Nutr.* 17(1): 33-45.

Oral V2T1D2

Effect of nanoscale gypsum foliar application on yield of groundnut crop

CH BHARGAVA RAMI REDDY[1]*, K V NAGAMADHURI[2] and G.P. LEELAVATHI[3]

Institute of Frontier Technology, Regional Agricultural Research Station,

ANGRAU, Tirupati-517502.

E-mail: bhargavaramireddy@angrau.ac.in

***Key Words**: Nano-Gypsum, Foliar Application, Yield*

INTRODUCTION

Nanotechnology deals with small particles with the dimension of 1-100 nm (one billionth of a metre). These particles have high surface mass ratio and are capable of improving the agricultural inputs including gypsum. Nanotechnology applications in agriculture are gradually transforming the theoretical possibilities into the practical applications. The potential is increasing with suitable techniques and sensors being identified for precision agriculture, natural resource management, early detection of pathogens and contaminants in food products, efficient delivery systems for agrochemicals such as fertilizers and pesticides, improved systems integration for food processing, packaging and other areas like monitoring agricultural and food system security.

MATERIALS AND METHODS

Nano-gypsum used in the study was prepared manually by using bentonite nano clay through physical methods. The synthesized nano-gypsum was characterized for its physical, chemical and high resolution microscopic and spectroscopic properties (SEM and TEM). Nano-gypsum was applied as foliar application at different doses and different quantity of water (1g, 2g, 3g per 5, 10, 15-liter water) along with 100% Gypsum (500 kg/ha) soil application as control in completely randomized block deign and replicated three times. Calcium and sulphur analysis before sowing and after harvest physico-chemical properties: Soil reaction (pH), Electrical conductivity (EC), OC; Chemical properties: Available Nitrogen, Available phosphorus, Available potassium, Exchangeable Ca and Mg, Exchangeable sodium; Nutrient content and uptake at flowering &harvest; Yield and Yield attributes.

RESULTS AND DISCUSSION

Nano-sized gypsum is supposed to have high specific surface area, high surface energy, reactivity, mobility and solubility (Verma, 2015) In this experiment attempt has been made to see the effect and reduce the quantity of gypsum and fixes the nano sized gypsum dosage in groundnut crop. Hence the experiment is initiated. The results of this study revealed that the application nano-gypsum @ 2gms nano gypsum in 10 liter water shows significantly highest yield compared to control and which is on par with application of nano-gypsum @ 3gm per 10 liter water.

Table 1: *Effect of nano gypsum (Foliar Application) on yield and yield attributes at harvest, Kharif, 2023*

TREATMENT	Pod yield (kg/ha)	Haulm Yield (kg/ha)	100 pod weight (g)	100 kernel weight (g)	Shelling %
T1= RDF(20-40-50 Kg N:P:K)	1755	3407	89.34	60.18	67.03
T2= RDF+ Nano Gypsum(500Kg/ha) soil application	1730	3481	95.61	66.42	69.45
T3= RDF + Nano Gypsum @1gm/5lit water application	1774	3259	86.81	59.40	68.38
T4= RDF + Nano Gypsum @1gm/10lit water application	1799	3481	103.50	71.74	69.35
T5= RDF + Nano Gypsum @1gm/15lit water application	1877	3630	105.41	73.33	69.48
T6= RDF + Nano Gypsum @2gm/5lit water application	1523	3383	93.39	64.02	68.38
T7= RDF + Nano Gypsum @2gm/10lit water application	2251	3185	106.38	75.87	71.30

CONCLUSIONS

Calcium is essential for most nutrients to be absorbed by plants roots. “Without adequate calcium, uptake mechanisms would fail,”. “Calcium helps stimulate root growth.” Soluble calcium enhances soil aggregation and porosity to improve water infiltration Nano-gypsum had shown nontoxic and higher efficacy in groundnut as compared to conventional gypsum, which could be due to its smaller particle size and higher solubility.

ACKNOWLEDGEMENT

The experiment was conducted during *kharif and rabi* season, 2023-24 in the Department of Soil Science and Agricultural Chemistry, RARS, ANGRAU, Tirupati to evaluate the efficacy of nano-gypsum (NG) on growth and productivity of groundnut crop. This study is hypothesized that nano-sized gypsum is supposed to have high specific surface area, high surface energy, reactivity, mobility, solubility and more efficiency in the ground nut productivity.

REFERENCES

Liu,X., F. Zhao-bin., Z. Fu-dao., Z. Shu-Qing and H.E. XU-Sheng. 2006. Preparation and testing of cementing and coating Nano-subnano composites of slow controlled- release fertiliser. *Agril. Sci. in India,* 5:700-706.

Moraru, C., C. Panchapakesan, Q. Huang, P. Takhistov, S. Liu, and J. Kokini. 2007. ‘Nanotechnology: A new frontier in food science’. *Food Technology,* 57(12): 24–29.

Niemeyer .C.M, P. Doz., 2001. Nanoparticles, Proteins, and Nucleic Acids: Biotechnology Meets Materials Science. *Angewandte Chemie International Edition.* 40(22): 4128-4158.

Nowack. B. 2009. Is anything out there what life cycle perspectives of nano-products can tell us about nanoparticles in the environment. *Nano Today, 4:* 11-12.

Nykypanchuk .D, M.M. Maye, D .van der Lelie and O. Gang., 2008. DNA guided crystallization of colloidal nanoparticles. *Nature,* 451: 549-552.

Oral V3T1D2

Salinity tolerance in coastal rice genotypes: Adaptive traits and yield responses

S. DEVIKA[1] *, D. BURMAN [1], U. K. MANDAL [1], T. D. LAMA [1], N. R. PRAKASH[2], KT. RAVIKIRAN[3], S. MALLICK[1]

[1]ICAR-Central Soil Salinity Research Institute, Regional Research Station, Canning Town, West Bengal, India -743 329

[2]ICAR-Central Soil Salinity Research Institute, Karnal-132001, Haryana, India

[3]ICAR-Central Soil Salinity Research Institute, Regional Research Station, Lucknow-226002 Uttrapradesh, India

E-mail: devika.s@icar.gov.in

Key Words: *Coastal Rice Genotypes, Grain Yield, Osmotic Adjustment, Root Length, Salinity Tolerance*

INTRODUCTION

Salinity stress limits rice (Oryza sativa L.) yield in coastal regions due to seawater intrusion, high evaporation, and poor drainage (Suresh *et al.,* 2024). Coastal states like West Bengal, Odisha,

Andhra Pradesh, Tamil Nadu, and Gujarat face significant yield losses, affecting food security (Dagar et al., 2016). Globally, over 20% of irrigated farmland and nearly 50% of rice areas experience salinity (Shrivastava, 2019). Rice is highly sensitive, especially at seedling and reproductive stages, where excess Na^+ and Cl^- disrupt cellular balance, impair photosynthesis, and reduce grain yield (Atta *et al.*, 2023).

MATERIALS AND METHODS

The study at ICAR-CSSRI, RRS, Canning Town, during Kharif 2024 evaluated five coastal rice genotypes among these here under four salinity levels (0, 4, 6, and 8 dS/m) using FCRD in pot culture. Physiological (days to flowering, root length, RWC) and agronomic traits (plant height, tillers, biomass, grain yield) were analyzed, with ANOVA detecting significant differences at a 5% probability level. The research aims to identify salinity-tolerant genotypes for sustainable rice cultivation in coastal regions.

RESULTS AND DISCUSSION

Plant height increased at moderate salinity (up to 6 dS/m), while root length progressively increased, peaking at 8 dS/m, indicating adaptive water and nutrient uptake. Tolerant genotypes (Nona Bokra, Amalmana, Canning 7) showed higher biomass accumulation and minimized grain yield reduction compared to sensitive types. Enhanced root elongation, biomass accumulation, and osmotic adjustment contributed to salinity tolerance, with root growth playing a crucial role in water absorption under stress.

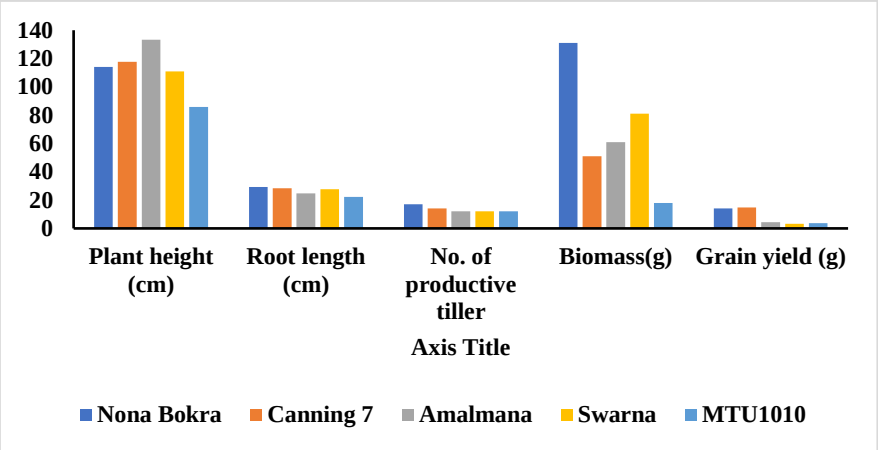

Fig 1: *Salinity Tolerance Traits of Different Rice Genotypes at 6 dS/m*

Table 1: *correlation between root length and different salinity level*

	salinity level ds/m	*Root length*
salinity level ds/m	1	
Root length	0.128351213	1

CONCLUSION

The research highlights the importance of improved root growth, biomass regulation, and yield stability in salinity tolerance. Selection and breeding of tolerant rice varieties are essential to maintaining coastal rice cultivation. Future studies need to adopt physiological, molecular, and breeding strategies to advance salinity tolerance in rice cultivars. The results are highly valuable for breeders and farmers to pursue rice cultivation in saline-susceptible soils, thereby securing stable yield and food security.

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REFERENCES

Suresh, R., Shanmugam, A., Viswabharathy, S., Antony, J. B., Samuthirapandi, S., & Manonmani, S. (2024). Climate Change Impact on Rice Production and Breeding for Climate Resilient Rice. In *Climate-Smart Rice Breeding* (pp. 1-24). Singapore: Springer Nature Singapore.

Dagar, J. C., Sharma, P. C., Chaudhari, S. K., Jat, H. S., & Ahamad, S. (2016). Climate change vis-a-vis saline agriculture: impact and adaptation strategies. *Innovative saline agriculture*, 5-53.

Srivastava, P., Wu, Q. S., & Giri, B. (2019). Salinity: an overview. *Microorganisms in saline environments: strategies and functions*, 3-18.

Oral V4T1D2

Exploring the BTB gene family in jute: Genome-wide analysis and its role in abiotic stress resilience

R. BHOWMICK*, K. N. CHOURASIA, THRIBHUVAN R, J. K. MEENA, K. MEENA and J. MITRA

ICAR-Central Research Institute for Jute and Allied Fibres, Barrackpore, Kolkata-700121, India

E-mail: inforak.007@gmail.com

INTRODUCTION

Jute, a bast fibre crop from the *Corchorus* genus, is known for its environmental sustainability and industrial applications. The two primary cultivated species of jute are *Corchorus olitorius* (tossa jute) and *Corchorus capsularis* (white jute), which differ in characteristics and geographic distribution. *C. olitorius* is believed to have African origins, while *C. capsularis* is thought to be native to Asia (Majumdar et al., 2020). BTB/POZ domains are conserved structural elements in many plant proteins in species like Arabidopsis, rice, tomato, cucumber, and maize, BTB/POZ genes have been shown to play roles in inflorescence architecture, gametophyte development, and responses to environmental stresses, including biotic stresse. This study focuses on analyzing the BTB/POZ gene family in jute at the structural, functional, and evolutionary levels, highlighting genes responsive to abiotic stressors.

MATERIALS AND METHODS

Genome sequences of two jute varieties, *C. capsularis* (CC) var. 'Huangma 179' (HM179) and *C. olitorius* (CO) var. 'Kuanyechangguo' (KYCG), were downloaded from the BIGD database (accession numbers GWHBCLC00000000 and GWHBCLB00000000). HMM profiles of the BTB/POZ domain (PF00651) were retrieved from the Pfam database. BTB/POZ genes were identified using HMM profile scanning with an E-value threshold of 1.0, followed by InterProScan. The physical distribution of BTB/POZ genes within the genome was visualized using MapChart, and intron-exon structures were depicted using the GSDS2.0 server. The molecular weight, isoelectric point, and sub-cellular localization of the proteins were predicted using tools such as CELLO, Isoelectric Point Calculator, and ExPasy Proteomics, respectively. Promoter regions were analyzed for conserved motifs using the PlantCare database. ClustalW was used to align coding sequences, and MEGA7 was used for constructing Neighbor-Joining phylogenetic trees. Synteny and gene duplication events were assessed using MCScanX and visualized using TBtools.

RESULTS AND DISCUSSION

A total of 43 BTB/POZ genes were identified in *C. capsularis*, and 38 in *C. olitorius*. These genes exhibited a broad range of physico-chemical characteristics. The molecular weights of *C. capsularis* BTB/POZ proteins ranged from 28.0 kDa to 154.8 kDa, with an average molecular weight of 66.4 kDa. In comparison, *C. olitorius* proteins ranged from 31.0 kDa to 154.9 kDa, with a mean weight of 68.7 kDa. The average isoelectric points for both species were 6.51 for *C. capsularis* and 6.42 for *C. olitorius*. BTB/POZ genes were distributed across all seven chromosomes in both species. Chromosome 2 in both species had the highest concentration of genes (12), followed by chromosome 3 with 4 genes in each species. Subcellular localization predictions showed that most BTB proteins were localized in the nucleus (26 in *C. capsularis* and 23 in *C. olitorius*), with some also found in the cytoplasm and chloroplasts (11 in *C. capsularis* and 9 in *C. olitorius*). Phylogenetic analysis using the Neighbor-Joining method revealed three clades among the BTB/POZ genes in both species. Clade I contained 36 genes, with 69.4% having NPH3 domains. Clade II included 33 genes, of which 36.3% had MATH domains. Clade III was the smallest, containing 12 genes, with multiple domain types from the zf-TAZ family.Synteny analysis identified 30 syntenic loci between *C. capsularis* and *C. olitorius*, indicating conserved gene clusters and functional roles. Four orthologous gene pairs on separate chromosomes suggested translocation or transposition events. Gene expansion in both species primarily occurred through dispersed and segmental duplication events. Most BTB/POZ proteins (40 out of 43 in *C. capsularis* and 35 out of 38 in *C. olitorius*) contained a single BTB domain, with some genes having multiple domains. The most prevalent domain combinations were BTB and NPH3, followed by BTB and MATH. Intron-exon structures varied, with genes containing 1 to 27 exons in *C. capsularis* and 1 to 28 exons in *C. olitorius*, with most genes having 1 to 5 exons.

In *C. capsularis*, drought stress resulted in increased expression of CcBTB2.9 and CcBTB3.4, while CcBTB2.2 and CcBTB7.5 showed reduced expression. Waterlogging stress triggered an early increase in CcBTB6.1 and CcBTB7.1 expression, while CcBTB3.3 remained repressed. In *C. olitorius*, drought stress induced minimal gene expression changes, with CoBTB5.3 showing significant upregulation. Under salinity stress, CoBTB1.1 exhibited upregulation in roots, while CoBTB5.2 showed

varying regulatory patterns across different tissues. Waterlogging stress induced complex changes, with CoBTB7.5 showing strong upregulation and CoBTB2.9 remaining downregulated.

Promoter analysis revealed 87 cis-regulatory motifs in *C. capsularis* and 84 in *C. olitorius*, with 78 motifs shared between the two species. The most common motifs were binding sites for MYB-type transcription factors, suggesting their role in regulating BTB gene expression under stress conditions. Both species also showed abundant stress-related cis-elements, such as STRE and ABRE, indicating that BTB/POZ genes are involved in stress response mechanisms.

CONCLUSION

This study provides a detailed analysis of the BTB/POZ gene family in *C. capsularis* and *C. olitorius*, highlighting their structural variations, evolutionary patterns, and roles in stress adaptation. The results suggest that BTB/POZ genes are essential regulators of stress responses in jute, governed by complex transcriptional networks involving MYB transcription factors. The study emphasizes the evolutionary expansion of this gene family via segmental and dispersed duplications, underscoring its critical role in enhancing plant resilience to abiotic stress.

REFERENCES

Majumder S, Saha P, Datta K, Datta SK. Fiber crop, jute improvement by using genomics and genetic engineering. Advancement in crop improvement techniques. 2020 Jan 1:363-83

Oral V5T1D2

Standardization of agronomic practices of summer groundnut under coastal tract of West Bengal

R. KUNDU, R. PODDAR, G. MOINUDDIN and T. ALI
Department of Agronomy, Bidhan Chandra Krishi Viswavidyalaya
Mohanpur, Pin-741252, Nadia, West Bengal
E-mail: rajibagro2007@gmail.com

Key Words: *Nutrient Management, Spacing, Summer Groundnut, TG-51, Variety*

INTRODUCTION

Groundnut a leguminous oilseed crop generally 81% is processed for edible oil, 12% is retained as seed for future crops, 6% is consumed domestically and about 1% is exported. Productivity of groundnut during summer season under irrigated situation is relatively high as compared to rainy season, but, injudicious application of inorganic nutrients along with inconsistency in plant density makes it more difficult to rationalize the yield potentiality. Again, selection of suitable cultivar may play an important role to achieve the higher productivity. With this back ground the present field experiment was conducted to assess the performance of groundnut cultivar TG-51 in comparison with local variety under similar agronomic management and to evaluate the response of varied agronomic practices such as fertility levels and plant density on productivity and economics in coastal tract.

MATERIALS AND METHODS

Present field experiment was conducted during two consecutive summer seasons of 2021 and 2022 at Farmer's field of Charabidya village (latitude: 22.19°N and longitude: 88.72°E with an altitude of 6m above mean sea level) of Basanti Block under Canning subdivision of South 24 Parganas District, West Bengal. The experiment was conducted using two cultivars i.e., TG-5 and local check variety along with two planting density (30 x 10 cm and 45 x 7.5 cm) and three nutritional levels (75%, 100% and 125% RDF) in completely randomized block design comprising with seven different treatment combinations replicated four times. The different treatments were T_1: Variety TG-51 along with plant spacing of 30 X 10 cm and 75% Recommended Doses of Fertilizers (RDF), T_2: variety TG-51 along with plant spacing of 30 X 10 cm and 100% RDF, T_3: variety TG-51 along with plant spacing of 30 X 10 cm and 125% RDF, T_4: variety TG-51 along with plant spacing of 45 X 7.5 cm and 75% RDF, T_5: variety TG-51 along with plant spacing of 45 X 7.5 cm and 100% RDF, T_6: variety TG-51 along with plant spacing of 45 X 7.5 cm and 125% RDF, T_7: Farmers' practices i.e. local check variety along with plant spacing of 30 X 10 cm and 100% RDF. The groundnut seed treated with the fungicide in combination with Carbendazim and mancozeb @ 3 g kg^{-1} seed at the time of sowing to prevent the seed borne diseases. Pre and post emergence herbicides were applied in recommended doses irrespective of treatments.

RESULTS AND DISCUSSION

Result revealed that the groundnut variety TG-51 recorded significantly higher pod yield (3083 kg ha^{-1}) over local check variety (2667 kg ha^{-1}) under same management i.e., recommended package practices (T_3 and T_7). The increment in pod yield was to the extent of 15.60 per cent. Further, the pod

yield of groundnut under both the plant spacing i.e., 30 x 10 cm and 45 x 7.5 cm increased significantly with increasing levels of nutrients (T_1 to T_3 and T_4 to T_6 respectively). The maximum pod yield was obtained with 125% RDF (3217 kg ha^{-1}) under plant spacing of 30 x 10 cm and was on par with 100% RDF (3083 kg ha^{-1}) with plant spacing of 30 x 10 cm followed by 125% RDF (3050 kg ha^{-1}) with plant spacing of 45 x 7.5 cm. The higher pod yield was obtained in the plant spacing of 30 x 10 cm as compared to 45 x 7.5 cm under every nutritional level.

Table 1: *Effect of plant spacing and nutrient levels on yield and economics of summer groundnut at coastal tract of West Bengal*

Treatment	Yield (kg ha^{-1})			Harvest Index (%)	Economics			
	Pod yield	Haulm yield	Kernel yield		Total cost (Rs ha^{-1})	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})	BCR
T_1	2810	3585	1978	43.94	42130	112400	70270	2.67
T_2	3083	3861	2195	44.40	44750	123320	78570	2.76
T_3	3217	4149	2313	43.67	47370	128680	81310	2.72
T_4	2503	3263	1775	43.41	40030	100120	60090	2.50
T_5	2884	3657	2068	44.09	42650	115360	72710	2.70
T_6	3050	4039	2199	43.02	45270	122000	76730	2.69
T_7	2667	3477	1856	43.41	44750	106680	61930	2.38
Mean	2888	3719	2055	43.71	43850	115509	71659	2.63
S.Em ±	81.15	105.63	64.75	0.41	--	--	--	--
LSD (0.05)	238.47	310.41	190.28	NS	--	--	--	--

CONCLUSIONS

Though, the treatment T_3 (variety TG-51 alongwith plant spacing of 30 X 10 cm and 125% RDF) produced the maximum seed yield of groundnut but due to its higher treatment cost it may not consider as most economic treatment combination, while, the maximum B:C was recorded under 100% RDF with plant spacing of 30 x 10 cm (2.76) with an increment of 14.28 % over check variety under same situation. Similar type of observation was reported by the Kundu *et al*. (2023).

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REFERENCES

Kundu, R., Poddar, R., Sen, A., Sarkar, A. and Ghosh, D. (2023). Effect of varietal selection and nutrient management on productivity, soil fertility and economics of summer groundnut (*Arachis hypogaea*). *Indian Journal of Agronomy*. 68(4): 392-397.

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Evaluation of maize based intercropping system under deficit irrigation management for improvement of crop and water productivity

R. PODDAR*[1], S. K. PATRA[1], P.K. BANDYOPADHYAY[1,2], ARUP SEN[2], R. KUNDU[1] and ARINDAM SARKAR[2]

[1]AICRP on Irrigation Water Management, Directorate of Research, Bidhan Chandra Krishi Viswavidyalaya, Gayeshpur, Nadia West Bengal-741234

[1]Department of Agricultural Chemistry and Soil Science, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia West Bengal-741252

E-mail: poddar.ratneswar@bckv.edu.in

Key Words: *Deficit Irrigation, Economics, Intercropping, Maize, Water Use Efficiency*

INTRODUCTION

Modern agriculture is facing two major challenges of concomitant changing climate and supplying of adequate food to the over growing human population throughout the world with shortage of land and water resources (Bouman, 2007). Efficient technology adoption for reduction of water waste in surface irrigation is essential for improving the water productivity. Intercropping of cereal with legumes or oilseeds has multidisciplinary advantages through reducing soil erosion, restricting weed infestation, improving soil fertility, minimising the use of chemical fertilizers, enhancing land-use efficiency, and ultimately increasing food diversity and security (Yu *et al*., 2016). Combination of maize

with groundnut or chickpea in an intercropping system may assure food security but their performance under water deficit condition is not examined yet fully. Maize based intercropping under deficit irrigation water management may open a new umbrella for crop production in dryland or limited water supply condition in this region.

MATERIALS AND METHODS

There were 3 levels of irrigations *viz.* ET_0 at 1, 0.8 and 0.6 and 5 level of cropping system *viz.* sole maize, sole groundnut, sole chickpea, maize and groundnut (1:1) (M+GN), maize and chickpea (1:1) (M+CP) under split plot design which were replicated thrice. The experiment was initiated during *rabi* season of 2021-22 and 2022-23 at Central Research Farm, Regional Research Station, Bidhan Chandra Krishi Viswavidyalaya, Gayeshpur, Nadia, West Bengal. Normal crop husbandry practices were followed for the successful raising of the crops. Irrigation was given according to the requirement of potential evapotranspiration (ET_0) of the field through surface furrow method as per requirement. The irrigation was applied in three critical stages (vegetative, reproductive and ripening stage) of the crop.

RESULTS AND DISCUSSION

Result of the experiment showed that under various irrigation regimes maximum growth attributes like plant height, dry matter, LAI, CGR were higher under optimum irrigation (ET_0 at 1.0) for all the component crops. In various intercropping systems, in general, all the sole crop *i.e.*, sole maize, sole groundnut or sole chickpea attained comparatively higher growth attributes when they were grown as a component crop in an intercropping system. Optimal moisture supply (ET_0 at 1.0) resulted more dry matter accumulation which was 5.43% - 11.08% in maize, 10.2 - 28.8% in ground nut and 21.9 - 56.1% in chickpea than deficit irrigation practices. Grain yield of maize was 10.7% and 26.4% higher in ET_0 at 1.0 than ET_0 at 0.8 and 0.6, respectively whereas the kernel yields of groundnut in optimal moisture regime was 14.4% -39.2% more than deficit irrigation practices and the result pf chickpea was 15.7% - 39.9% more in ET_0 at 1.0 in comparison with ET_0 at 0.8 and ET_0 at 0.6, respectively (Table 1). Sole crop generally resulted in lower WUE than intercropping practices and among the sole crop, chickpea resulted lowest CWP under deficit irrigation with ET_0 at 0.6. Among the intercropping M+GN with ET_0 at 1.0 resulted maximum WUE (35.6 kg/ha-mm) followed by same intercropping system with deficit irrigation with ET_0 at 0.8 (34.6 kg/ha-mm). Maize + groundnut (1:1) irrigated with ET_0 at 1.0 showed the maximum benefit, cost ratio (2.94) whereas the lowest value (1.75) was with ET_0 at 0.6 under same intercropping system.

CONCLUSION

From the experiment it can be concluded that intercropping of Maize + Groundnut intercropping cultivation with irrigation application at ET_0: 1.0 can be recommended for higher growth, crop and water productivity as well as economic benefit for this location. If water is scare then irrigation with ET_0 at 0.8 combines with Maize + Groundnut intercropping system can also be recommended based on their performance.

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REFERENCES

Bouman, B.A.M. (2007). A conceptual framework for the improvement of water productivity at different spatial scales. *Agricultural Systems.* 93: 43–60.

Yu, Y., Stomph, T.J., Makowski, D. and van der Werf, W. (2016). A meta-analysis of relative crop yields in cereal/legume mixtures suggests options for management. *Field Crops Research* 184: 133–144.

Table 1. Effect of deficit irrigation and maize based intercropping system on growth, yield, WUE and economics of different crops

Treatment	Plant height (cm) at harvest			Dry matter (g/plant) at harvest			Yield (kg/ha)			WUE (kg/ha-mm)	BCR
	M	GN	CP	M	GN	CP	M	GN	CP		
I_1	243.94	26.76	61.09	125.89	22.21	18.78	5538	1495	1331	28.78	2.63
I_2	242.72	25.46	60.52	119.41	20.15	15.41	5002	1304	1150	28.32	2.34
I_3	236.85	24.49	58.70	113.33	17.25	12.03	4224	1074	951	26.76	2.00
S.Em (±)	**1.88**	**0.35**	**0.81**	**1.54**	**0.50**	**0.03**	**9**	**11**	**14**	**-**	**-**
LSD (p=0.05)	**NS**	**1.38**	**3.20**	**6.05**	**1.95**	**0.13**	**36**	**44**	**55**	**-**	**-**
C_1	245.22	-	-	120.40	-	-	5109	-	-	24.57	2.34
C_2	-	26.60	-	-	20.80	-	-	1921	-	26.57	2.01
C_3	-	-	61.55	-	-	16.03	-	-	1610	22.80	2.21
C_4	241.26	24.54	-	119.51	18.94	-	4900	762	-	34.00	2.56
C_5	237.03	-	58.65	118.73	-	14.79	4755	-	678	31.83	2.51
S.Em (±)	**1.77**	**0.19**	**0.23**	**1.31**	**0.05**	**0.04**	**12**	**8**	**12**	**-**	**-**
LSD (p=0.05)	**5.46**	**0.58**	**0.69**	**NS**	**0.15**	**0.13**	**36**	**25**	**37**	**-**	**-**
I_1C_1	246.86	27.84	-	126.57	-	-	5732	-	-	24.7	2.58
I_1C_2	-	-	-	-	22.89	-	-	2048	-	26.9	2.23
I_1C_3	-	25.67	62.22	-	-	19.17	-	-	1833	23.3	2.48
I_1C_4	243.53	-	-	125.77	21.53	-	5521	943	-	35.6	2.94
I_1C_5	241.42	-	59.95	125.34	-	18.40	5360	-	829	33.4	2.92
I_2C_1	244.99	26.14	-	120.30	-	-	5129	-	-	24.4	2.35
I_2C_2	-		-	-	21.34	-	-	1848	-	27.0	2.04
I_2C_3	-	24.77	61.71	-	-	16.38	-	-	1675	23.8	2.31
I_2C_4	242.32	-	-	119.49	18.97	-	5019	761	-	34.6	2.62
I_2C_5	240.86	-	59.33	118.45	-	14.45	4857	-	626	31.8	2.40
I_3C_1	243.82	25.81	-	114.34	-	-	4464	-	-	24.6	2.07
I_3C_2	-	-	-	-	18.18	-	-	1567	-	25.8	1.75
I_3C_3	-	23.18	60.72	-		12.53	-	-	1323	21.3	1.85
I_3C_4	237.92	-	-	113.26	16.32	-	4160	581	-	31.8	2.13
I_3C_5	228.80	**0.33**	56.68	112.39	-	11.53	4049	-	578	30.3	2.21
S.Em (±) (I×C)	**3.07**	**1.01**	**0.40**	**2.28**	**0.09**	**0.07**	**20**	**14**	**21**	-	-
LSD (p=0.05) (I×C)	**9.46**	**0.35**	**1.20**	**7.02**	**0.27**	**0.22**	**63**	**43**	**63**	-	
S.Em (±) (C×I)	**3.13**	**1.26**	**0.70**	**2.41**	**0.41**	**0.05**	**19**	**12**	**17**	-	-
LSD (p=0.05) (C×I)	**10.61**		**2.69**	**8.27**	**1.60**	**0.17**	**63**	**44**	**58**	-	-

Where, I_1: ET_0 at 1.0; I_2: ET_0 at 0.8; I_3: ET_0 at 0.6 and C_1: Sole Maize; C_2: Sole Groundnut; C_3: Sole Chickpea; C_4: Maize + Ground nut intercropping (1:1); C_5: Maize + Chickpea intercropping (1:1); M: maize; GN: groundnut; CP: chickpea

Oral V7T1D2

Customized and mechanized direct-seeded rice with stress-tolerant cultivars and good agronomic practices

MALAY K. BHOWMICK[1*], SHUBHADIP KAR[2], RAMBILASH MALLICK[2], KEYA BANERJEE[1], INDRANI DANA[1], SUNIL KUMAR[3], P. PANNEERSELVAM[3], VIRENDER KUMAR[4] and SUDHANSHU SINGH[3]

[1]Rice Research Station, Chinsurah (R.S.)-712102, West Bengal, India

[2]Institute of Agricultural Science, University of Calcutta, Kolkata-700019, West Bengal, India

[3]IRRI-South Asia Regional Centre, Varanasi-221106, Uttar Pradesh, India

[4]International Rice Research Institute (IRRI), Los Baños, Laguna 4031, Philippines

E-mail: bhowmickmk@gmail.com

Key Words: *Climatic Resilience, Direct-Seeded Rice, Environmental Sustainability, Stress-Tolerant Cultivars*

INTRODUCTION

Rice farming has become more challenging due to impending climatic vagaries, rising production costs, imbalanced input use, increasing water scarcity, growing labour and energy shortage, *etc*. To address these issues and challenges, direct-seeded rice (DSR) has been regaining its popularity as a climate-resilient, cost-effective, and resource-efficient alternative to puddled-transplanted rice (Kumar, 2022; Kumar *et al*., 2024). Despite multiple benefits, adoption of DSR has been slow and inconsistent due to certain related risks, including early season flooding, poor seed germination, uneven crop stand, severe weed menace, yield decline, *etc*. There is a need to customize and popularize DSR with stress (biotic and/or abiotic)-tolerant rice cultivars coupled with conforming agronomic practices, especially under fragile ecosystem.

MATERIALS AND METHODS

Efforts were undertaken at the Rice Research Station, Chinsurah (Hooghly), West Bengal in collaboration with the International Rice Research Institute (IRRI) to identify appropriate cultivars for their weed tolerance and yield performance under puddled (wet)-DSR condition during both *boro* and

kharif seasons of 2022-23. Four inbreds (*Ajit*, DRR Dhan 42, DRR Dhan 44, *Swarna Shreya*) and four hybrids (27P37, 28P67, Arize 6444 Gold, Arize 8433DT) were evaluated under weed-free and partial weedy situations in split-plot design with three replications. In addition, specific component technologies of wet-DSR were also tested whereas certain others are under investigation at different locations in West Bengal.

RESULTS AND DISCUSSION

The results revealed that the hybrids could display 19.12-37.25 and 17.82-33.78% higher grain yields than the inbreds during *kharif* and *boro* seasons, respectively. Besides yield superiority, hybrids exhibited more tolerance to weed pressure than the inbreds under wet-DSR condition due to a smothering effect and the advantage of heterosis that the crop had over the weeds. The yield losses due to weed competition under partial weedy conditions in hybrids were to the extent of 20.50-21.80 and 20.31-26.90%, whereas inbreds recorded 23.91-41.11 and 29.95-53.78% yield losses during *kharif* and *boro* seasons, respectively. These results demonstrate that the hybrids could buffer yield losses caused by weed competition under sub-optimal weed management. Crop-weed competition could further be manipulated by adjusting/optimizing seeding rate/depth and crop geometry, thereby aiding crop plants to better compete with the weeds. Deployment of good agronomic practices (optimum sowing window, land leveling, mechanized seeding, alternate wetting and drying, integrated weed management, *etc.*) altogether can make the DSR system more customized and precise.

CONCLUSIONS

Rice cultivars suitable for direct seeding should have an appropriate combination of traits, depending on the growing conditions and cropping seasons. Potential cultivars coupled with good agronomic practices hold huge promise for making transformative improvements in upscaling and adoption of DSR towards improving climatic resilience, environmental sustainability, and farmers' profitability under fragile rice ecosystem.

REFERENCES

Kumar, A., Verma, R.L., Sah, R.P., Satapathy, B.S., Mohanty, S., Tripathi, R., Chattopadhyay, K., Samantaray, S. and Nayak, A.K. (2024). *Direct Seeded Rice: A Technology for Enhancing Climate Resilience*. NRRI Research Bulletin No. 50, ICAR-National Rice Research Institute, Cuttack, Odisha, India. pp.32.

Kumar, V. (2022). *DSRC Annual Research Report*, August 2022, International Rice Research Institute, Philippines. 114 p.

Oral V8T1D2

Exploring new rice varieties for rainfed fragile ecosystem in eastern India

INDRANI DANA[1*], MONORANJAN JANA[1], UDAY S. RAY[2], MALAY K. BHOWMICK[1], CHALLA VENKATESHWARLU[3], PALLAVI SINHA[3], VIKAS K. SINGH[3] and SUDHANSHU SINGH[4]

[1]Rice Research Station, Chinsurah (R.S.)-712102, West Bengal, India

[2]Zonal Drought Resistant Paddy Research Station, Hathwara-723147, West Bengal, India

[3]IRRI-South Asia Hub, ICRISAT Campus, Patancheru-502324, Hyderabad, Telangana, India

[4]IRRI-South Asia Regional Centre, Varanasi-221106, Uttar Pradesh, India

E-mail: indranidana@gmail.com

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INTRODUCTION

Rice is the most important food staple in India. Currently, rice production in the country, especially in the eastern region, is being constrained by several factors, including conventional use of traditional cultivars/varieties, concurrent/consecutive occurrence of biotic and/or abiotic stresses, *etc*. Among abiotic stresses, submergence and drought are the most devastating ones that mostly affect the crop in rainfed fragile ecosystem. Meeting future rice demand projections in a sustainable manner is a challenging task in the face of shrinking natural resources and climatic aberrations (Siddiq and Vemireddy, 2021). Breeding rice varieties with enhanced yield, good grain quality and better resilience to different abiotic stresses needs to be an important part of the overall strategy for ensuring food and nutritional security in eastern India (Pradhan *et al*., 2021).

MATERIALS AND METHODS

Breeding efforts were undertaken at Rice Research Station (RRS), Chinsurah (Hooghly) and Zonal Drought Resistant Paddy Research Station (ZDRPRS), Hathwara (Purulia) in collaboration with the Indian Council of Agricultural Research (ICAR) and International Rice Research Institute (IRRI). A

high-yielding variety (HYV), '*Irabati*' (IET 25903), was developed through hybridization between CN 1039-9 (♀) and IR 84196-32 (♂) followed by pedigree method of selection at RRS, Chinsurah, whereas other three HYVs *viz. Lachmanti* (IET 28367), Musafir (IET 28374) and *Suvashini* (IET 29216) were developed through hybridization followed by backcrossing [MTU 1010*3/(♀) x Khao Nok (♂), CT9993-5-10-1-M(♀)/2*Samba Mahsuri(♂) and IR09L204*3/(♀) x Cicih Gedu(♂) , respectively] at ZDRPRS, Hathwara.

RESULTS AND DISCUSSION

Four new rice varieties *viz*. *Irabati* (CN 2068), *Lachmanti* (HTW 33), *Musafir* (HTW 30) and *Suvasini* (HTW 46) have recently been developed, and considered for release by the State Variety Release Committee (SVRC) in West Bengal, India. Among these, *Irabati* proved to be an alternative to *Rajdeep* (IET 17713) under rainfed semi-deep water (40-70 cm) situation for its non-lodging nature and submergence tolerance with higher yield potentials (5.48 t ha^{-1}). Other HYVs (*Lachmanti*, *Musafir* and *Suvasini*) were found resistant to lodging and shattering, and suitable for drought-prone rainfed upland and medium land ecologies. As an alternative to IR 64 (IET 9671), *Satabdi* (IET 4786) and MTU 1010 (IET 15644), *Lachmanti* exhibited an average grain yield of 5.18 t ha^{-1}, whereas *Musafir* registered an average grain yield of 5.55 t ha^{-1}, being higher than the most popular variety '*Lalat*' (IET 9947). *Suvasini* was found to be a potential alternative to IR 64, *Satabdi* and *Lalat*, yielding 5.19 t ha^{-1} in drought-prone areas during *kharif* season.

CONCLUSIONS

Newly evolved rice varieties can be explored for replacing the existing popular ones with a view to ensure sustainable production in the region. Advances in rice breeding by exploiting cutting-edge technologies would help innovate improved rice varieties with higher genetic gains and better climatic resilience.

REFERENCES

Pradhan, S.K., Das, S.R. and Patra, B.C. (2021). Advances in Rice Breeding: Stress Tolerance, Climate Resilience, Quality & High Yield. ICAR-National Rice Research Institute, Cuttack, Odisha, India, p x+426.

Siddiq, E.A. and Vemireddy, L.R. (2021). Advances in Genetics and Breeding of Rice: An Overview. In: *Rice Improvement* (Ali, J. and Wani, S. H., eds.). pp 1-29.

Oral V9T1D2

Studies of F_2 mapping population for stem rot tolerance in Tossa Jute (*Corchorus olitorius*)

JITENDRA KUMAR MEENA[1*], THRIBHUVAN R[1]., KUMAR NISHANT CHOURASIA[1], RAKESH BHOWMICK, KUNAL MANDAL[1], S. SATPATHY[1] and JIBAN MITRA[1]

[1]ICAR- Central Research Institute for Jute and Allied Fibres, Barrackpore, Kolkata, West Bengal - 700121, India

E-mail: jkdhanawat01@gmail.com

Key Words: *Mapping Population, Resistance, Stem Rot, Tossa Jute*

INTRODUCTION

Jute, a natural bast fibre crop from the Malvaceae family and Corchorus genus (Benor, 2018), is primarily grown for fibre in Southeast Asia and as a vegetable in Europe and Africa. Its cultivation is hindered by abiotic and biotic stresses, notably stem rot, which significantly impacts fibre yield and quality (Ashraf and Javaid, 2007). Stem rot, caused by the necrotrophic fungal pathogen *Macrophomina phaseolina* (Tassi) Goid, leads to fibre yield losses of 30-40% in India and Bangladesh. To combat this, there is a need to develop a mapping population for stem rot resistance by using contrasting parents and evaluating resistant/tolerant lines. This study aims to screen for stem rot resistance in jute and identify resistance levels in individual plants of the F2 mapping population under artificial inoculum conditions.

MATERIAL AND METHODS

In this investigation, F_2 mapping population derived from crossing jute accession RS-6 (resistant parent) with OIJ-172 (susceptible parent) was screened for resistance to stem rot disease. These parental lines were differentiated by stem colour as the parental line RS-6 had a red stem while the parent OIJ-172 had a green stem (Figure 1). The F_2 mapping population comprising 125 plants along with the parental lines was raised in summer (Apr-July) of 2024 and artificial stem inoculation of *Macrophomina* fungi was done (following Mandal et al., 2021) in each and every plant (Figure 2) and data were recorded.

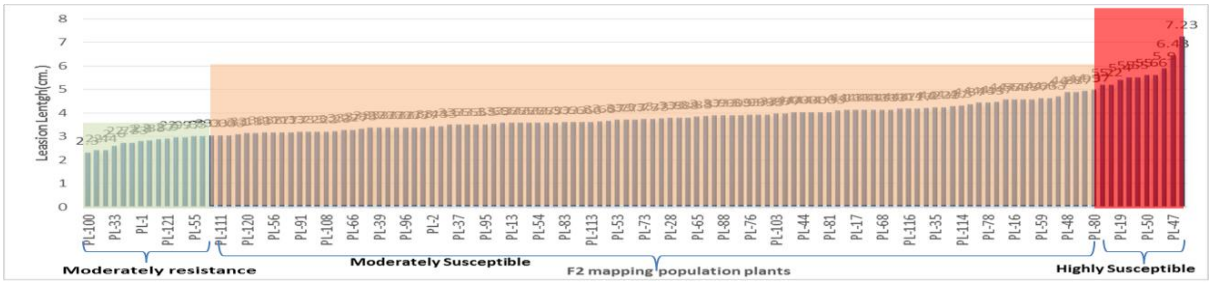

Fig 3: *Description of F_2 mapping population plants based on lesion length (cm) of M. phaseolina pathogen infection.*

RESULTS AND DISCUSSION

Development of mapping population:

In this study, F_2 mapping population derived from the cross, OIJ-172×RS-6, was evaluated against the pathogen of stem rot (*M. Phaseolina*) in the summer-2020 cropping season. The parent OIJ-172 exhibited high susceptibility to stem rot with an average lesion length of 5.53 cm, while the parent RS-6 exhibited moderate resistant reaction with an average lesion length of 2.30 cm (Table 1).

Screening of F_2 population:

In the summer of 2024, 125 F2 plants from the cross OIJ-172×RS-6 were screened for stem rot resistance caused by *Macrophomina phaseolina* using stem inoculation. Lesion lengths were measured at 7, 14, and 21 days post-inoculation (DPI). Plant PL-51 showed the maximum lesion length (6.7 cm) at 7 DPI, while PL-100 had the minimum (2.3 cm). At 21 DPI, PL-51 and PL-100 had lesion lengths of 7.0 cm and 2.4 cm, respectively. Based on lesion lengths at 21 DPI, plants were categorized as smallest (2.0–3.0 cm) in 14 plants, small (3.1–4.0 cm) in 66 plants, medium (4.1–5.0 cm) in 35 plants, large (5.1–6.0 cm) in 8 plants, and largest (>6.0 cm) in 2 plants. Fourteen plants with the smallest lesions (PL-100, PL-40, PL-99, etc.) are considered resistant and suitable for further breeding (Figure 3). No plant was immune or highly resistant; 14 were moderately resistant, while the rest were moderately to highly susceptible.

CONCLUSION

In this investigation, we identified 14 plants (PL-100, PL-40, PL-99, PL-33, PL-89, PL-119, PL-1, PL-43, PL-118, PL-121, PL-6, PL-11, PL-55 and PL-86) as moderately resistant against a deadly disease stem rot caused by *M. phaseolina*. These plants should be further exploited for developing resistant lines by using them in the breeding programme.

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REFERENCES

Ashraf, H., Javaid, A., 2007. Effect of *Macrophomina phaseolina* on the cultivated spp. of jute. Mycopathology 5, 81–84.

Benor, S., 2018. Molecular phylogeny of the genus Corchorus (Grewioideae, Malvaceae sl) based on nuclear rDNA ITS sequences. *The Crop Journal*, 6(5), 552-563.

Mandal, K., Kumar, A.A., Ghosh, D., 2021. Development of screening techniques to evaluate response of jute (*Corchorus olitorius*) to *Macrophomina phaseolina*. *Australian Journal of Plant Pathology*, 50,621–63

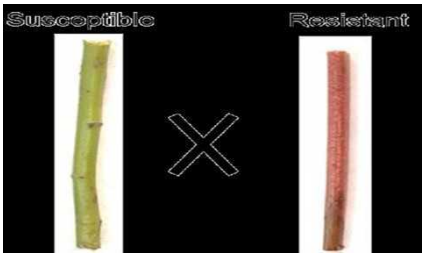


Fig 1: *Susceptible and Resistance Parents*

Fig 2: *Stem inoculation in jute plants*

Table 1: *Screening of parents for M. phaseolina based on stem inoculation*

Lesion length (cm)				
Parents	After 7 days Post Inoculation (7 DPI)	After 14 days Post Inoculation (14 DPI)	After 21 days Post Inoculation (21 DPI)	Reaction type
OIJ-172	5.6	5.2	5.8	Susceptible
RS-6	2.3	2.1	2.5	Moderate resistance

Oral V10T1D2

Enhancing jute (*Corchorus olitorius* L.) fibre yield through hybridization and combining ability studies for breaking the yield plateau

KUMAR NISHANT CHOURASIA[1*], JITENDRA KUMAR MEENA[1*], RAKESH BHOWMICK[1],VIKAS MANGAL[2], A ANIL KUMAR[3], THRIBHUVAN R*[1], , CHANDAN SOURAV KAR[1], AMIT BERA[1], PRATIK SATYA[1], JIBAN MITRA[1], GOURANGA KAR[1]

[1]ICAR Central Research Institute for Jute and Allied Fibres, Kolkata-700121

[2]ICAR Central Potato Research Institute, Shimla – 171001

[3]ICAR-Indian Institute of Oilseeds Research, Hyderabad 500 030

E-mail: chourasiakn@gmail.com

Key Words: *Yield Barrier, Jute, Heterosis, Combining Ability, Diversity, Molecular Markers, Sustainable Fibre Production*

INTRODUCTION

Jute (*Corchorus olitorius L.*) is a versatile, eco-friendly, and biodegradable lignocellulosic fibre regarded as the "fibre for the future". Its high cellulose content, energy absorption capacity, and fire resistance support applications in textiles, composites, and nanomaterials. Additionally, jute serves as a leafy vegetable with nutritional benefits due to its rich composition of vitamins, minerals, and proteins. With global demand for jute bags reaching 500 billion units annually, jute presents a sustainable alternative to plastic, contributing to environmental goals (Alimuzzaman et al., 2024). However, yield stagnation and reduced cultivation area challenge production. Hybridization, leveraging general and specific combining abilities, is crucial for breaking yield plateaus. Molecular markers like ILPs can enhance breeding efficiency, supporting genetic diversity and yield improvement. Therefore, this study was designed to break this yield plateau through hybridization and selection, aiming to create new gene combinations that improve fibre yield.

MATERIALS AND METHODS

Plant Material and Field Evaluation:

Ten genotypes of *Corchorus olitorius,* selected for traits such as pre-flowering maturity, fine fibre quality, and stress resistance, were crossed in a diallel design following Griffing (1956). Ninety crosses, including reciprocals, were developed at ICAR-CRIJAF during August–November 2021. These crosses, along with parental lines and the national check variety JRO 204, were evaluated in a randomized complete block design (RCBD) with three replications during March–June 2022. Yield traits such as plant height, basal diameter, and fibre weight were recorded post-harvest and retting.

Heterosis and Combining Ability*:*

Mid-parent, better-parent, and standard heterosis were calculated using JRO 204 as a standard check. Combining ability analysis was conducted using Griffing's method (1956) and the 'Agricolae' package in R. Variance components and heritability estimates were calculated assuming an inbreeding coefficient (F=1).

DNA Analysis and Marker Studies:

Genomic DNA was extracted via the CTAB method and PCR amplification of ILP markers was conducted to evaluate genetic diversity. Dendrogram construction employed UPGMA clustering and Nei's genetic similarity index (Nei, 1972). ANOVA, Tukey's HSD test, and Pearson's correlation were performed using SAS v9.4 and cross-checked with TNAUSTAT (Manivannan, 2014).

RESULTS AND DISCUSSION

Parents and Hybrids Performance:

The ANOVA results revealed significant genotype effects across all studied traits, indicating the effectiveness of the experimental design with a coefficient of variation (CV) below 20%. Among hybrids, plant height ranged from 401.3 cm (JROBA 4 × JROM 1) to 498.93 cm (JBO 1 × S 19), with a mean of 443.53 cm. Fibre weight per plant was highest in the hybrid JROBA 3 × JRO 2407 (27 g), while the least fibre weight was recorded for JRO 2407 × JROBA 4 (12.85 g). Yield components such as stick weight, green weight, and basal diameter were higher in hybrids compared to parents. Pearson's correlation revealed a positive association between fibre yield and traits like plant height ($r = 0.24–0.406$, $P < 0.01$), stick weight ($r = 0.731$, $P < 0.01$), and green weight ($r = 0.609$, $P < 0.01$).

Heterosis:

The extent of heterosis varied across traits and hybrids. Mid-parent heterosis (MH) for plant height ranged from -3.29% to 9.20%, while better-parent heterosis (BH) spanned -29.13% to 8.81%. Positive heterosis for basal diameter was observed in JROBA 3 × JRO 2407 (28.18%). For fibre weight, MH ranged from -34.08% (JRO 204 × S 19) to 66.15% (JROBA 3 × JRO 2407), with 31 hybrids displaying significant positive MH.

Combining Ability:

The analysis of general (GCA) and specific combining ability (SCA) revealed significant variability, with no parent showing positive GCA effects for all traits. However, JROBA 3 exhibited significant positive GCA effects for fibre yield-related traits. Dominance genetic variance exceeded additive variance, with low narrow-sense heritability (3.38%–12.47%) and moderate broad-sense heritability (37.20%–66.65%).

Genetic Diversity:

Out of 70 ILP markers, 12 were polymorphic, with Nei's genetic similarity index ranging from 0.182 to 1.000. The dendrogram grouped genotypes into two major clusters, revealing significant divergence between hybrids such as JROM 1 and JROBA 3 (Nei's index = 0.183).

Significant genetic diversity among 10 jute parents was observed in traits such as plant height, basal diameter, fibre weight, stick weight, and green weight, demonstrating considerable potential for improvement through breeding. Jatothu et al. (2018) highlighted that stick weight and fibre weight contributed over 75% of total variability in jute germplasm, while Ghosh et al. (2017) and Mangal et al. (2023) reported limited genetic variability among tossa jute genotypes. Zhang et al. (2015) found genetic similarity coefficients ranging from 0.520 to 0.910, suggesting variability influenced by differences in pedigree. Developing hybrids from diverse parents could broaden the genetic base and increase the chances of recovering superior recombinants. Fibre yield, a quantitative trait influenced by factors such as stick weight, green weight, and plant height, exhibited significant associations consistent with previous findings (Sharma et al., 2016; Hasan et al., 2024). High-yielding hybrids outperformed parents, demonstrating hybrid vigour. JROBA 3 × JRO 2407 showed a fibre yield advantage of 24.42% over the national check variety JRO 204, confirming heterosis effects. Mid-parent heterosis (MPH) displayed the highest values for yield traits, followed by standard heterosis (SH). JROBA 3 showed superior general combining ability (GCA) for fibre weight, while specific combining ability (SCA) was prominent in hybrids such as JROM 1 × JRO 8432. Non-additive gene action predominated, as evidenced by high dominance and low narrow-sense heritability (h^2), with fibre weight being an exception. Progeny testing and selection in later generations are recommended for improving traits influenced by non-additive effects.

CONCLUSION

This study demonstrates the potential of hybridization and combining ability analysis to break the jute yield plateau, meeting the growing global demand for sustainable natural fibres. This research identifies superior parental lines and cross combinations that express positive general and specific combining abilities through diallel mating, which would be very important for improving traits like the yield of fibre and biomass accumulation. Observations postulate that hybrid vigour or heterosis is the largest factor for some hybrids to out-yield their parents in fibre yield and other agronomic traits. The cross JROBA 3 × JRO 2407 exhibited the highest SCA, with a notable yield advantage of 24.42% over the national check variety, JRO 204. Therefore, this implies that these hybrids may make a handsome contribution to the fibre production of jute. The study also underscores the importance of genetic diversity and the role of non-additive gene action, suggesting that heterosis should be exploited in breeding programs.

REFERENCES

Alimuzzaman, S., Arin, M. R. A., Mamun, M. A. A., Rahman, A. N. M. M., & Islam, M. R. (2024). A novel approach of manufacturing sustainable seamless jute bags and evaluation of its properties: A comparative study with commercial bags. *Journal of Natural Fibers*, 21(1).

Griffing, B. (1956). Concept of General and Specific Combining Ability in Relation to Diallel Crossing Systems. *Aust J Biol Sci* 9, 463–493. doi: 10.1071/BI9560463

Manivannan N. (2014). TNAUSTAT – Statistical package. Available at: https://sites.google.com/site/tnaustat

Oral V11T1D2

Screening of promising prerelease sugarcane clones for salinity tolerance in Andhra Pradesh

B. VAJANTHA*[1], K. R. TAGORE[1], T. M. HEMALATHA[2], V. SUMATHI[2], M. SREEVALLI DEVI[1], P. NAGAMANI[1] and N. V. SARALA[1]

[1]Agricultural Research Station, Perumallapalle, Tirupati - 517 505, ANGRAU, Andhra Pradesh, India.

[2]Regional Agricultural Research Station, Tirupati - 517 502, ANGRAU, Andhra Pradesh, India.

E-mail: b.vajantha@angrau.ac.in

***Key Words**: Juice Quality, K/Na ratio, Salinity, Sugarcane and Yield.*

INTRODUCTION

Sugarcane (*Sacharun officinarum* L.) is a typical glycophyte grown in arid and semiarid regions and frequently subjected to soil salinity It is one of the important commercial crops in Southern zone of Andhra Pradesh mainly used for manufacture of sugar and jaggery. Chittoor and Tirupati districts have great export potential for jaggery but jaggery prepared from salt affected soils will have inferior quality. About 3% of total sugarcane area is under salt affected soils in the zone. Salinity inhibits plant growth by ion toxicity, nutritional imbalances, osmotic effect and oxidative stress (Chinnusamy *et al.*, 2005). Growing tolerant varieties is one of the management practices and it is mandate to screen prerelease varieties for salinity tolerance before recommending for general cultivation. Keeping this in view an experiment was conducted during 2021-22 with an objective of to study the influence of salinity on growth and yield of promising sugarcane clones at Agricultural Research Station, Perumallapalle, ANGRAU, Andhra Pradesh.

MATERIALS AND METHODS

The experiment was conducted at Agricultural Research Station, Perumallapalle, Tirupati, ANGRAU, Andhra Pradesh, India during 2021-2022 by using micro plot technique. Four pre release sugarcane genotypes along with four standard checks were evaluated with two treatments *viz.*, control and salt treatment (soil EC @ 6 dS m^{-1}) for salinity tolerance. The experiment was laid out in factorial RBD design with three replications. Ten single bud setts per each plot were planted during February, 2021 and harvested in January, 2022. The initial and post harvest soil samples were collected and analyzed by following standard procedures. Before planting of setts, soil EC was developed to 6 dS m^{-1} and maintained until harvest with addition of salt water contains NaCl, $CaCl_2$ and Na_2SO_4 in ratio of 2:2:1 to salt treated plots. The plant samples were collected at grand growth stage for determination of K and Na content. The data on germination, cane length, girth, single cane weight, juice quality parameters like sucrose, commercial cane sugar (CCS), purity, K/Na ratio in plant tissue were recorded in both the treatments for all genotypes. Data obtained from the experiment was statistically analysed by method described ny Panse and Sukhatme (1985).

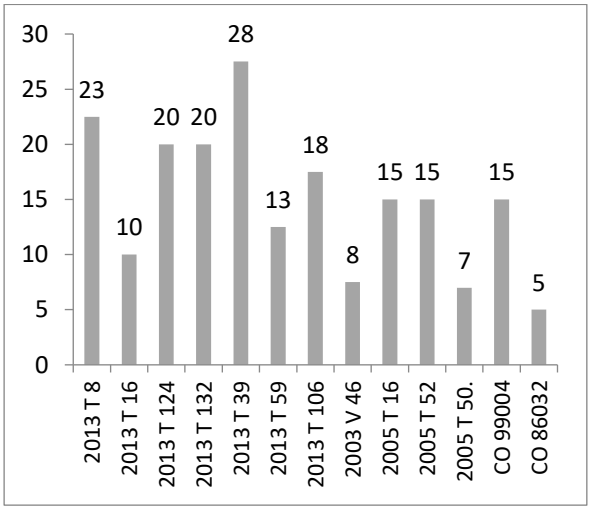
RESULTS AND DISCUSSION

Characteristics like germination, cane weight and K+/Na+ ratio have been considered useful guide to assess plants for salt tolerance. Selection of genotypes on this basis is an important strategy to minimize yield losses in saline soils (Santa maria and Epstcin, 2001). The mean germination percent in control plots (74%) was higher than salt treated plots (59%). Among the entries 2003 V 46 showed highest mean germination percent (74%) and recorded less percent reduction in salt treated plots (8%). The cane weight was significantly affected by varieties and treatments. Control plots showed high mean single cane weight (1.760 kg) than salt treated plots (1.330 kg). The less percent reduction was recorded with 2003 V 46 (2.93%), 2013T59 (3.12%) and Co 86032 (3.89%). Reduction in cane weight of sugarcane genotypes in salt treatment might be due to toxicity of Na+ ions which causes imbalance of other nutrients like K+ and Ca+. It consequently resulted in metabolic imbalances which reduces growth and yield. (Ashraf *et al.*, 2007).

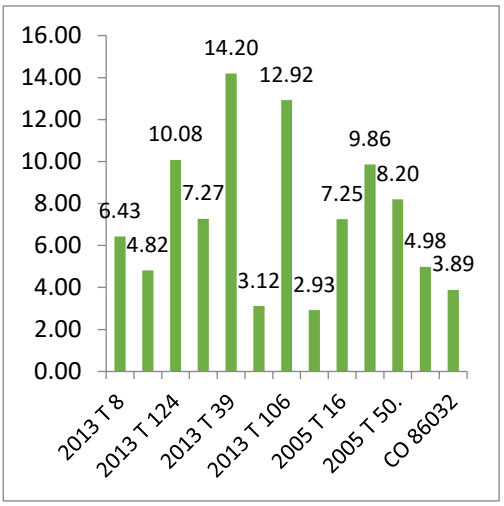
The sucrose and CCS percent was significantly affected by varieties and interaction. The entries 2013 T 39, 2013 T 106 and 2013 T 132 showed less percent reduction in sucrose (1.06, 1.91 and 2.90%. respectively) in salt treated plots. The Na content in plant tissue were significantly affected by treatments. The higher K/Na ratio was recorded with 2013 T 16 (5.50) followed by 2013 T 132 (5.18) and 2013 T 106 (4.87).

Table: *Effect of salinity on germination, cane yield, quality and K/Na ratio.*

Variety	Germination %			Cane yield (kg single cane^{-1})			Sucrose (%)			CCS *%)			K/Na ratio	
	Control	Salt treated	Mean	Control	Salt treated	Mean	Control	Salt treated	Mean	Control	Salt treated	Mean	Control	Salt Treat
2013 T 8	75	53	64	1.52	1.43	1.48	17.1	16.3	16.7	11.0	10.5	10.7	5.3	4.5
2013 T 16	75	65	70	2.20	2.10	2.15	16.9	16.3	16.6	11.9	11.0	11.4	6.1	5.5
2013 T 124	80	60	70	1.73	1.55	1.64	16.5	16.0	16.2	11.3	10.6	10.9	6.1	4.3
2013 T	75	55	65	2.11	1.95	2.03	18.6	18.1	18.3	10.9	10.3	10.6	6.9	5.1
2013 T 39	70	43	56	1.66	1.43	1.54	17.0	16.8	16.9	12.1	10.8	11.4	5.1	4.6
2013 T 59	68	55	61	1.60	1.55	1.58	16.9	16.3	16.6	11.7	10.3	11.0	6.1	4.4
2013 T	73	55	64	2.00	1.75	1.87	17.8	17.4	17.6	12.0	11.4	11.7	6.4	4.8
2003 V 46	78	70	74	1.64	1.59	1.62	16.8	16.2	16.5	11.6	10.2	10.9	4.3	4.1
2005 T 16	78	63	70	1.75	1.63	1.69	18.2	17.4	17.8	12.1	10.9	11.5	6.4	4.8
2005 T 52	80	65	73	2.00	1.80	1.90	19.0	18.5	18.7	11.5	11.3	11.4	5.4	4.8
2005 T 50	75	68	72	1.62	1.49	1.55	17.8	17.2	17.5	11.2	11.0	11.1	6.2	5.6
CO 99004	73	58	65	1.41	1.34	1.37	18.5	18.0	18.2	10.8	10.2	10.5	5.1	3.8
CO 86032	70	65	68	1.62	1.56	1.59	19.3	18.8	19.1	11.6	11.5	11.6	4.9	4.2



Germination %



Cane weight

Fig: *Percent reduction in germination and cane weight*

CONCLUSION

From this study, it is concluded that sugarcane genotypes showed significant difference in germination, single cane weight, sucrose and K+/Na+ ratio when grown under saline conditions. The genotypes 2013 T 16, 2013 T 59, 2013 T 132 and 2013 T 106 were suitable for saline conditions.

REFERENCES

Ashraf, M., Rahmatullah, S., Kanwar, M.A., Tahi, A., and Ali, L., 2007. Differential salt tolerance of sugarcane genotypes. *Pakistahn Journal of Agricultural Sciences.* 44(1):85-89.

Chinnusamy, V., Jagender, A., and Zhu, J. K., 2005. Understanding and improving salt tolerance in plants. *Crop Science*. 45(2):437-448.

Santa maria, G. E., and Epstein, E., 2001. Potassium/Sodium selectivity in wheat and the amphiploid c ross wheat. *Plant Science*. 160:523-534.

Oral V13T1D2

Development and validation of soil test-based fertilizer prescription equations for enhancing yield of mustard in Eastern India

S.P. MAZUMDAR*, B. MAJUMDAR, A. PASWAN, N.M. ALAM, S. GHOSH, S. SARKAR, S. SAHA, G.KAR
Crop Production Division
ICAR-CRIJAF, Barrackpore, Kolkata-700120
E-mail: sonalimazumdar110@gmail.com

Key Words: *Fertilizer Prescription Equation, Mustard, Soil Test Crop Response*

INTRODUCTION

Fertilizer recommendation based on qualitative/ semi quantitative approaches do not give expected yield responses. For judicious application of fertilizers there is a need for fertilizer recommendation on the basis of nutrient requirement of the crop, inherent fertility status of the soil and also on integrated nutrient supply system. Therefore, new approach of location specific fertilizer application based on soil test against the existing practice of general fertilizer recommendation is promoted among the farming community to overcome the current mismatch of fertilizer rates and crop nutrient demand. Fertilizer savings, mean yield, net benefit and benefit-cost ratio is higher where fertilizer was applied on the basis of fertilizer prescription equations as compared to recommended dose or farmers' practice (Mazumdar et al., 2018; Mazumdar et al., 2020; Rangaiah et al., 2024). Therefore, the present investigation was undertaken with the objective to develop economically viable integrated fertilizer prescription equation for recommendation of fertilizers in mustard on alluvial soils of Eastern India

MATERIALS AND METHODS

Soil test crop response (STCR) experiments were conducted in alluvial soils of Eastern India during the 2021-22 rabi season to develop fertilizer prescription equation for targeted yield on mustard. The maize was grown as an exhaust crop during kharif for stabilizing fertility gradient. After harvesting maize, mustard (cv. Kesari 5111) was planted. The main field was divided into three strips and each strip into three organic blocks. Each strip was further divided into 21 plots (18 fertilizer treatments + 3 control plots), resulting in 63 plots. Treatments comprised various combination levels of nitrogen (0, 40, 80, 120 kg N ha^{-1}), phosphorus (0, 20, 40, 60 kg P_2O_5 ha^{-1}), potassium (0, 20, 40, 60 kg K_2O ha^{-1}), and farmyard manure (0, 5, 10 tons ha^{-1}) and were randomized in each of the three strips. Fertilizers used included urea, single superphosphate, and muriate of potash. The optimal fertilizer doses for different yield targets were determined based on crop nutrient requirements, soil efficiency, fertilizer efficiency, and farmyard manure (FYM) efficiency, with validation through farmers' field trials for economic comparison with general fertilizer recommendations and farmers' practices.

RESULTS AND DISCUSSION

The basic data viz., nutrient requirement for producing one quintal mustard, per cent contribution of nutrients from soil (% CS), fertilizer (% CF) and FYM (% CFYM) have been calculated. These basic parameters were used for developing the fertilizer prescription equations under NPK alone and NPK plus FYM. The nutrient requirement of N, P_2O_5 and K_2O, were 3.29, 1.10 and 7.10 kg q^{-1} of mustard, respectively. The % CS and % CF were found to be 22.45 and 31.26 for N, 33.75 and 43.92 for P_2O_5 and 53.28 and 118.89 for K_2O, respectively. Similarly, the per cent contribution of N, P_2O_5 and K_2O from FYM was 12.26, 14.60 and 8.39, respectively. Targeted yield equation for mustard for alluvial soil of Eastern India was developed based on soil test values, nutrient requirement and contribution of NPK from soil and fertilizer sources as well as FYM. Validity of the yield target was tested in farmer's fields and variation in mustard yield obtained from targeted yield was ±10% deviation. Application of ST-TY based fertilizer application with and without FYM, gave higher mustard yield, B:C ratio over farmers practice and RDF

CONCLUSION

The developed equations can be used to make precise fertilizer recommendations for achieving targeted mustard yields in alluvial soils of Eastern India. These fertilizer recommendations are more quantitative and meaningful. This approach allows farmers to choose yield targets based on their resources and management conditions. A ready reckoner of fertilizer doses for mustard has been prepared which will be useful for extension workers, scientists and farmers in balanced fertilization of crops for targeted yield. The ready reckoner revealed that fertilizer requirement increased with increasing yield targets of mustard and decreased with increasing soil test values.

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REFERENCES

Mazumdar, S.P., A.R. Saha, B. Majumdar, M. Kumar, S. Biswas, S. Mitra, R. Saha, S. Sasmal and R. Bhattacharya (2018). Soil test based optimal fertilizer doses for attaining different yield targets of jute in alluvial soils of West Bengal. *Journal of Crop and Weed*, 14, 20-27.

Mazumdar, S.P., Saha, A.R., Majumdar, B., Kumar, M., Alam, N.M., Dey, P., Saha, R., Sasmal, S., Bhattacharya, R (2020). Integrated nutrient management and formulation of fertilizer prescription equation for recommendation of fertilizers for potato on alluvial soils of eastern India. *Journal of Environmental Biology*, 41, 92–100.

Rangaiah KM, Nagaraju B, Kasturappa G, Nagendrachari AN, Kadappa BP, Narayanaswamy UKS, et al. (2024) Inductive cum targeted yield model-based integrated fertilizer prescription for sweet corn (Zea mays L. Saccharata) on Alfisols of Southern India. PLoS ONE 19(8): e0307168. https://doi.org/10.1371/journal.pone.0307168.

Poster T1P01

Genotypic variation in mungbean [*Vigna radiata (*L.) Wilczek] for pre-harvest sprouting and the physiological basis of tolerance

MD. SAZZAD ALI MONDAL*, ISHITA SAMAI, NAJFIMUL SHEIKH, ANJAN KUMAR PAL and ARPITA DAS
Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya
Mohanpur, Nadia-741252, West Bengal, India
E-mail: sazzadali3110@gmail.com

Key words*: Amylase Activity, Mungbean, Phenol, Pre-Harvest Sprouting*

INTRODUCTION

Pre-harvest sprouting is one of the most important abiotic stress factors for lower productivity in crops like wheat, rice, soybean, mungbean, urdbean and groundnut. Prolonged or short spells of rain and high relative humidity at the time of pod or grain maturity leads to premature germination of seeds still being attached to mother plant before crop harvest leading to reduced yield and quality of seeds in these crops. Among the legumes, the incidence of PHS is very high in *Vigna* species. Yield reduction up to the extent of 60–70% have been reported in mungbean due to PHS (Durga and Kumar, 1997). So far, little research works have been done on pre-harvest sprouting in mungbean (Lamichaney *et al*., 2017). The current research work has been envisaged to evaluate few genotypes of mungbean for tolerance against pre-harvest sprouting and to study important biochemical characters in selected genotypes.

MATERIALS AND METHODS

Twenty-six genotypes of mungbean were sown on 14th February, 2022 at District Seed Farm, AB Block, B.C.K.V. at Kalyani, Nadia. The field experiment was conducted in randomized block design (RBD) with three replications. Data were recorded on pre-harvest sprouting in laboratory by exposing the harvested mature pods to optimum moisture and a fixed temperature of 30±1°C. Additionally, data were recorded on some morpho-physiological characters associated with pre-harvest sprouting.

RESULTS AND DISCUSSION

Among all the genotypes, SVM 98, Pusa M 22-31, SML 1933 and PM 1802 scored very low incidence of pre-harvest sprouting with the mean values of 1.02, 1.04, 1.25 and 1.80 percent, respectively and were found to be the most tolerant to PHS. On the contrary, four genotypes, Pusa M 22-32, PMD-14, IPM-512-1 and IPM 205-7 with PHS ranging from 32-51%, had the highest occurrence of such sprouting. Out of all the four tolerant genotypes, Pusa M 22-31 and SML 1933 revealed comparatively higher percentage of fresh seed germination, while the other two, SVM 98 and PM 1802 scored the lowest germination. The four genotypes with high incidences of PHS had higher scores of seed germination. The three genotypes, SVM 98, Pusa M 22-31 and PM 1802 also had comparatively thicker pod wall averaging from 0.18 – 0.21mm. The four tolerant genotypes showed comparatively lower means of pod imbibition percentage, very low percentage of seed imbibition and medium to high seed density. Earlier, Naidu *et al.* (1996) considered thick pod wall and low rate of moisture absorption by pod wall to be the important characters for conferring PHS tolerance in mungbean. The dendrogram revealed that the four genotypes Pusa M 22-32, PMD-14, IPM 512-1 and IPM 205-7 showing comparatively higher susceptibility to PHS grouped in a common cluster B along with two other genotypes MML 2577 and IPM1205-2 scoring moderately higher values of PHS. Whereas the four tolerant genotypes found their positions in a sub-cluster A1 under the big cluster A. Principal component analysis (PCA) indicated that the PHS and seed imbibition with very high positive scores at PC1 and seed density and pod wall thickness with high negative scores contributed maximally for genotypic discrimination. The four tolerant genotypes showed higher content of total phenol in pod wall and seed coat as compared to the susceptible ones. Also, the α-amylase activity in germinating seeds of the tolerant genotypes were found to be lower than the four susceptible ones.

CONCLUSION

The mungbean genotypes under study showed considerable variation in PHS percentage. The higher content of total phenol in pod wall and seed coat along with comparatively lower activity of α-amylase activity during germination contributed towards PHS tolerance.

REFERENCES

Durga, K. K. and Kumar, S. S. (1997) Screening for pre-harvest sprouting in pulses. *Legum. Res.***,** 20: 193–197.

Lamichaney, A., Katiyar, P.K., Laxmi, V. and Pratap, A. (2017). Variation in pre-harvest sprouting tolerance and fresh seed germination in mungbean (*Vigna radiata* L.) genotypes. *Plant Genet. Res.*, 16(5): 437-445.

Naidu, N. V., Seenaiah, P. and Satyanarayana, A. (1996). Mechanism of resistance to pre-harvest sprouting in mungbean (*Vigna radiata* L. Wilczek). *Ann. Agric. Sci*., 17(2): 167-170.

Poster T1P02

Mitigation of salinity stress in wheat by seed priming: A physiological study

NAJFIMUL SHEIKH*, MD. SAZZAD ALI MONDAL, BIPASA HALDER, ANJAN KUMAR PAL and ANIRBAN MAJI

Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya

Mohanpur Nadia West Bengal 741252

E-mail: rronysk10@gmail.com

***Key Words**: Lipid Peroxidation, Salinity, Seed Priming, Reserve Mobilization, Wheat*

INTRODUCTION

The productivity of wheat is constrained by several biotic and abiotic stresses, of which salinity is a major factor. It can affect all the stages of wheat crop starting from seed germination till the seed production. But as compared to late periods, wheat is much more sensitive to salinity during germination and seedling emergence periods (Akkaya,1994). Some earlier studies advocated the use of seed priming as a practical, cost-effective, and low-risk alternative to mitigate the adverse effects of abiotic stresses on seed germination and seedling emergence (Migahid *et al*., 2019). Sowing of primed seeds leads to shortening of imbibition phase and lag phase of water absorption. The pre-germination metabolic processes are also stimulated. The present research work was envisaged to explore the possibility of mitigation of salinity stress in wheat by seed priming treatment.

MATERIALS AND METHODS

Three different priming agents viz., Polyethylene glycol (PEG) 6000, L-Proline and hydrogen peroxide (H_2O_2), were tried for mitigating the salinity stress effect of 100 mM NaCl on wheat cv DBW 39. In each case three concentrations were used. A hydro-priming check (soaked with distilled water) was used along with a no-priming control for comparison of data. The seeds without any salinity exposure were also used for growing seedlings under non-stress condition.

RESULTS AND DISCUSSION

The results indicated that treatment of wheat variety DBW 39 with 100 mM NaCl led to drastic reduction in seed germination and the growth of 10-day old seedling. Moreover, the salinity stress also adversely affected the amylase activity of germinating seeds as well as reserve mobilization at 24 and 48 hours of germination. The membrane damage also increased drastically by salinity treatment as indicated by lipid peroxidation. However, seed priming with different agents significantly mitigated the stress effect although the priming treatments varied among them in respect of mitigating effects. Out of the three concentrations of PEG 6000, the concentration of 2.5% mostly registered the highest mitigating effect of salinity stress in respect of seed germination, seedling growth parameters as well as the physiological characters related to seedling development. On the other hand, proline 25 mM and H_2O_2 10 mM were found to be the best among the different proline and H_2O_2 treatments used as priming agents. The results corroborated the earlier findings of Fuller *et al*. (2012), Feghhenabi *et al*.(2020) and Arican and Demirbas (2022). Principal component analysis (PCA) revealed that the length and fresh weight of seedling along with seed germination with high positive scores and lipid peroxidation with high negative scores contributed maximally for treatment discrimination at PC 1, while amylase activity and reserve mobilization at 24 hours with high positive scores and seedling dry weight having very high negative scores at PC 2 were the main contributors for such discrimination at 2nd component. Among all the treatments, PEG 2.5% and H_2O_2 10 mM grouped together in the first quarter with the positive values of both the principal components.

CONCLUSION

Salinity stress imposed by NaCl 100 mM caused drastic damage to seedling growth of wheat cv DBW 39. Different priming agents caused a substantial mitigation of the stress with PEG 2.5% and H_2O_2 10 mM proving to be the best.

REFERENCES

Akkaya, A. (1994). Buğday Yetiştiriciliği Kahramanmaraş Sütçü İmam Üniversitesi Ziraat Fakültesi Genel Yayın No:1, Ders Kitabı No:1, Kahramanmaraş S 225.

Arican, E. S. and Demirbas, S. (2022). Effects of sequential hydrogen peroxide applications on salt stress tolerance in bread wheat varieties. *J. Agric. Sci*., 28(4): 592-602. DOI: *10.15832/ankutbd.896112.*

Feghhenabi, F., Hadi, H., Khodaverdiloo, H. and van Genuchten, M. T. (2020). Seed priming alleviated salinity stress during germination and the emergence of wheat (*Triticum aestivum* L.). *Agric. Water Manag*., 231: 106022.

Fuller, M. P., Hamza, J. H., Rihan, H. Z. and Al-Issawi M. (2012). Germination of Primed Seed under NaCl Stress in Wheat. *Int. Scholarly Res. Netw.* (ISRN Botany). pp1-5.

Migahid, M. M., Elghobashy, R. M., Bidak, L. M. and Amin, A. W. (2019). Priming of *Silybum marianum* (L.) Gaertn seeds with H_2O_2 and magnetic field ameliorates seawater stress. *Heliyon*, 5(6).

Poster T1P03

Effect of irrigation and fertigation levels through pulse drip irrigation on yield parameters of carrot (*Daucus carota* L.)

G. RAWAT[1*], S. K. JENA[2] and U. S. KADAM[3]

[1]Indian Institute of Water Management, Bhubaneswar-751023, Odisha, India

[2]Indian Institute of Water Management, Bhubaneswar-751023, Odisha, India

[3]College of Agricultural Engineering and Technology, Dapoli-415712, Maharashtra, India

E-mail: gvndrawat@gmail.com

Key Words: *Fertilizer Level, Irrigation Level, Pulse Number, Root Length, Shoulder Diameter*

INTRODUCTION

The estimated available water in India is about 199.9 Mha-m out of which 112.3 Mha-m can be used. The demand of fresh water in India for domestic, irrigation, energy, industries and others are 4.26, 55.38, 2.13, 3.55 and 5.68 Mha-m respectively, which sums up to 71.0 Mha-m (Vohra & Franklin, 2021). The growing population and social-economic development of world increase demand of water resources day by day (Zapata & Segura, 1995). Water savings can be achieved either by decreasing the frequency of irrigation events or by a systematic reduction of water for irrigation (Darwish *et al*., 2006). The application of irrigation water in stages or pulses rather than all at one time can save water by giving the media time to moisten from the first pulse of water thereby allowing it to absorb subsequent irrigation more readily and reducing the total amount of water required. The present study was conducted to study the effect of different levels of irrigation and fertigation through pulse drip on yield parameters of carrot (*Daucus carota* L.).

MATERIAL METHODS

The experimental site is situated at 17° 45' 14" N latitude and 73° 10' 45" E longitude with altitude of 250 m. The location is in coastal belt of Konkan region of Maharashtra state. The experimental design was strip-split plot and replicated three times. The unit plot size was 22.0 m × 15.1 m having a single bed dimension was of 2 m × 0.80 m. Plant to plant and row to row spacing of carrot was 5 cm and 20 cm, respectively. The inline lateral of 16 mm diameter with emitter spacing of 40 cm was used which has 4 Lph discharge at 1.0 $Kg.cm^{-2}$ operating pressure. The daily water applied for carrot (Daucus carota L.) under pulse drip irrigation was worked out based on modified Penman-Monteith method (Allen *et al*. 1998). The statistical analysis was done by "analysis of variance" appropriate for the 'strip-split plot design' with the statistical software SAS. The carrot cultivar used in the experiment was "Desi red" with daily values of Kc as 0.7, 1.05, 1.05 and 0.95 for the initial, crop development, mid and maturity stages of the carrot crop, respectively (Allen *et al*. 1998). The yield parameters such as shoulder diameter and carrot length were recorded from 5 randomly selected plants before final harvesting of the crop.

RESULT AND DISCUSSION

The crop evapotranspiration (net depth) during the year 2019-20 and 2020-21 was varied from 317.9 mm to 284.1 mm. The yield parameters were significantly affected by pulse numbers and maximum average shoulder diameter and average root length i.e., 3.96, 4.07 and 4.02 cm and 21.50, 24.65 and 23.08 was found in P_4 and P_1 pulse levels during 2020, 2021 and pooled analysis. The value of 3.74, 3.75 and 3.75 cm in I_2 and 20.86, 24.39 and 22.63 cm in I_1 irrigation levels was found maximum during 2020, 2021 and pooled analysis for shoulder diameter and root length, respectively. The measurement of yield parameter was found increased as fertigation level increased and the maximum average shoulder diameter and average root length were found to be 3.71, 3.75 and 3.73 cm and 20.89, 24.57 and 22.73 cm in F_3 fertigation level during 2020, 2021 and pooled analysis, respectively.

The maximum average shoulder diameter is found to be in $P_4I_2F_2$ i. e. 4.25, 4.33 and 4.29 cm during the year 2020, 2021 and pooled data. The study also revealed that maximum average root length was found in $P_2I_3F_3$ (25.50, 31.37 and 28.44 cm). It is clearly indicated that the carrot crop found congenial condition in root zone of four pulses (P_4) with optimum irrigation level I_2 under fertigation level F_2, therefore carrot diameter value was more. The treatment combination $P_2I_3F_3$ revealed maximum carrot length, it might be due to availability of ample water and nutrients in the soil which provided favorable condition for root elongation at moderate pulse irrigation.

CONCLUSION

In present study input resources were water and fertilizer quantity along with recent technology pulse irrigation, which concluded as that yield parameters like average shoulder diameter and root length has shown highest value in $P_4I_2F_2$ and $P_2I_3F_3$, where available soil moisture depletion was observed less than 20% before irrigation and slightly higher than field capacity after 2 hrs of irrigation about the emitter at 30 cm depth with more nutrient availability, which might have created favorable environment in root zone for root growth.

REFERENCES

Allen, R. G., Pereira, L. S., Raes, D., and Smith, M. (1998). "Crop evapotranspiration: Guidelines for computing crop requirements." *Irrigation and Drainage Paper No. 56*, FAO, Rome, Italy.

Darwish, T. M., Atallah, T. W., Hajhasan, S. and Haidar, A. (2006). Nitrogen and water use efficiency of fertigated processing potato. *Agric. Water Manage*. (85):95-104.

Vohra K. and Franklin M. L. (2021). Water Resources Management– An Indian Perspective. *Hydrological Aspects of Climate Change*: 237-252.

Zapata M. and Segura P. (1995). Riego deficitario controlado: Fundamentos y aplicaciones. Ediciones Mundi Prensa, Madrid, España: p. 188.

Poster T1P04

Rice water productivity mapping for Lawan command area using ANN model and GIS

FANESH KUMAR[1*], S. K. JENA[1] and JITENDRA SINHA[3]

[1]ICAR- Indian Institution Water Management, Bhubaneswar – 751023, Odisha, India

[2]Indira Gandhi Agriculture University, Raipur - 492012, Chhattisgarh, India

E-mail: faneshsahu1994@gmail.com

Key Words: *Artificial Neural Network, Reference Evapotranspiration, Water Productivity*

INTRODUCTION

Water, is our most important natural resources, which is scarce at certain times and at certain places. The scarcity of water, regarded as the most important factor in crop production, is usually a limiting factor in the development of irrigation scheme particularly in semiarid regions. Irrigation scheduling is the process of supplying the needed amount of water for crops at the most appropriate time so that soil water content never falls below the allowable depletion level to avoid the crop stress, thus maximizing the yield. Another important objective of maximize irrigation efficiency by minimizing runoff and percolation, losses and in turn, saving water and energy. Artificial Neural Networks (ANN) is one of several methods being utilized to address this issue. ANN are high-performance computing systems that use interconnected neurons to model nonlinear systems, making them easier to use than climatological models.

MATERIALS AND METHODS

To estimate rice water productivity, long term (20 years) of climatological data from the study area were analyzed in ANN. The crop considered in this study is rice (variety: Swarna- Sub1), which is predominantly grown in the command area during the *Kharif* season and has an average sowing date of 23rd June and an average harvesting date of 14th November. There are 4 different stages (initial stage, development stage, mid-season stage, and the late season stage) of rice growth in the command area. The study was conducted for Lawan Command Area (LCA), in this scheme irrigated 2965 ha *Kharif area* of Balodabazar district, Chhattisgarh. In this experiment use Artificial Neural Networks (ANN) and MATLAB model. ANN was used for daily reference crop estimation using evapo-transpiration (ET_o). Concerns related to ANN usage included the number of processing components, hidden layers, and various learning techniques. Three learning strategies were taken into consideration, back propagation with momentum and normal back propagation (Kumar *et al.*, 2002).

RESULTS AND DISCUSSION

This study incorporates three different ANN models (A1, A2, and A3), depending on the combination of inputs to the network. The final model structure (A1LC) in terms of number of layers – number of input neurons – number of hidden neurons – number of output nodes – number of iterations was "3-6-7-1-500" with normalized 'sse' performance 33.4. At this stage the model was considered as generalized. It was also shown that a greater number of iterations was causing over learning by the network. Similarly, the final model structure A2LC (A2 model of Lawan command) and A3LC (A3 model of Lawan command) were found to be "3-4-7-1-500" and "3-2-7-1-500" with normalized 'sse' performance 28.1 and 31.2 respectively.

Crop water productivity in *Kharif* rice was estimated using various ANN models over a 20-year period in village-wise for the LCA. The crop evapotranspiration (ET_c) was found to be 553.6 mm, 554.0 mm, and 557.8 mm for models A1LC, A2LC, and A3LC, respectively. The maximum and minimum consumptive water usages were found in Sundrawan, Gora, and Sundry, respectively. The maximum CWP was 0.662 kg-m^{-3} in Sundry, and 0.575, 0.575, and 0.571 kg-m^{-3} in Harinbhatta for models A1LC, A2LC, and A3LC. GIS maps of crop water productivity in the LCA were also used. The average crop evapotranspiration of *Kharif* rice was estimated using the CROPWAT model, which showed variations of 0.13 %, 0.21 %, and 0.88 % for models A1LC, A2LC, and A3LC, respectively.

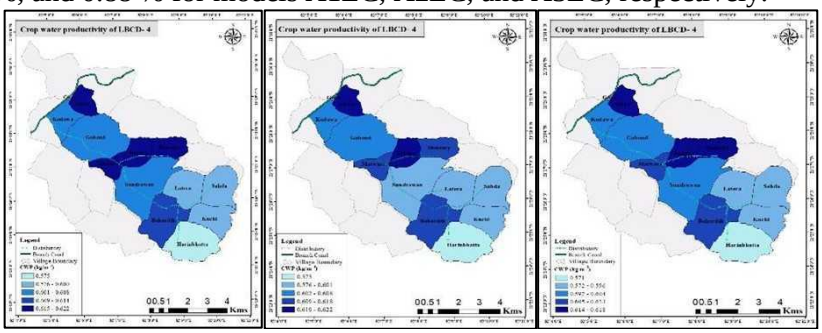

Fig. 1*: Crop water productivity map of A1LC, A2LC and A3LC models*

Table 1: *Estimation of 20 years average Rice Water Productivity of A1LC model in 11 villages*

Villages	Yield (kg)	CWU (m^3)	CWP (kg-m^{-3})	Villages	Yield (kg)	CWU (m^3)	CWP (kg-m^{-3})
Kodawa	830519	1364991	0.608	Sundrawan	1798180	2956436	0.608
Gaboud	1432370	2357397	0.608	Latera	816039	1368814	0.596
Girra	490592	789880	0.621	Bohardih	1052230	1713600	0.614
Matwari	486707	787751	0.618	Sahda	1175416	1958659	0.600
Sisdeory	341706	551546	0.620	Kuchi	838612	1412822	0.594
Sundry	679393	1091625	0.622	Harinbhatta	763156	1327370	0.575
Gora	28883	48388	0.597	-	-	-	-

CONCLUSIONS

The study assessed the long-term rice water productivity in command areas using ANN. The findings can help increase yield per unit area by reducing unproductive water outflows and depletion, thereby maximizing rainfall use. The results can guide farmers on water use for crop production.

ACKNOWLEDGEMENT

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REFERENCES

FAO (1998). Crop evapotranspiration: Guidelines for computing crop water requirements. *FAO irrigation and drainage* paper 56. Rome, Italy.

Kumar, F., Sinha, J., Tripathi, V.K., Jangre, N. (2023). Assessment of rice water productivity for Pindrawan command area using ANN model and GIS. *Pharma Innovation Journal* 12(10): 1816-1822.

Fanesh Kumar, Jitendra Sinha, Vivek Kumar Tripathi and Nilima Jangre. Kumar, M., Raghuwanshi, N.S., Singh, R., Wallender, W.W. and Pruitt, W.O. (2002). Estimating evapotranspiration using artificial neural network. *Journal of Irrigation and Drainage Engineering*, ASCE 128:224-233.

Poster T1P05

Bio efficacy evaluation of bio stimulant product in growth and yield of *rabi* maize in coastal saline zone of West Bengal

S. SARKER[1*] and D. KUNDU[2]

[1]Department of Agronomy, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur-741252, Nadia, West Bengal, India

[2]Regional Research Station (CSZ), BCKV, Akshaynagar, Kakdwip-743347, South 24 Parganas, West Bengal, India

E-mail: sudiptasarker2015@gmail.com

Key Words: *Bio Stimulant, Coastal Saline Zone, Maize, Phytotoxicity, Yield*

INTRODUCTION

Use of bio-stimulant products is becoming popular as a tool to combat changing climatic scenario in different field crops apart from their standard managerial practices. Bio-stimulants are natural or synthetic substances containing different organic acids, seaweed extracts, vitamins and amino acids etc. that are applied at different growth stages of crop through seed, plant or soil at low concentration leading to better seed germination, enhanced crop vigor and root growth (Du Jardin, 2015). The application of bio-stimulants should be in optimum doses and appropriate growth phase of a crop to attain maximum benefits. Simultaneously, phytoxicity, if any must be well evaluated. On the other hand, incorporation of maize in cropping system in coastal saline zone may turn out successful and satisfy the local needs. In this context, a field experiment was conducted to evaluate the bio-efficacy of bio-stimulant product in growth and yield improvement of maize in coastal saline zone.

MATERIALS AND METHODS

The experiment was conducted at Regional Research Station (Coastal Saline Zone), Bidhan Chandra Krishi Viswavidyalaya, Kakdwip, South 24 Parganas, West Bengal in *rabi* 2023 (variety P3535) to evaluate the efficacy of different levels of bio stimulant Sosdia Stress. The field trial was laid in Randomized Block Design (RBD), with 6 treatments and 4 replications with a plot size of 3 m× 10 m. Seeds were sown manually on 13.10.2023 with spacing of 60 cm × 20 cm and a seed rate of 20 kg/ha. Standard nutrient management and weed control schedule for maize were followed. Crop phyto-toxicity, plant height, dry matter accumulation, crop vigor was measured 20 days after 1st and 2nd application of bio-stimulant sprayed during V7 stage and silking, respectively. Yield parameters and yield was recorded at the time of harvesting (26.02.2024). All the collected data were analyzed statistically by the analysis of variance (ANOVA) technique using SPSS software (IBM).

Treatment details:

Treatments No.	Treatments	Rate	Timing
T1	Sosdia ™ Stress	500 ml/ha	A
T2	Sosdia ™ Stress	500 ml/ ha	B
T3	Sosdia ™ Stress	250 ml/ha	A+B
T4	Sosdia ™ Stress	500 ml/ha	A+B
T5	Dhnanzyme Gold	Label rate (625 ml/ha)	A+B
T6	Untreated check	-	-

A: 30 Days After Emergence (V7 stage), B: 60 DAE (R1 or silking stage)

RESULTS AND DISCUSSION

Application of Sosdia Stress 500 ml/ha both after V7 and R1 stage (T4) increased plant height and crop biomass significantly as compared to untreated control and even commercial bio-stimulant applied at label rate (T5) after 1st spray and it was found to be significantly superior to all other treatments after 2nd spray. Kiran *et al.* (2020) found similar kind of effect of biostimulent on plant height of maize. Visual crop biomass and crop vigor assessment revealed that the application of bio-stimulant products boosted up the growth and vigor of maize crop that could be observed visually. No major phytotoxicity was found after spraying bio-stimulants at V7 and silking stages.

All the yield attributes and subsequently seed yield were found to be increased with application of biostimulant- Sosdia Stress. Cob length (24.8 cm), number of seeds/cob (561.9) and weight of grains/cob (198.2 g/cob) were recorded to be highest with application of T4 (Table 1). Seed yield was highest with application of T4 (8.36 t/ha) which was around 22% higher than control (6.49 t/ha) and significantly higher than all other treatments mainly due to higher yield attributing parameters. Praveen *et al.* (2024) reported that application of 75% RDF + *Azotobacter* + PGPR + HA + SWE was better than other treatment in maize.

***Table 1**. Effect of application of Sosdia Stress on yield attributes and yield of maize*

Treatments	Cob length (cm)	No. of seeds/cob	Wt. of seeds/cob (g)	Seed yield (t/ha)
T1	22.1bc	397.8b	155.9ab	7.19bc
T2	23.3c	415.5c	165.5bc	6.91ab
T3	19.3ab	437.6d	170.4cd	7.49c
T4	24.8c	561.9f	198.2e	8.36d
T5	22.7c	488.8e	180.5d	7.378bc
T6	18.2a	378.7a	149.3a	6.49a
CD at 5%	3.1	16.2	10.2	0.48

CONCLUSION

Growth and development and seed yield of maize improved significantly with application of bio-stimulants. Application of Sosdia™ Stress @ 500 ml/ha applied after both V7 and silking stage was found to significantly enhance the crop growth and seed yield of maize**.**

REFERENCES

Du Jardin, P. (2015). Plant biostimulants: Definition, concept, main categories and regulation. *Scientia horticulturae*, 196: 3-14.

Kiran, S. K., Prakash, S. S., Chamegowda, T. C., Krishnamurthy, R., Yogananda, S. B., and Asha, N. N. (2020). Effect of different biostimulants on growth parameters of maize in red soils of karnataka. *Journal of Pharmacognosy and Phytochemistry*, 9*(*6): 541-545.

Praveen, B.R., Singh, M., Babu, R. C., Kumar, S., Naragund and Teli, K. G. (2024). Biostimulants based nutrient management on growth and yield of spring maize (*Zea mays*) under legume based cropping sequence. *The Indian Journal of Agricultural Sciences*, 94(12): 1305-1310.

Poster T1P06

Inoculation of microbial consortium in soil reduces the application of nitrogen fertilizer in rice (*Oryza sativa L.*) production

SOURAN BHUKTA and SANJIB KAR

Department of Agricultural Chemistry and Soil Science, Institute of Agricultural Science, University of Calcutta. 35, B.C. Road, Kolkata-700019.

E-mail: souranbhukta1998@gmail.com

***Key Words:** Microbial Inoculants, Organic N-Fertilizer, Rice Yield, Sustainable Agriculture,*

INTRODUCTION:

Increase in the use of N-fertilizers, the global N-cycle has been altered, resulting in higher production of greenhouse gases (N_2O, NO_X), depletion of stratospheric ozone, decrease of the soil organic matter and loss of biodiversity (Hakeem *et al.,* 2016; Singh, 2018) and increase fiscal burden of the government in terms of urea subsidy. A sustainable alternative is the use of "Microbial inoculants" i.e. preparation containing live or latent cells of efficient strains of nitrogen fixing, phosphate solubilizing or cellulolytic microorganism used for application to seeds, soil or composting areas with the objective of increasing the number of such microorganisms and accelerate those microbial process which augment the availability of nutrients that can be easily assimilated by plants (Borasate *et al.,* 2009). The objective of the study was to evaluate the effect of selected stains of microbial inoculants in rice production along with different doses of nitrogen fertilizer.

MATERIALS AND METHODS

Different combinations of Microbial inoculants (Biofertilizers), organic composts, and chemical fertilizers at certain doses were used as treatments, pot experiment, incubation study and chemical analysis is done in regular time intervals. *Azotobacter* inoculants were used as a source of N fixing bio-fertilizer. Phosphorus solubilizing fungi i.e., vesicular arbuscular mycorrhiza (VAM) was applied to release fixed P in soil and make them available to plants and plant growth promoting rhizobacteria (PGPR) *i.e., Pseudomonas fluorescens* and *Trichoderma viride*. Organic compost had been made by mixing Humic acid @ 0.5%, and Vermicompost with FYM @ 1:1 ratio @ 2% per 5kg soil. Treatments T1-T3 contains only microbial inoculants; In T4-T6 biofertilizers + NPK used; T7-T9 contains biofertilizers + NPK + humic acid; T10-T12 contains biofertilizers + NPK + organic composts; T13-T15 contains biofertilizers + organic compost; T16 is the control with only NPK (120:60:60).

RESULTS AND DISCUSSION

The maximum yield was seen in T12 which consisted of tetra microbial inoculants along with organic compost (humic acid, Vermicompost and FYM) and chemical fertilizer followed by T14 which consist of tetra microbial inoculants along with organic compost (humic acid, Vermicompost and FYM),

no chemical fertilizer. While the minimum yield was seen in T1 where only Azotobacter was applied. Highest available N was recorded in T12 (188.0 mg kg-1), it indicates the microbial activity increases the N availability in soil than the application of chemical fertilizer during the crop growth stage and after the harvesting.

Table 1: *Effects of chemical and microbial inoculants on grain and straw yields, total biomass and harvest index*

Treatments	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Total biomass (t ha^{-1})	Harvest index (%)
T_1	2.43	3.07	5.773	43.391
T_2	3.097	3.835	6.862	45.068
T_3	4.01	4.587	8.598	46.739
T_4	4.11	4.52	8.867	46.583
T_5	4.36	5.098	9.412	46.247
T_6	4.93	5.528	10.415	46.988
T_7	4.67	4.787	9.587	48.755
T_8	5.117	5.14	10.427	48.607
T_9	6.213	6.6	12.566	48.419
T_{10}	6.04	6.58	12.317	48.304
T_{11}	6.61	6.703	13.39	48.60
T_{12}	7.85	7.989	15.532	48.973
T_{13}	5.89	6.828	12.68	47.717
T_{14}	6.66	6.87	13.427	48.207
T_{15}	7.46	7.56	14.687	48.55
Control(T_{16})	4.54	5.012	9.397	45.989
SEm±	0.21	0.14	0.10	0.10
CD (P=0.05)	0.62	0.41	0.30	0.29

Phosphorous availability in soil increases, compare to control. Phosphorous availability increases up to, eight to nine times in T5 T6 T8 T9 and T11 treatments. This observation indicates that microbial inoculants is best for making phosphorus become solubilizing in soil and a significant remedial treatment rejuvenating phosphorous deficient soil.

Benefits of humic acid are reflected in improved seed germination, root growth, uptake of minerals by plants. α-tocopherol (vitamin E) and globulin protein concentration increases more compared to inorganic fertilizer treatments.

CONCLUSION

Application of these selected strain significantly increased seed germination, growth and yield of rice compare to an untreated control. Grain quality was superior in inoculated treatments reaching specific increases of 33% (N) than non-inoculated treatments.

The strains showed that the parameters such as shoot dry weight, tillering and grain quality were superior and even similar between inoculated treatments receiving doses of 100% Nitrogen (N) (120 kg of N ha^{-1}). It is concluded that the use of selected native bacterial consortiums reduces the use of nitrogen fertilizer by up to 30%, increasing the productivity of rice cultivation.

REFERENCES

Ahmed, M., Rauf, M., Mukhtar, Z., Saeed, N.A., 2017. Excessive use of nitrogenous fertilizers: an unawareness causing serious threats to environment and human health. Environ. Sci. Pollut.

Etesami, H., Alikhani, H.A., 2016. Co-inoculation with endophytic and rhizosphere bacteria allows reduced application rates of N-fertilizer for rice plant. Rhizosphere. 2, 5-12.

Meena, V., (Eds.), Role of Rhizospheric Microbes in Soil. Springer, Singapore, pp.47-75

Sahu, A., Bhattacharjya, S., Mandal, A., Thakur, J.K., Atoliya, N., Sahu, N., Manna, M.C., Patra, AK., 2018. Microbes: a sustainable approach for enhancing nutrient availability in agricultural soils.

Wu S C, Cao Z H, Li Z G, Cheung K C and Wong D H. 2005. Effects of biofertilizers containing N-fixers, P and K solubilizers containing N-fixers, P and K solutions and AM fungi on maize growth. A greenhouse trial. *Geoderma* 125(1/2): 155-166.

Poster T1P07

Exploring *casparian strip* (CASPs) genes in Tossa jute towards salinity stress resilience

S. BISWAS* and S. DATTA

Biotechnology Unit, Division of Crop Improvement, ICAR-Central Research Institute for Jute and Allied Fibres, Barrackpore – 700 121, West Bengal, India

E-mail: shreyosib8@gmail.com

Key Words: *CASP Genes, Corchorus Olitorius L., Salinity Stress*

INTRODUCTION

Tossa jute (*Corchorus olitorius*), a significant fiber crop grown predominantly in West Bengal and Bangladesh, faces extreme risks of increasing salinity from saltwater intrusion because of rise in sea level due to global warming. Therefore, breeding salt-tolerant varieties is crucial, and identifying

major genes conferring salt tolerance in jute is the prerequisite for this. CASP genes, involved in the formation of the casparian strip, a distinct, modified carbohydrate structure, that forms an apoplastic barrier, making selective movement across endodermis (Calvo-Polanco *et al.*, 2021) hence having a crucial role in developing salt tolerance in plants. By targeting CASP genes and their signalling pathways, salt-tolerant jute variety can be developed. With this aim, the present study was undertaken to identify and characterize the genes of casparian strip and predict their role in salinity tolerance in jute.

MATERIALS AND METHODS

The protein sequences of CASP genes of Arabidopsis thaliana (At) and Theobroma cacao (Tc) were extracted from NCBI (https://www.ncbi.nlm.nih.gov/) used as query in BLASTP analysis with Corchorus olitorius L. for identification of casparian strip membrane domain proteins with an E-value threshold of <1e−5. Subsequently, ProtParam Expassy (https://web.expasy.org/protparam/) was utilized to predict its physicochemical properties. The subcellular localization of each casparian strip membrane domain protein was predicted using WoLF PSORT(https://wolfpsort.hgc.jp/). The positional data on exons, introns, and untranslated regions (UTRs) of the genes of casparian strip were retrieved from the jute genome annotation file (GTF), and the structural representation of the genes was generated utilizing GSDS2.0 (https://gsds.gao-lab.org/). Conserved motifs present in casparian strip domain proteins were identified using MEME (Motif EM for Motif Elicitation) Version 5.5.7 (https://meme-suite.org/meme/tools/meme) with the following parameters: optimum motifs (10–50 amino acids) and number of motifs (10). The protein sequences of casparian memebrane domain were aligned using MUSCLE program. The phylogenetic tree was constructed utilizing MEGA 11 software.

RESULT AND DISCUSSION

In *Corchorus olitorius L.* twelve casparian strip membrane domain proteins were identified based on sequence homology with *Arabidopsis thaliana (At)* and *Theobroma cacao (Tc)*. By analyzing these proteins with the help of ProtParam Expassy tool (Duvaud et al., 2021) diverse physiochemical properties of these proteins can be predicted. The molecular weight of the proteins lying in a range between 46665.12Da to 11581.52Da and amino acid number with a range between 105-421 among the identified proteins suggest there is variability in complexity of structure among these proteins. PI of the predicted proteins ranging from 7.62 to 9.67 represents that these proteins are basic in nature and they might be optimally functional in slightly alkaline condition and their subcellular localization may correspond to this alkaline PH. The GRAVY values of these proteins are falling between 0.107 to 0.844, indicating these proteins are slightly hydrophilic to moderately hydrophobic in nature, hence they can interact with both nonpolar and aqueous environments. The subcellular localization of these proteins was predicted via WoLF PSORT. The result showed that eight out of twelve proteins were located in the vacuolar membrane, three in the chloroplast membrane, and only one in the nuclear membrane. The proteins localized in vacuolar membrane suggest their probable role in transport of solutes. Presence of some casparian strip proteins in chloroplast membrane indicates their role in transport regulation between chloroplast and other compartments. These proteins may have role in photosynthesis and other metabolic pathways. The only protein identified in the nuclear membrane may have some role in membrane trafficking, further study is required for conformation.

Table 1. *Physicochemical properties and in silico analysis of Corchorus olitorius L.*

Gene ID	Molecular Weight	Theoritical PI	Length	GRAVY	Aliphatic Index	Instability Index	Cellular location
COLO4_29669	21164.09	7.76	200	0.799	111.85	20.28	vacuolar membrane
COLO4_34011	21766.7	9.36	203	0.662	108.72	36.79	vacuolar membrane
COLO4_10331	20161.83	9.82	188	0.78	114.2	27.23	vacuolar membrane
COLO4_30183	17928.5	9.38	163	0.844	132.82	33.76	vacuolar membrane
COLO4_09668	19844.4	8.14	179	0.609	111.62	25.16	vacuolar membrane
COLO4_16682	20142.03	9.42	181	0.756	112.1	40.19	vacuolar membrane
COLO4_00299	11581.52	9.42	105	0.107	93.9	35.93	nuclear membrane
COLO4_31477	46665.12	9.31	421	0.129	98.15	32.4	plastid membrane
COLO4_17388	22352.85	7.62	204	0.453	97.26	37.43	vacuolar membrane
COLO4_26886	21414.21	9.58	199	0.458	105.53	23.07	plastid membrane
COLO4_13923	21720.98	9.67	204	0.747	111.86	37.16	vacuolar membrane
COLO4_13922	41384.41	9.46	377	0.135	111.43	39.94	plastid membrane

Analysis of these gene structures using the GSDS2.0 tool showed the variable number of coding sequences (CDS) from one to eight per gene. The variability reflects difference in complexity and functional distinction of these genes. The presence of multiple exons indicated there is a possibility of alternate splicing in these genes, hence producing multiple isoforms of the product. The MEME (Bailey et al., 2015) online analysis tool predicted jute casparian strip membrane domain protein sequence motifs, namely 1-10. The number of motifs of the predicted genes is 3–7. These motifs could be related to functional domains of the proteins, hence involved formation of the casparian strips.

Fig 1. *Analysis of the number of Coding Sequences (CDS) in CASP genes*

CONCLUSION

This study gives significant insights into the role of CASP genes and their associated casparian strip membrane domain proteins in salt tolerance of *Corchorus olitorius L*. Key CASP genes in jute were identified and characterized by bioinformatics analysis. Their subcellular localization was predicted and the motifs were analysed. Targeting CASP genes and their signalling pathways may help to develop cultivars having improved resistance to salinity thus increasing the productivity of jute. Further experimental validation is required to confirm the role of these genes in salt stress tolerance and potential for genetic improvement of jute.

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REFERENCES

Calvo-Polanco, M., Ribeyre, Z., Dauzat, M., Reyt, G., Hidalgo-Shrestha, C., Diehl, P., Frenger, M., Simonneau, T., Muller, B., Salt, D. E., Franke, R. B., Maurel, C., & Boursiac, Y. (2021). Physiological roles of Casparian strips and suberin in the transport of water and solutes. New Phytologist, 232(6), 2295–2307.

Duvaud, S., Gabella, C., Lisacek, F., Stockinger, H., Ioannidis, V., & Durinx, C. (2021). Expasy, the Swiss Bioinformatics Resource Portal, as designed by its users. Nucleic Acids Research, 49(W1), W216–W227.

Bailey, T. L., Johnson, J., Grant, C. E., & Noble, W. S. (2015). The MEME suite. Nucleic Acids Research, 43(W1), W39–W49.

Poster T1P08

Enhancing rice resilience in saline soils: The role of plant growth promoting microbial consortia in sustainable pokkali cultivation

SREELATHA, A.K[1]*., SURENDRA GOPAL[2], K, SREEJA, S.J[1], DEEPA THOMAS[1] and VEENA VIGHNESWARAN[1]

[1]Rice Research Station, Kerala Agricultural University, Vyttila P.O, Kochi-682019, Kerala, India

[2]College of Agriculture, Kerala Agricultural University, Vellanikkara, Thrissur-680656, Kerala, India

E-mail: sreelatha.ak@kau.in

Key Words*: Acid Saline, Grain Quality, Microbial consortia, Pokkali*

INTODUCTION

Pokkali cultivation, a traditional and eco-friendly farming method in the coastal saline lands of Kerala, India, effectively addresses soil salinity management. This practice is prevalent in the coastal paddy fields of Ernakulam, Thrissur, Alleppey, and Kottayam districts, where tidal wetlands naturally accumulate salinity through tidal action. Pokkali soils are characterized as acid saline, with pH levels ranging from 3.0 to 6.8 and fluctuating electrical conductivity influenced by seasonal salinity variations. Climate change-induced challenges, such as floods and saline water intrusion, pose significant threats to the fertility of Pokkali soils. To maintain ecosystem integrity and ensure compatibility with prawn farming, chemical inputs are avoided. Instead, plant growth-promoting microbes offer a sustainable alternative by improving nutrient availability, mitigating salinity effects, and enhancing crop resilience. This study aims to evaluate the effectiveness of three saline-tolerant microbial consortia derived from acid-saline Pokkali soils under field conditions at the Rice Research Station, Vyttila, during 2024–2025.

MATERIALS AND METHODS

Ten promising isolates from previous research (Sreelatha *et al.,* 2022) were selected based on their functional efficiency to develop three talc-based microbial consortia by mixing culture broth media with talc in 1:3 ratio. The selected isolates included three nitrogen-fixing bacteria (S3B2N, S5B3N, and S5B2N), three phosphate solubilizers (S6B2P, S5B2P, and S9B1P) and three zinc solubilizers (S10F1Zn, S7F1Zn, and S10F2Zn). The experiment was conducted using a randomized block design (RBD) using the rice variety Vyttila 10 with four replications for each treatment. The treatments included three saline-tolerant rhizobacterial consortia (Consortium I, II, and III) derived from Pokkali soils, a standard check (PGPR Mix 1), and an absolute control. The talc-based formulation of saline-tolerant rhizobacterial consortia was applied at 2% concentration. Applications were carried out as seed treatment, seedling dip, and foliar spray during the maximum tillering and panicle initiation stages.

RESULTS AND DISCUSSION

The results revealed a statistically significant increase in the test weight of grains in plants treated with saline-tolerant microbial consortia from Pokkali soils, with the maximum weight observed in Consortium II (28.6 g) compared to the control (27.2 g). Additionally, plants treated with the saline-tolerant microbial consortia exhibited a notable reduction in the percentage of chaffy grains (10.08%) compared to the control (21.97%). Chomba *et al.* (2024) also noted that inoculation with a consortium of *Bacillus tequilensis* and *Bacillus aryabhattai* significantly improved the dry weight of shoots and roots in Pokkali rice seedlings under saline conditions. These findings suggest that the saline-tolerant microbial consortia positively impacted grain quality parameters of rice plants under salt stress conditions.

Table 1. *Evaluation of saline-tolerant microbial consortia for grain quality in Pokkali rice*

Treatment	Chaffy grains (%)	Test weight of grains (g)
Consortium 1	10.85±3.71 ^{b}	27.3009±0.72^{bc}
Consortium 2	11.79±6.47 ^{b}	28.58±1.26 ^{ab}
Consortium 3	10.08±1.46^{b}	28.65±0.79^{a}
PGPR Mix 1	11.04±3.97^{b}	29.60±1.04 ^{a}
Absolute Control	21.97±6.57^{a}	27.20±0.41^{c}
CD	7.44	1.318
SE(m)	2.415	0.428
CV(%)	36.735	3.026

CONCLUSION

Pokkali cultivation, a sustainable farming practice in Kerala's coastal saline lands, effectively manages soil salinity. The study highlights the potential of saline-tolerant microbial consortia in enhancing rice growth and quality under salt stress. Significant improvements were observed in grain test weight and reduced chaffy grains, though other growth and yield metrics showed no major differences. These findings underscore the role of plant growth-promoting microbial consortia as eco-

friendly alternatives to chemical inputs, promoting soil fertility and crop resilience while ensuring the sustainability of Pokkali farming amidst environmental challenges.

REFERENCES

Sreelatha, A. K., Surendra, G. K., Vigneshwaran, V., Thomas, D. and Reshma, K. S. 2022. Screening of acid and saline tolerant beneficial microflora from Pokkali soils of coastal Kerala. In: Kumar, P., Arunachalam, V., Das, P., Gokuldas, P. P., Rajkumar, S., Mayekar T. S. and Uthappa, A. R. (eds), National Symposium on Self-Reliant Coastal Agriculture. Proceedings of a national symposium, Ela, Old Goa. Association for Coastal Agricultural Research (ACAR) and ICAR – Central Coastal Agricultural Research Institute, Goa, pp 36.

Chompa, S. S., Zuan, A. T. K., Amin, A. M., Hun, T. G., Ghazali, A. H. A., Sadeq, B. M., Akter, A., Rahman, M .E. and Rashid, H. O. (2024). Molecular identification and effect of salt-tolerant plant growth-promoting rhizobacteria on the biochemical aspect and growth of rice. *Chilean journal of agricultural research*, 84(5), 606-619.

Poster T1P09

Effect of farmyard manure and temperature on sorption of zinc and cadmium in some alluvial soils of West Bengal: Investigations through vertical column experiment and kinetics study

R. K. CHOUDHURY[1]*, S. MOHANTY[2] and D. MUKHOPADHYAY[2]
[1]Department of Agricultural Chemistry and Soil Science, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal – 741252, India.
[2]Department of Soil Science and Agricultural Chemistry, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal – 736165, India.
E-mail: rkrchoudhry.ssac1998@gmail.com

Key Words: *Breakthrough Curve, FYM, Metal Sink, Rate Kinetics, Sorption*

INTRODUCTION

Heavy metal contamination in soils, particularly by zinc (Zn) and cadmium (Cd), poses significant environmental concerns due to their potential toxicity and mobility. To understand the role of organic manure (FYM) in stabilizing and retaining these metals in soil, a study was conducted by Uttar Banga Krishi Viswavidyalaya, Pubdibari which investigated both the leaching behavior of Zn and Cd through a vertical soil column and their sorption kinetics at 35ºC and 45ºC temperature under the influence of FYM (F_1) and without FYM (F_0) in soils collected from two distinct agroclimatic zones of West Bengal. Breakthrough curves (BTCs) were analyzed to assess the degree of retention of the metals, where a leftward shift from the inflection point (PV = 1) indicated higher retention (Mukhopadhyay & Sanyal, 2002). Additionally, a sorption kinetics study examined Zn and Cd adsorption onto soil colloids, fitting the data to modified Freundlich and Elovich models). Additionally, sorption data were fitted to modified Freundlich and Elovich kinetic models (Kuo and Lotse, 1974; Sparks, 1986) and the kinetic parameters (ka, n, C_0, α, β) were analyzed to predict the adsorption behavior of Zn and Cd under two different incubation temperatures in both of the FYM treated and untreated soils.

MATERIALS AND METHODS

Two sampling sites in West Bengal were selected for this study - Pundibari and Malda. Approximately 10 kg of surface soil (0-20 cm depth) was collected from each site, air-dried, sieved, and subjected for the laboratory analysis including texture, clay content, pH, EC, SOC, CEC, and DTPA-extractable Zn and Cd, following standard procedures. The vertical soil column experiment was conducted using vertical glass with two replications for each soil type. Air-dried soils were filled into the columns, while another set was treated with FYM. Aqueous Zn and Cd solutions (100 mg L^{-1}) were added to each of the soil columns from the top and were allowed to leach after getting fully saturated. Ten leaching events were carried out and the collected leachates from each leaching intervals were analyzed for Zn and Cd. Breakthrough curves (BTCs) were plotted as C/C_0 against pore volume (P_V) where C_0 is the initial concentration of the solution and C is the concentration of the leachate at the specific interval. For the kinetics study, 5 g of soil from each sampling sites was placed in conical flasks (S_1, S_2) without FYM (F_0) and similarly, 4.5 g of soil from each sampling sites were taken again (S_1 and S_2) and mixed with 0.5 g of FYM separately in another conical flasks (F_1). 50 ml of $CaCl_2$ (0.01M) solution containing 100 ppm of Zinc and Cadmium was added separately followed by two drops of toluene into all the conical flasks. These were shaken in a water bath at 35ºC and 45ºC for 15 min, 30 min, 1 hr, 2 hr, 4 hr, and 6 hr. After centrifugation at the end of each period, Zn and Cd in the supernatant were measured using AAS. The decrease in the concentration of Zn and Cd was considered to have been sorbed by soil during the given reaction period.

RESULTS AND DISCUSSION

In case of the soils collected from Pundibari, the breakthrough for Zinc and Cadmium occurred at 0.97 pore volume and 0.96 pore volume respectively. Whereas soil treated with FYM, the breakthrough for Zinc occurred at 0.85 pore volume and at 0.83 pore volume for Cadmium. While in case of soils collected from Malda, the breakthrough for Zinc and Cadmium occurred at 0.49 pore volume and 0.96 pore volume respectively. Whereas soil treated with FYM, the breakthrough for Zinc occurred at 0.36 pore volume and at 0.34 pore volume for Cadmium. Moreover, the leachate concentration as well as C/C_0 ratio of both Zn and Cd in collected leachates has been found significantly lower in FYM treated soils than the untreated soils for both Pundibari and Malda region. The order of the times of dilution in the collected leachate followed the trend: Malda (Soil+FYM) > Pundibari (Soil+FYM) > Malda (Soil) > Pundibari (Soil) which are statistically significant from each other as per Duncan's Multiple Range Test. This investigation thus indicates that the more retention capacity of heavy metals exhibited by the soil treated with FYM as compared to untreated soil for the both places.

It also highlights the more retention capacity of Malda soil as compared to Pundibari Soil. The reason may be due to higher clay content in soils of Malda as compared to that of Pundibari. Moreover, complexation between organic matter and metals, restricts the mobility of metals and exhibits more sorption sites of reaction (Igloria *et.al.*,1996).

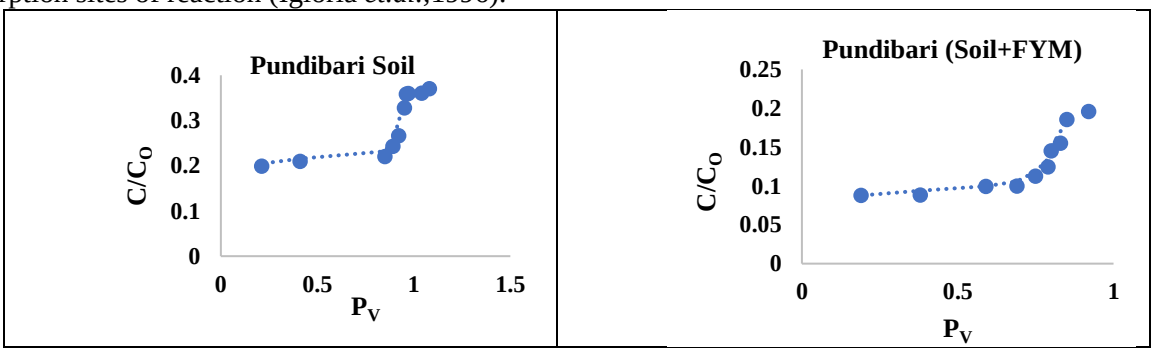

Fig.1: *Experimental Breakthrough curve in soils of Pundibari using Cadmium Solution*

Table 1*: Comparison between Zinc and Cadmium retention by Soil and (Soil+FYM) for both Pundibari and Malda region*

Soil	Leachate concentration of Zn (mg/l)	C/C_0 (Zn)	Times of Dilution (Zn solution)	Leachate concentration of Cd (mg/l)	C/C_0 (Cd)	Times of Dilution (Cd solution)
Pundibari (S_1F_0)	45.31 ^{a}	0.453 ^{a}	2.26 ^{d}	29.17 ^{a}	0.292 ^{a}	3.63 ^{d}
Pundibari (S_1F_1)	20.92 ^{c}	0.209 ^{c}	4.82 ^{b}	12.92 ^{c}	0.129 ^{c}	8.37 ^{b}
Malda (S_2F_0)	34.28 ^{b}	0.342 ^{b}	2.96 ^{c}	23.71 ^{b}	0.237 ^{b}	4.27 ^{c}
Malda (S_2F_1)	20.63 ^{d}	0.206 ^{d}	4.95 ^{a}	11.17 ^{d}	0.111 ^{d}	9.17 ^{a}
LSD (P=0.05)	7.488	0.075	0.857	6.648	0.066	2.303
SE(m) ±	2.476	0.025	0.284	2.199	0.022	0.761

[S_1F_0 = Soils of Pundibari without FYM; S_1F_1 = Soils of Pundibari with FYM;
S_2F_0 = Soils of Malda without FYM; S_2F_1 = Soils of Malda with FYM

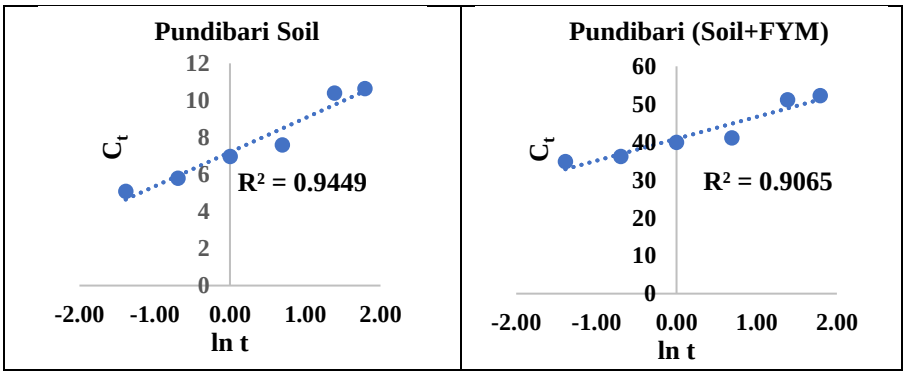

Fig.2*: Graphical presentation of Ct vs lnt for Elovich parameters for Zinc sorption (0-20 cm) at 35^0 C for pundibari soil*

From the kinetics study it have been observed that for both of the Zinc and Cadmium sorption at 35ºC and 45ºC, the magnitude of the kinetic parameters (ka, n, C_0, α, β) followed the order Malda (Soil + FYM) > Malda soil > Pundibari (Soil + FYM) > Pundibari soil which indicates that Malda soil had a higher adsorption capacity (ka) for both Zn and Cd than Pundibari soil and soils amended with FYM also exhibit relatively higher adsorption capacity than the untreated soils for the both of the places. Addition of FYM might have increased the extent of surface coverage area, thus resulting in more sorption (Kumar, et al., 2010). The sorption capacity of Malda soil have been found higher and this may be because of relatively high clay content as compared to the soils of Pundibari. Both of the modified

Freundlich and Elovich isotherm models have been proven as well suited to explain the sorption behaviour of both Zn and Cd by analysing their Determination Coefficient (R2) values. When the temperature was increased from 35oC to 45oC, the values of the kinetic parameters (ka, n, C0, α, β), also got increased for the both soils the samples and the reason might be due to the fact that with increase in with increase in reaction time and temperature the bound metals tends to get more immobilized (Wang, et al., 2009).

Table 2: *Estimated kinetic parameters for Zinc and Cadmium sorption of soil (0-20cm) at 35°C*

Treatments	Modified Freundlich equation $\left(\frac{x}{m}\right)_t = k_a C_0 t^{\frac{1}{n}}$					Modified Elovich Model $C_0 - C_t = \frac{1}{\beta}\ln(\alpha\beta) + \frac{1}{\beta}\ln t$					
	Zinc sorption at 35°C										
	ka	n	Model equation (linear)	R^2	SD	C_o	α	β	Model equation (linear)	R^2	SD
S_1F_0	0.14	4.05	y = 0.2465x + 0.1405	0.97	0.48	5.41	7.20	0.17	y = 1.843x + 7.203	0.94	2.38
S_1F_1	0.90	7.29	y = 0.1371x + 0.9041	0.92	1.52	34.87	40.88	0.54	y = 5.7911x + 40.871	0.91	7.60
S_2F_0	0.974	21.98	y = 0.0455x + 0.974	0.96	0.54	45.44	47.15	0.46	y = 2.16x + 47.152	0.96	2.69
S_2F_2	1.15	42.55	y = 0.0235x + 1.1503	0.97	0.41	69.36	70.70	0.59	y = 1.6686x + 70.701	0.97	2.07

[Ka = constant related to the adsorption capacity; n = constant related to the energy of adsorption
C_0 = soluble metal concentration in the solution in a given soil at zero time; α = initial adsorption rate constant;
β = extent of surface coverage]

CONCLUSIONS

Thus, from the present study conducted on soils collected from two different sites, it can be concluded that, soil treated with FYM served as an effective sink for Zinc and Cadmium, thereby retaining it better in comparison to soil in their matrix. Such kind of retention was highly influenced by the interactions of Zinc and Cadmium in soil with organic matter. Hence, it can be said that, Zinc and Cadmium retentions in soil could be augmented by applications of farm yard manure, which helped bind these metals into soil matrix by forming complexes with them, thereby preventing their rapid transport to crop rhizospheric zone, and consequently the uptake of these metals by growing crops in the given soil. Moreover, increase in sorption amount with increase of temperature, suggests the endothermic nature of the kinetic process and thus, confirms that the rate-controlling mechanism observed here in chemisorption. The findings will aid in formulating effective soil management strategies to moderate the hazards due toxicity of heavy metals like Zinc and Cadmium in the soil-crop systems and understanding the exchangeable zinc and cadmium release pattern in soils and soils mixed with FYM under different soil temperate regimes.

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REFERENCES

Igloria R V, Hathhorn W E, and Yonge D R (1996). Effects of natural organic matter on heavy metal transport during infiltration. *Transportation research record* 1523: 167-172.

Kumar P S, Ramakrishnan K, Kirupha S D and Sivanesan S (2010). Thermodynamic and kinetic studies of cadmium adsorption from aqueous solution onto rice husk. *Brazilian Journal of Chemical Engineering* 27: 347-355.

Kuo S and Lotse E G (1974). Kinetics of phosphate adsorption and desorption by hematite and gibbsite. *Soil Science* 116:400- 406.

Mukhopadhyay, D. and Sanyal, S. K. (2002). Studies on arsenic transport across and down some soils of West Bengal, *Journal of the Indian Society of Soil Science* 50: 456–463.

Wang Y, Tang X, Chen Y, Zhan L, Li Z and Tang Q (2009). Adsorption behaviour and mechanism of Cd (II) on loess soil from China. *Journal of Hazardous Materials* 172: 30-37.

Poster T1P10

Evaluation of little wild gourd genotypes in genetic diversity studies for coastal region of Karaikal

V. KANTHASWAMY* J. PRABU, M. S. MARICHAMY, V. KRISHNAN, N. BAVYA
Department of Horticulture, Pandit Jawaharlal Nehru College of Agriculture and Research Institute
Pondicherry University, Karaikal – 609603
Department of Horticulture
Pandit Jawaharlal Nehru College of Agriculture and Research Institute
Pondicherry University, Karaikal – 609603
E-mail: v.kanthaswamy@gmail.com

Key Words: *Genotypes, High Yielding, Little Wild Gourd*

INTRODUCTION

Athalakkai or little wild gourd botanically called as *Momordica cymbalaria,* is a perennial vine from the Cucurbitaceae family, native to Southeast Asia (Shantha *et al*., 2009). It is rich in calcium, fiber, potassium and bioactive compounds, offering significant nutritional and medicinal benefits. Once considered a weed in parts of India, it is now recognized for its superior nutrition, with three times the calcium and fiber and twice the potassium and ascorbic acid of bitter gourd and highly potential medicinal for diabetics. The fruit can be used to treat subacute cases of liver and spleen illnesses, rheumatism, and gout disease and tuber is to cure diarrhoea, constipation, and indigestion. It is also used as an astringent, abortifacient and aphrodisiac. (Jeyadevi *et al*., 2012). Despite its potential, research remains limited. This study evaluates its nutritional composition, identifies the best genotypes for the Karaikal coastal region, *per se* performance for yield traits and examines genetic variation in growth and yield. Understanding genetic diversity among genotypes will aid in selecting high-yielding, nutritionally rich varieties for improved cultivation and utilization.

MATERIALS AND METHODS

The present experiment was carried out at the Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, Pondicherry, India. The 15 little wild gourd genotypes which were collected from different agro-climatic regions of Tamil Nadu and Andra Pradesh were used for the experiment and denoted as (*Momordica cymbalaria*) MC.1 to MC.15 (MC-1(Sattur local); MC-2 (Aruppukottai local);MC-3(Mudukulathur local);MC-4 (Ambasamudram local);MC-5 (Vilathikullam local);MC-6 (Karambakkudi local);MC-7 (Dharapuram local);MC-8 (Gobichettipalayam local) ;MC-9 (Koilakuntla local);MC-10 (Thandrampattu local);MC-11 (T. Kallupatti local) ;MC-12 (Andipatti local);MC-13 (Kariapatti local);MC-14 (Uthupatti local);MC-15 (Illayarasanendal local)).The experiment was laid out in a randomized block design with 3 replications for each genotype. A spacing of 1.75 x 1.75 m was adopted and one plant was maintained pit^{-1} and planting was done in such a way that in each replication there was a single row of five plants per accession. The observations were recorded by selecting five random plants for 17 quantitative traits along with one qualitative trait. Two crops were raised; one during June 2023 to January 2024 and another January 2024 to June 2024 and mean value of both crops are used for statistical analysis.

RESULTS AND DISCUSSION

The genotype T_{12} (MC.12) showed the best yield performance, followed by T_5 (MC.5), T_2 (MC.2), and T_{10} (MC.10). High GCV and heritability (h^2) estimates with high genetic advance (GA) were observed for key traits like days to tuber sprouting, flowering time, vine length and fruit yield per vine. Traits such as individual fruit weight, fruit length, number of fruits per vine, primary branches per vine and tuber yield per vine also exhibited high h^2 and GA, making them valuable for selection. Correlation analysis highlighted that vine length, primary branches per vine, fruit count, individual fruit weight, fruit girth, and ascorbic acid significantly influenced yield. Path analysis confirmed that traits like number of fruits per vine, individual fruit weight, flowering time, sex ratio, seed count, tuber weight, and ascorbic acid had a direct impact on yield. Genetic divergence analysis grouped 15 genotypes into five clusters Table.2 with Cluster V (T_{12} – MC.12) showing superior performance in 14 out of 18 traits, followed by Cluster III (T_5 – MC.5, T_{10} – MC.10). The early flowering and maturity of T_{12} (MC.12) make it a promising candidate for crop improvement programs. Hybridizing genotypes from different clusters could enhance heterotic vigor, leading to better-performing segregants in the F_2 generation. Fruit yield per vine, ascorbic acid content, and seed count contributed most to genetic diversity, making them key traits for selection in breeding programs as mentioned in Table.1

CONCLUSION

The cluster mean for fruit yield vine^{-1} was maximum in cluster V (MC.12) followed by cluster III (MC.2, MC.5, MC.10). Selection of genotypes from this cluster and intermating within the genotypes to produce superior segregants. The genotypes in cluster V also recorded early performance for days to tuber sprouting, node bearing first male flower, node bearing first female flower, days to first male flower anthesis, days to first female flower anthesis and days taken from flowering to harvest. Hence, these genotypes *viz* MC.12, MC.2, MC.5, MC.10 would be used for selection for high yielding and earliness in crop improvement programme.

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REFERENCE

Jeyadevi, R. A., Sivasudha, T., Rameshkumar, A., Sangeetha, B., Ananth, D. A., and Aseervatham, G. S. B. (2012). Nutritional constituents and medicinal values of *Momordica cymbalaria* (Athalakkai)–A review. *Asian Pacific Journal of Tropical Biomedicine*, *2*(1), S456-S461.

Shantha, T. R., Venkateshwarlu, G., Ammal, M. I., and Gopakumar, K. (2009). Pharmacognostical studies on the fruits of *Momordica cymbalaria* fenzl ex Nand. *Journal of Research and Education in Indian Medicine*. ***1***, 1-

Table.1: *Mean performance of Little wild gourd (Athalakkai) genotypes for tuber yield vine^{-1} (kg) and ascorbic acid (mg/100g)*

S.No	Treatments	Name of the genotype	Tuber yield vine^{-1} (g)	Ascorbic acid (mg/100g)
1	T_1	MC-1 (Sattur local)	447.83**	270.93
2	T_2	MC-2 (Aruppukottai local)	403.23**	281.37
3	T_3	MC-3 (Mudukulathur local)	397.87*	272.90
4	T_4	MC-4 (Ambasamudram local)	382.43	276.90
5	T_5	MC-5 (Vilathikulam local)	338.57	286.83**
6	T_6	MC-6 (Karambakkudi local)	373.97	277.70
7	T_7	MC-7 (Dharapuram local)	356.97	279.23
8	T_8	MC-8 (Gobichettipalayam local)	326.77	275.57
9	T_9	MC-9 (Koilakuntla local)	298.93	258.87
10	T_{10}	MC-10 (Thandrampattu local)	282.53	283.43*
11	T_{11}	MC-11 (T. Kallupatti local)	365.77	273.67
12	T_{12}	MC-12 (Aundipatti local)	243.83	289.67**
13	T_{13}	MC-13 (Kariapatti local)	412.67**	277.27
14	T_{14}	MC-14 (Uthupatti local)	394.83*	276.37
15	T_{15}	MC-15 (Illayarasanendal local)	389.97*	269.20
		Mean	361.08	276.66
		Sed	9.66	2.007
		CD (0.05)	27.98	5.816
		CD (0.01)	37.75	7.8457
		CV (per cent)	4.63	1.26

Table 2: *Clustering pattern of 15 genotypes on the basis of Mahalanobis D^2 statistics*

S,No	Cluster	No. of Genotypes	Genotypes
1.	I	7	MC.4, MC.7, MC.8, MC.11, MC.13, MC.14
2.	II	3	MC.3, MC.3, MC.15
3.	III	3	MC.2, MC.5, MC.10
4.	IV	1	MC.9
5.	V	1	MC.12

Poster T1P11

Physiological and morphological responses of Indian bitter gourd accessions to salinity stress at early growth stage

JAGANNATH RAJAMMA MEGHASHREE[1], VASANT MAGUNDAPPA GANIGER[1], GURUBASAPPA BHUVANESHWARI[1], THYAVANAHALLY HANUMAIAH SHANKARAPPA[1], SARASWATHIPURA LAKSHMAIAH KRISHNAMURTHY[2] · BYRAGONDLU MUTHAIAH LOKESHKUMAR[3*]

[1] University of Horticultural Sciences (UHS), Bagalkot, Karnataka 587104, India

[2] ICAR-Indian Rice Research Institute Hyderabad 500030, India

[3]Division of Crop Improvement, Central Soil Salinity Research Institute, Indian Council of Agricultural Research (ICAR), Karnal 132001, India

E-mail: lokeshbm8050@gmail.com

Key Words: *Bitter Gourd, Early Growth Stage, Salinity Tolerance*

INTRODUCTION

Salinity is a major environmental stress affecting agricultural production worldwide. High level of salinity threatened the crops productivity, primarily in irrigated crop lands which produce 40% of the world's food. Two other effects of salinity are toxicity of ions, mainly Na^+ and Cl^- and nutrient imbalance due to a decrease in uptake and/or transport (Xiong et al., 2018). Bitter gourd (*Momordica charantia* L.) exhibits moderate sensitivity to salinity, with its growth and yield adversely affected by increased salt levels in the soil. Studies have shown that irrigation with saline water (electrical conductivity, ECw, of 5 dS/m) can lead to approximately a 41% reduction in production (Soomro *et al.* 2015). Breeding cultivars that can grow and produce economic yields under saline conditions is a more permanent solution for minimizing the deleterious effects of salinity. In order to breed resistant cultivars, it is essential to know the salt tolerance of the particular crop in advance. Salinity tolerance can be enhanced by effective screening techniques that might be constructive in evolving the salt-tolerant genotypes with increased productivity. There is dire need to identify the salt tolerant genotypes of plants, so that it can be utilized in breeding programme. Hence, in the present study we are evaluating 50 bitter gourd genotypes for salinity tolerance at early growth stage.

MATERIALS AND METHODS

Fifty bitter gourd genotypes were screened for salinity tolerance at early growth stage. This was performed in plastic pots (18 cm × 25 cm) without holes by direct sowing in completely randomized design (CRD) with two replications under control and salt stress condition. Three plants were maintained in each pot. When the plants started to produce tendrils at four-leaf stage, the salt treatment was initiated. Saline stress condition was maintained by irrigating the pots with salt dissolved water. Equal quantity of salinized water (300 ml) containing three salts (7NaCl: 1Na2SO4: 2CaCl2) with EC ~ 12 dS/m were added to pots in salt stress condition for every alternate day. The stress condition was maintained until majority of the plants start showing severe stress symptoms or dead (21 days). The pots in control condition were irrigated with normal water. Observations on vigor score, vine length, sodium and potassium ratio of leaf was measured. Scoring was performed at 14 days and 21 days after salinization at this time, there was a clear differentiation between the test entries. Vigour scoring is relative and ranged between 1-9 out of which 1 indicates the highly salt tolerant genotype and 9 for highly sensitive.

RESULTS AND DISCUSSION

The results from the analysis of variance revealed highly significant differences among the 50 genotypes for all the parameters studied which indicated the existence of variability in the germplasm and the differential response of each genotype across the treatment (Table 1). The vine length was varied from 3.00 (IC-622910) to 9.00 (IC-622911 and Preethi) with an overall mean of 6.02 for vigour score

at 14 days after sowing. With regard to the vigour score at 21 days after sowing it was varied from 4.00 (IC-622910) to 9.00 (IC-45351, IC-44413, IC-264770, IC-85603A, IC-85649, IC-256206, IC-505621, IC-68275, IC-398610, IC-599434, IC-50527, IC-66023, IC-541429, IC-505640, IC-427694, IC-470556, IC-622911 and Preethi) with a grand mean of 7.96 in all the genotypes under salt stress condition. About 27 (54%) and 18 (36%) genotypes were recognized as sensitive and highly sensitive to salinity stress with SES scores of 7 and 9, respectively. Whereas, only one genotype IC-622910 found tolerant (SES-3) and 4 (8%) genotypes namely IC-50524A, Gy 3-1-1-1-2, IC-33275 and IC-470943 exhibited a moderately tolerant (SES-5) response to salinity stress.

Table 1: *Analysis of variance (mean sum of squares) for different attributes of bitter gourd genotypes in control and saline condition*

Sl. No.	Source of variation	Treatments	Error	SEm±	CD (0.05)
	Degrees of freedom	49	50		
I.	Control condition				
1.	Vine length	1559.4435**	189.5693	9.7357	27.6547
2.	Sodium content	10.3860**	2.1118	1.0276	2.9188
3.	Potassium content	66.7905**	9.0833	2.1311	6.0535
4.	Sodium/Potassium ratio	0.0254**	0.0048	0.0490	0.1391
II.	Saline condition				
5.	Vigour score @ 14DAS	3.9584**	1.1600	0.7616	2.1633
6.	Vigour score @ 21DAS	2.6906**	0.9600	0.6928	1.9680
7.	Vine length	195.4584**	27.5867	3.7139	10.5496
8.	Sodium content	250.2270**	52.0294	5.1005	14.4880
9.	Potassium content	32.6388**	3.6923	1.3587	3.8595
10.	Sodium/Potassium ratio	5.9226**	0.6840	0.5848	1.6612

The vine length ranged between 21.33 cm (IC-44413) and 148.00 cm (IC-450520) with a mean of 91.38 cm under control condition. However, in a saline stress environment, it was observed in the range of 11.80 cm (IC-505621) to 51.75 cm (IC-470550) with a grand mean of 31.49 cm. The decrease in vine length may be due to the uptake and accumulation of salts in plant tissues and such accumulation restrict the plant growth by hindering chloroplasts functioning and photosynthetic activity and disrupt carbohydrate transportation in plants (Machado and Serralheiro, 2017). Salinity causes nutrient imbalance like lower transport of essential ions such as NO3 which causes reduction in nitrogen compounds and this may be the basic reason of reduction in plants growth (Chien *et al.,* 2009). The difference between the genotypes for sodium/potassium ratio found to vary from 0.16 (IC-50527) to 0.58 (Tumkur Local) with a total mean of 0.36 in normal environment. The mean values differed between 1.87 (IC-50524A) and 8.39 (Phule Green Gold) for this attribute with a general mean of 4.02 in relation to saline stress condition. Genotypes with lower Na+/K+ ratio showed greater tolerance to salinity compared to salt sensitive genotypes. Plants having higher K+/Na+ ratio were considered as salt tolerant (Taffouo *et al.,* 2008).

CONCLUSIONS

Among 50 diverse accessions of bitter gourd genotypes evaluated for salinity tolerance at ECe ~12 dS/m the line IC-622910 found tolerant and 4 genotypes namely IC-50524A, Gy 3-1-1-1-2, IC-33275 and IC-470943 exhibited a moderately tolerant response to salinity stress. The identified salt tolerant lines can be used to breed salinity resistant varieties.

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REFERENCES

Chien, S. W. C., Liao, J. H., Wang, M. C. and Mannepalli, M. R. (2009). Effect of Cl−, SO42− and fulvate anions on Cd2+ free ion concentrations in simulated rhizosphere soil solutions. *J. Hazard. Mater.*, 172(2-3): 809-817.

Machado, R. M. A. and Serralheiro, R. P. (2017) Soil salinity: effect on vegetable crop growth. Management practices to prevent and mitigate soil salinization. Horticulturae, 3(2): 30.

Soomro, A., Soomro, K. B., Akhtar, J., Soomro, S., & Ali, A. (2015). Impact of salinity on growth, yield and water use efficiency of Momordica charantia L. under raisedbed irrigation. *Int. J. Biol. Biotechnol*, 12, 485-491.

Taffouo, V. D., Djiotie, N. L., Kenne, M., Din, N., Priso, J. R., Dibong, S. and Akoa, A. (2008). Effects of salt stress on physiological and agronomic characteristics of three tropical cucurbit species. *J. Appl. Biosci.*, 10: 434-441.

Xiong, M., Zhang, X., Shabala, S., Shabala, L., Chen, Y., Xiang, C., Nawaz, M. A., Bie, Z., Wu, H., Yi, H., Wu, M. and Huang, Y. (2018). Evaluation of salt tolerance and contributing ionic mechanism in nine Hami melon landraces in Xinjiang, China. *Sci. Hortic*., 237: 277-286.

Poster T1P12

Combined effect of soil and foliar applied nutrients on nutrient use efficiency of mesta (*Hibiscus sabdariffa var. altissima*)

K. BHAVANA VARMA[1], T. SREELATHA[2], A. SIREESHA[3] AND M. SRINIVASA RAO[4]

[1]M.Sc. Soil Science, Department of Soil Science and Agricultural Chemistry, Agricultural college, Bapatla, Andhra Pradesh, India.

[2]Principal Scientist & Head, Department of Soil Science and Agricultural Chemistry, Agricultural college, RARS, Anakapalle, India.

[3]Principal Scientist, Department of Soil Science and Agricultural Chemistry, RARS, Anakapalle, India.

[4]Scientist, Department of Agronomy, ARS, Amadalavalasa, Srikakulam, India.

INTRODUCTION

Mesta is one of the important fibre crops which provides fibre, forage and paper pulp and broad end our agricultural diversity to reduce pressure on forest resources. It belongs to the family Malvaceae. The high cost of fertilizers deters farmers for balanced application of nutrients which leads to low productivity of mesta. The organic sources are storehouses of nutrients and at the same time improve the physical environment of soil considerably. Judicious mixing of inorganics with organic sources of nutrients minimizes the expenditure on costly fertilizer inputs and improves the efficiency of added fertilizers and maintains soil health, besides supplying nutrients to crops for higher productivity (Laxminarayana and Patiram, 2006).

METRIALS AND METHODS

A field experiment was conducted during the *Kharif* season of 2022-23 at Agricultural Research Station Farm, Amadalavalasa on a sandy loam soil with nine treatments laid out in Randomized Block Design with three replications. The soil of the experimental site was sandy loam in texture neutral in reaction (pH 6.85), low in organic carbon (0.49%) , low in available nitrogen (188 Kg ha^{-1}) medium in available phosphorus (36.45 Kg ha^{-1}) and high in available potassium (282 Kg ha^{-1}) with electrical conductivity of 0.20 dS m^{-1}. The test crop AMV -10 variety of mesta was cultivated during *kharif* with a seed rate of 5 kg ha^{-1} and recommended fertilizer dose of 40-20-20 kg N, P_2O_5 and K $_2$O kg ha^{-1}.

RESULTS AND DISCUSSION

Higher values of nutrient utilization of mesta from soil were recorded in treatments which were imposed with biofertilizers might be due to the synergistic effect of phosphate solubilizing bacteria with *Azospirillum* enhanced efficiency of N_2 fixation and P solubilization thus increased biomass and nutrient utilization from the soil. These results were in consonance with Singh *et al*. (2009).

Table 1. *Combined effect of soil and foliar applied nutrients on nutrient use efficiency of mesta*

Treatments	N	P_2O_5	K_2O
Control	28.40	26.73	25.00
100% RDF + 25% N through VC + Biofertilizers (*Azospirillum*+ PSB)	34.87	33.97	34.10
100% RDF + 25% N through FYM + Biofertilizers (*Azospirillum*+ PSB)	34.60	30.41	33.49
T_2 + 2% Urea (Foliar spray)	39.55	40.99	38.07
T_3 + 2% Urea (Foliar spray)	38.47	36.26	37.44
T_2 + 2% KNO_3 (Foliar spray)	42.78	41.17	39.27
T_3 + 2% KNO_3 (Foliar spray)	39.38	37.00	38.38
125% RDF	28.67	27.86	30.98
150% RDF	33.14	32.96	32.89
Mean	35.54	36.04	34.40

CONCLUSIONS

From the present study, it can be concluded that foliar sprays along with INM treatments gives higher yields compared to 150% RDF. Further use of biofertilizers improves nutrient use effeciency, and reduced environmental pollution.

REFERENCES:

Laxminarayana, K and Patiram, P. 2006.Effect of integrated use of inorganic, biological and organic manures on rice productivity and soil fertility in ultisols of Mizoram. *Journal of the Indian Society of Soil Science*. 54 (2): 213-220.

Singh, S.R., Bhat, M.I., Wani, J.A and Najar, G.R. 2009. Role of Rhizobium and VAM fungi for improvement in fertility and yield of green gram under temperate conditions. *Journal of the Indian Society of Soil Science.* 57 (1): 45-52.

Poster T1P13

Evaluation of Pearl millet inbreds for blast resistance

T. M. HEMALATHA, L. MADHAVILATHA, B. VAJANTHA and V. SUMATHI
Agricultural Research Station, Perumallapalle
E-mail: hema.agri@gmail.com

Key *Words:* *Millet, Resistant Hybrids, Leaf Blast Disease, Cultivars*

INTRODUCTION

Pearl millet [*Pennisetum glaucum* (L) R. Br.] is the most important millet species, accounting for approximately half the total worldwide production of millets (Nehra *et al*., 2017; Reddy *et al.*, 2021). It is mainly cultivated in India and Africa and is uniquely tolerant of hot and dry conditions. Pearl millet seems to be one of the important crops to resist/survive itself under erotic rainfall with high temperature. It has been almost exclusively a subsistence crop but today is becoming widely employed in commercial small-scale food manufacture. It is one of cereal which has strong development of roots and tends to have effective adaptive mechanism to cope with drought (Choudhary *et al*., 2021). It is an excellent forage crop because of its lower hydrocyanic acid content than sorghum. Its green fodder is rich in protein, calcium, phosphorous and other minerals with oxalic acid within safe limits (Makwana *et al*., 2021). Pearl millet blast originally documented in 1942 from Kanpur, UP, India has become a serious threat in the last decade causing rampant in India's pearl millet-growing areas. In India, the incidence of Pearl millet blast (*Magnaporthe grisea*) disease, which was once considered a minor disease, but now it has been increased at an alarming rate, primarily on commercial hybrids, in numerous states (Thakur *et al.*, 2009). Severe outbreaks of Pyricularia leaf spot known as blast disease was reported in major pearl millet producing states, including Gujarat, Rajasthan, Uttar Pradesh, Madhya Pradesh, Karnataka and Delhi were shown an upsurge in the occurrence of this disease both in pearl millet leaves and grains. The severity of the blast disease is exacerbated by humid weather conditions and dense plant stands. The fungus may infect plants at any stage of development, from seedling to adult, lowering grain and forage yields in varying degrees with occasionally dramatic negative consequences. The symptoms of Magnaporthe blast in pearl millet are most generally known as grey leaf spot. Initially, the symptoms appear as minute lesions or specks that expand and develop, necrotic elliptical greyish brown lesions, leading to extensive chlorosis and premature drying of leaves. The typical symptoms of the plants infected by *Pyricularia pennisetigena* showed small, brown, pinpoint, elliptical lesions with greying of

the center in the later stages. The *M. grisea* group is specific in its host range, but it is highly versatile in its ability to adapt to new environments.

MATERIALS AND METHODS

The experiment was conducted in a randomized complete block design with two replications, one row of 2 m length/entry in each replication. Susceptible check entry (ICMB 95444) were planted on every 5th row alternately. Plants were thinned to 20 plants/row 15 days after planting and other agronomic practices were followed as per local practices. High humidity was provided by perfo-irrigation twice a day on rain-free days, 30 min each to promote disease development. Disease severity was recorded at the hard dough stage using a 1–9 progressive scale followed by AICRP on Pearl millet.

RESULTS AND DISCUSSION

A total of 85 inbred lines of pearl millet were evaluated against blast and the data are summarized in the table 1. None of the inbred lines were completely free and highly resistant from blast (0.00). The blast scores of the tested entries ranged from 1.0 to 7.3 on a 1–9 scale compared to a score of 8.2 in the susceptible check (ICMB-95444). Twenty-five lines were found resistant (score 1.0–3.0), 18 moderately resistant (score 3.1–5.0), 23 entries showed moderately susceptible reaction, 13 susceptible (score 6.1–7.0) and the remaining 6 highly susceptible (score >8.0) (Table 1).

Table 1*: Evaluation of pearl millet Inbred lines against blast during kharif 2022 and 2023*

S.No	Entry	PDI during Kharif, 2022	PDI during Kharif, 2023	Mean PDI	S.No	Entry	PDI during Kharif, 2022	PDI during Kharif, 2023	Mean PDI
1	PPBI-1	3.8	3.6	3.7	42	PPBI-42	5.2	5.2	5.2
2	PPBI-2	1.8	1.8	1.8	43	PPBI-43	6.4	6.4	6.4
3	PPBI-3	1.1	1.1	1.1	44	PPBI-44	5.0	5.0	5.0
4	PPBI-4	4.5	4.5	4.5	45	PPBI-45	5.9	5.9	5.9
5	PPBI-5	6.7	6.7	6.7	46	PPBI-46	3.8	3.8	3.8
6	PPBI-6	4.2	4.2	4.2	47	PPBI-47	1.0	1.0	1.0
7	PPBI-7	3.4	3.4	3.4	48	PPBI-48	1.1	1.1	1.1
8	PPBI-8	2.2	2.2	2.2	49	PPBI-49	4.5	4.5	4.5
9	PPBI-9	2.4	2.4	2.4	50	PPBI-50	6.7	6.7	6.7
10	PPBI-10	3.6	3.6	3.6	51	PPBI-51	3.2	3.2	3.2
11	PPBI-11	2.0	2.0	2.0	52	PPBI-52	4.8	4.8	4.8
12	PPBI-12	2.9	2.9	2.9	53	PPBI-53	5.9	5.9	5.9
13	PPBI-13	3.4	3.4	3.4	54	PPBI-54	5.9	5.9	5.9
14	PPBI-14	3.1	3.1	3.1	55	PPBI-55	2.3	2.3	2.3
15	PPBI-15	1.0	1.0	1.0	56	PPBI-56	6.6	6.6	6.6
16	PPBI-16	6.4	6.4	6.4	57	PPBI-57	1.6	1.6	1.6
17	PPBI-17	2.3	2.3	2.3	58	PPBI-58	2.8	2.8	2.8
18	PPBI-18	3.7	3.7	3.7	59	PPBI-59	7.1	7.1	7.1
19	PPBI-19	4.6	4.6	4.6	60	PPBI-60	4.9	4.9	4.9
20	PPBI-20	5.7	5.7	5.7	61	PPBI-61	6.8	6.8	6.8
21	PPBI-21	4.2	4.2	4.2	62	PPBI-62	4.3	4.3	4.3
22	PPBI-22	1.4	1.4	1.4	63	PPBI-63	6.4	6.4	6.4
23	PPBI-23	2.2	2.2	2.2	64	PPBI-64	5.3	5.3	5.3
24	PPBI-24	2.4	2.4	2.4	65	PPBI-65	5.7	5.7	5.7
25	PPBI-25	5.7	5.7	5.7	66	PPBI-66	5.4	5.4	5.4
26	PPBI-26	2.9	2.9	2.9	67	PPBI-67	4.3	4.3	4.3
27	PPBI-27	3.0	3.0	3.0	68	PPBI-68	3.1	3.1	3.1
28	PPBI-28	2.4	2.4	2.4	69	PPBI-69	3.2	3.2	3.2
29	PPBI-29	6.8	6.8	6.8	70	PPBI-70	4.0	4,0	4.0
30	PPBI-30	1.8	1.8	1.8	71	PPBI-71	3.6	3.6	3.6
31	PPBI-31	3.0	3.0	3.0	72	PPBI-72	3.6	3.6	3.6
32	PPBI-32	1.9	1.9	1.9	73	PPBI-73	6.1	6.1	6.1
33	PPBI-33	2.2	2.2	2.2	74	PPBI-74	2.6	2.6	2.6
34	PPBI-34	2.3	2.3	2.3	75	PPBI-75	3.1	3.1	3.1
35	PPBI-35	5.7	5.7	5.7	76	PPBI-76	3.2	3.2	3.2

36	PPBI-36	3.4	3.4	3.4	77	PPBI-77	4.1	4.1	4.1
37	PPBI-37	7.3	7.3	7.3	78	PPBI-78	5.1	5.1	5.1
38	PPBI-38	4.4	4.4	4.4	79	PPBI-79	4.5	4.5	4.5
39	PPBI-39	7.1	7.1	7.1	80	PPBI-80	6.6	6.6	6.6
40	PPBI-40	6.1	6.1	6.1	81	PPBI-81	7.2	7.2	7.2
41	PPBI-41	7.1	7.1	7.1	82	PPBI-82	3.1	3.1	3.1
42	PPBI-42	5.2	5.2	5.2	83	PPBI-83	2.9	2.9	2.9
43	PPBI-43	6.4	6.4	6.4	84	PPBI-84	7.2	7.2	7.2
44	PPBI-44	5.0	5.0	5.0	85	PPBI-85	6.3	6.3	6.3
45	PPBI-45	5.9	5.9	5.9	86	ICMB-95444	8.2	8.2	8.2

CONCLUSION

It can be concluded from present investigation that 25 entries viz., PPBI-2,3,8,9,11,12,15, 17, 22,23,24,26,27,28,30,31,32,33,34,47,4855,58,74 and 83 were found resistant against leaf blast disease under field conditions. Consequently, these promising lines may be employed in breeding programme to develop blast resistant hybrids/cultivars.

REFERENCES

Choudhary ML, Tripathi MK, Gupta N, Tiwari S, Tripathi N, Parihar P, et al. RK Screening of pearl millet germplasm lines against drought tolerance based on biochemical traits. Current Journal of Applied 2021c;40(23):1-12.

Gupta SK, Sharma R, Rai KN, Thakur RP. Inheritance of foliar blast resistance in pearl millet (Pennisetum glaucum). Plant Breed. 2011;131(1):217-219.

Makwana K, Tiwari S, Tripathi MK, Sharma AK, Pandya RK, Singh AK. Morphological characterization and DNA finger printing of pearl millet (Pennisetum Glaucum (L.) germplasms. Range Management and Agroforestry. 2021. 42(2):205-211.

Nehra M, Kumar Devvart KJ, Sharma RK. Molecular characterization of pearl millet [Pennisetum glaucum (L.) R. Br] inbreeds using microsatellite markers. J Appl Nat Sci. 2017; 9(1):357-363.

Reddy SP, Satyavathi CT, Khandelwal V, Patil HT, Gupta PC, Sharma LD, Mungra KD, Singh SP, Narasimhulu, R, Bhadarge HH, Iyanar, K, Tripathi MK, Yadav D, Bhardwaj R, Talwar AM, Tiwari VK, Kachole UG, Sravanti K, Shanthi Priya M, Athoni BK, Anuradha N, Govindaraj M, Napoleon T and Tonapi VA. 2021.Performance and stability of pearl millet varieties for grain yield and micronutrients in arid and semi-arid regions of India. Frontiers in Plant Sciences. 12: 670201.DOI: 10.3389/fpls.2021.670201.

Sharma R, Sharma S, Gate VL. 2000. Tapping Pennisetum violaceum, a wild relative of pearl millet (Pennisetum glaucum), for resistance to blast (caused by Magnaporthe grisea) and rust (caused by Puccinia substriata var. indica). Plant Dis. 2020,104(5)

Sharma R, Upadhyaya HD, Manjunatha SV, Rai KN, Gupta SK, Thakur RP. Pathogenic variation in the pearl millet blast pathogen Magnaporthe grisea and identification of resistance to diverse pathotypes. Plant Dis. 2013;97:189-195.

Thakur RP, Sharma Rajan, Rao VP. Screening techniques for pearl millet diseases. Information Bulletin No. 89. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics, 2011, 56 pp.

Poster T1P14

Stress mitigation of late-sown lentil (*Lens culinaris*) through hormonal and nutritional interventions

ANANYA BAIDYA, S. MONDAL, A.K.PAL, R. NATH*

Department of Physiology, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya Mohanpur, Nadia-741252, West Bengal

* Department of Agronomy, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya Mohanpur, Nadia-741252, West Bengal

E-mail: theananya4@gmail.com

Keywords*: Terminal Drought, Hormones, Micronutrients, Pollen*

INTRODUCTION

Lentil is a vital winter-season grain legume majorly grown in rice fallows using residual soil moisture in eastern India. Delayed monsoon disrupts lentil sowing and crop growth stages through terminal drought and heat stress. An experiment with fifteen-day interval sowing dates (15th November,

30th November, and 15th December) was conducted to assess stress responses. Late sowing often exposes the crop to high temperatures (30–32°C) during reproductive and grain-filling stages, leading to flower and pod abortion, lower seed set and seed weight, and premature senescence, eventually contributing to yield loss (Maphosa *et al*., 2023). Hormonal and nutritional interventions, *i.e.* NAA, GA_3, boron, and zinc application, can enhance reproductive sink to improve stress resilience; however, the potential of hormonal and nutritional interventions of lentil for stress tolerance remains underexplored, prompting this study to evaluate diverse genotypes under terminal drought and heat stress and assess the efficacy of hormonal and micronutrient treatments in mitigating stress effects.

MATERIALS AND METHODS

Lentil genotypes were sown in residual soil moisture on three different dates *viz.*, 15th November, 30th November, and 15th December in the first year of experiment with three replications. Data were recorded on seed yield attributing traits. The selected lentil genotype from the first year *i.e.* WBL-58 was sown following the same sowing dates in the second year and treated with singular application of different bioregulators in the form of foliar spray (ST_0: Control, ST_1: $ZnSO_4$ 0.25%, ST_2: $ZnSO_4$ 0.5%, ST_3: H_3BO_3 25 ppm, ST_4: H_3BO_3 50 ppm, ST_5: NAA 40 ppm, ST_6: NAA 50 ppm, ST_7: GA_3 100 ppm, ST_8: GA_3 200 ppm) at 45 DAS and 55 DAS. The same genotype was exposed to combined bio-regulator foliar treatments (CT_0: control, CT_1: $ZnSO_4$ 0.5%, CT2: $ZnSO_4$ 0.5% + H_3BO_3 50 ppm, CT_3: H_3BO_3 50 ppm + NAA 40 ppm, CT_4: $ZnSO_4$ 0.5% + H_3BO_3 50 ppm + NAA 40 ppm, CT_5: $ZnSO_4$ 0.25% + H_3BO_3 50ppm + NAA 20 ppm) at 45 DAS and 55 DAS at three dates of sowing (15th Nov, 30th Nov, and 15th Dec) in the subsequent year for assessing the crop performances regarding terminal heat and drought stress responses and yield-attributing traits were measured.

RESULTS AND DISCUSSION

Considering the methodologies employed in conducting the study, arrays of data based on physiological and morphological yield attributes and stress indicators were collected. Based on stress response index (SRI) of seed size, pods/plant, and seed yield/plant under the third sowing date the twenty genotypes were analyzed for genetic similarity based on Euclidean distance using Un-weighted Pair Group Method with Arithmetic Mean (UPGMA) algorithm. *In vitro* pollen germination percentage was studied under high temperature (32°C) with the use of pollen culture medium and *in-vitro* pollen germination percentage of the lentil genotypes was recorded at an interval of thirty minutes up to ninety minutes under varying temperatures (viz., 16, 24 and 30°C). Perusal of data indicated that reproductive development events, such as first flowering, 50% flowering, first podding, and 50% podding, exhibited changes depending on the sowing date. Results collaborated with the earlier findings of Venugopalan *et al*., 2022. The lentil crop sown on 15th November exhibited delayed flowering, while the 15th December sowing resulted in accelerated flower primordia development along with higher days of germination and seedling establishment phase. Thus, the genotypes showed earliness in flowering when they were subjected to late sowing dates. The stress on such much-delayed crop might be mitigated by application of bio-regulators like zinc, boron, and NAA; the best bio-regulator treatments for the December sown crop was $ZnSO_4$ 0.25 % and 40 ppm NAA was very effective in yield enhancement in crops sown on or before 30th November. Among combination treatments, CT_4: $ZnSO_4$ 0.5% + H_3BO_3 50 ppm + NAA 40 ppm, CT_5: $ZnSO_4$ 0.25% + H_3BO_3 50ppm + NAA 20 ppm had the positive impact on delayed and very delayed sown condition (30th November and 15th December).

Conclusion

The present study predominantly summarized the detrimental impact of terminal heat and drought stress on phenophases, seed production, and yield-attributing characteristics of lentil along with its mitigation through the implementation of aforementioned bioregulators both in singular and combination. Optimum stress mitigation was observed in late-sown lentil treated with the combination of $ZnSO_4$ 0.25% +H_3BO_3 50 ppm + NAA 20 ppm, prompting to reduction of lipid peroxidation. Hence, this study paved the way by establishing an effective protocol through selection of late-sown lentil based on physiological and phenological traits to withstand terminal heat and drought stress.

ACKNOWLEDGEMENT

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REFERENCES

Maphosa, L., Preston, A., & Richards, M. F. (2023). Effect of sowing date and environment on phenology, growth and yield of Lentil (Lens culinaris Medikus.) Genotypes. Plants, 12(3), 474. https://doi.org/10.3390/plants12030474.

Venugopalan, V. K., Nath, R., Sengupta, K., Pal, A. K., Banerjee, S., Banerjee, P.& Siddique, K. H. (2022). Foliar spray of micronutrients alleviates heat and moisture stress in lentil (*Lens culinaris* Medik) grown under rainfed field conditions. Frontiers in plant science, 13, 847743. http://dx.doi.org/10.3389/fpls.2022.847743.

Poster T1P15

Spectrum of genetic makeup studies for yield and its attributing characters in rice *(Oryza Sativa* L.*)*

*SANTANU NANDI, SANJAY KUMAR, DEBASHIS SAREN
Department of Genetics and Plant Breeding
Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, W.B. India
E-mail: santanunandi32@gmail.com

Rice (*Oryza sativa* L.*)* belongs to the genus *Oryza* of family *(Graminae*) and is a true diploid with chromosome number 2n = 2X = 24. 756 million tonnes of rice are produced worldwide on 164.19 million ha. of cultivable land (FAO, 2020). In India, 122.27 million tons of grains are produced from the 45.07 million hectares of rice (Directorate of Economics and Statistics, 2021). The state has 5.8 million ha. Under rice cultivation, with the average productivity of 2.6 tons/ha. 25 rice genotypes were under for estimating genetic variation, genetic advance and heritability between agro-morphic and physical grain quality. The data were recorded on nine agromorphic and six grain quality traits. The analysis of variance showed that there was a highly significant difference among all the genotypes for all the traits showing greater chances of improvement in all genotypes for the parameters studied. Narrow difference found between GCV and PCV, that indicates there were low environmental influence for different traits. Most of the traits were found maximum heritability with greater genetic advance, indicating that the genotypes were controlled by gene action. From the study MTU 7029(880 g/m2) and Pratiksha (753.3 g/ m2) genotypes were found superior for yield and some other related characters.

Key Words*: Genetic Variability, Genetics Variance, GCV, PCV, Heritability, Yield.*

Technical session 2: Technological advancement in fisheries management

Lead Lect-1T2D1

Decline of hilsa (*Tenualosa ilisha*) fishery in the Narmada estuary, west coast of India: Challenges and pathways to sustainability

BASANTA KUMAR DAS*, DIBAKAR BHAKTA, SUHAS P. KAMBLE, LOHITH KUMAR and ARUN PANDIT

ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata-700 120, West Bengal, India.

E-mail: basantakumard@gmail.com

***Key Words**: Hilsa fishery, Declining trends, Narmada estuary, Threats, Conservation measures, West coast*

INTRODUCTION

The Narmada River stands as one of the most significant west-flowing rivers in the country, originating from Amarkantak in the Shahdol District of Madhya Pradesh and flowing towards the Arabian Sea via the Gulf of Cambay in Gujarat, spanning 1312 km. Migration is a natural occurrence for many fish species during spawning, and any obstruction in their spawning routes can significantly impact the recruitment process. The construction of dams significantly affects fish migration patterns. According to De and Saigal (1989), hilsa is classified as an anadromous fish, which migrates from the sea into freshwater river stretches primarily for breeding activities. Hossain et al. (2019) indicates that fish historically migrated from the Bay of Bengal to the inland freshwater rivers of Myanmar, Bangladesh, and the east coast of India, including the Hooghly-Bhagirathi estuary, for spawning purposes. The construction of a dam and the resulting impoundment led to a rapid change from a flowing water environment to a standing water one. In recent decades, there has been a significant decline in the Hilsa fishery within the Narmada Estuary. The construction of the Sardar Sarovar dam is blamed for the drop in hilsa catch (Bhakta *et al*., 2019). This study looks at the spawning season, the composition of commercial catches, and the methods of exploitation in the Narmada estuary.

MATERIALS AND METHOD

The geographical coordinates of the Narmada estuarine region are 21°40'05.19" N; 72°34'26.90" E. Tidal effects primarily influence the salinity regimes, characterising the Narmada estuary as a freshwater estuary. The funnel-shaped estuarine zone spans 72 kilometres and encompasses an area of 6,346 square kilometres. The total area of the estuarine system is approximately 14,250 hectares. We conducted monthly sampling at local landing sites like Bharuch, Bhadbhut, Mehgam, and Ambetha to observe the hilsa catches at the Narmada estuary. Secondary data was collected to corroborate the primary data. We conducted the identification of hilsa species using the standard taxonomic keys established by Talwar and Jhingran (1991).

RESULTS AND DISCUSSION

Tenualosa ilisha (hilsa) landings in the Narmada Estuary have been steadily going down over the last decades, according to an analysis of historical fish catch data (Figure 1). Constructing of Sardar Sarovar dam resulting the reduction of freshwater flow from upstream and uncertain water flow badly affected the migration of hilsa in lower stretches of Narmada estuarine region. Data pertaining to pre-impoundment of dam shows that *T. ilisha* contributed to the tune of 977.1 and 3,727 t during the year 1974-75 and 1982-83. Highest catch of hilsa was recorded as 15,319 t during 1993-94. After construction of dam steady decline of hilsa catch was reported (3448 t during 2004-05 to 419 t during 2014-15). The total estuarine production also reduced drastically from 4463 t (2000-01) to 1618 t (2014-15). Before construction of the dam, carp fishery (1958-66) was dominated (60.4%) in the middle stretches of the river and after the construction of the dam, catfishes were the most dominant species (43.3%). Nath and Shrivastava (1999) studied decline in carp fishery in the Narmada in the context of the construction of the dam on the river and its tributaries. They observed a decline of carp fishery (31.29%) in 280 km stretch between Sandia and Mola after the construction of dam against 60.4% of carp fishery before dam construction (1958-66).

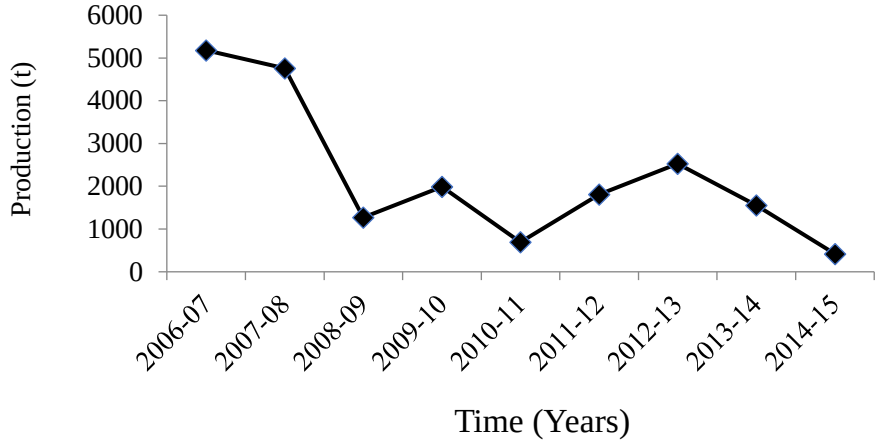

Fig. 1. *Production trend of hilsa of Narmada estuary (Data source: Department of Fishery, Bharuch district, Gujarat)*

Naskar et al. (2015) reported a significant decline of 52.38% in hilsa catch from the Narmada estuary attributed to the construction of the Sardar Sarovar dam. Pathak and Tyagi (2010) reported a significant decline in hilsa catch from the Allahabad region, dropping from 91 kg/km in 1960 to nearly zero by 2006, attributed to the Farakka barrage. Sinha *et al.* (1996) looked at how the Farakka barrage affected the fisheries in the Hooghly estuary. They found that marine and neritic species decreased in the upper part of the estuary, while hilsa catch increased all over the estuary. Sugunan (1995) noted the disappearance of hilsa and *Puntius* species from upstream of the Cauvery River because of the Mettur Dam's construction.

CONCLUSIONS

The dam has notably decreased the water flow, particularly in the post-monsoon, winter, and summer seasons. The development of sandbars at the estuary's mouth hinders the migration of fish into it. The lack of sufficient headwater discharge into the estuary has led to silt deposition, resulting in a decrease in water depth and causing the estuary to dry out during low tides. The practice of overfishing and the harmful methods employed in juvenile fishing, particularly using small-meshed bag nets, have led to the overexploitation of fish stocks. To control and regenerate the hilsa fishery, several management measures can be implemented. These include enforcing a fishing ban during the spawning season, regulating mesh sizes, halting destructive methods of capturing juveniles, ensuring the sustainable exploitation of fish while maintaining natural recruitment, conducting periodic dredging in silted areas, etc.

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REFERENCES

Bhakta, D., Meetei, W. A., Vaisakh, G., Kamble, S. P., Solanki, J. K. and Das, S. K. (2019). Season-wise length-weight relationship and relative condition factor of *Tenualosa ilisha* (Hamilton, 1822) at Narmada estuary, Gujarat, India. *Indian Journal of Geo Marine Sciences*, 48(5): 635-638.

De, D.K. and Saigal, B.N. (1989). Spawning of hilsa, *Tenualosa ilisha* (Hamilton), in the Hooghly estuary. *Journal of the Inland Fisheries Society of India*, 21: 46-48.

Hossain, M. A., Das, I., Genevier, L., Hazra, S., Rahman, M., Barange, M. and Fernandes, J. A. (2019). Biology and fisheries of Hilsa shad in Bay of Bengal. *Science of the Total Environment*, 651, 1720-1734.

Nath, D. and Shrivastava, N.P. (1999). Decline in carp fishery in Narmada in the context of construction of dam on the river and its tributaries. *Journal of the Inland Fisheries Society of India*, 31(2): 25-27.

Talwar, P.K. and Jhingran, A.G. (1991). Inland Fisheries of India and adjacent countries, Vol. 2: Oxford and IBH Publishing, New Delhi.

Inv-01T2D1

Captive rearing of hilsa with a goal to protect its fishery

S. SAMANTA[1]*, D. DE[2], S. ADHIKARI[3], D.N. CHATTOPADHYAY[3], G. BISWAS[4], S. DASGUPTA[4], R.K. MANNA[1], A.K. SAHOO[1] and B.K. DAS[1]

[1]ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata 700 120, India

[2] Kakdwip Research Centre of ICAR-CIBA, South 24 Parganas, West Bengal 743347

[3] Regional Research Centre-Rahara, ICAR-CIFA, Kolkata 700118

[4] Kolkata Centre of ICAR-CIFE, 32 GN Block, Salt Lake City, Kolkata 700091

E-mail: samantacifri66@gmail.com

Key Words: *Captive Rearing, Conservation aquaculture, Hilsa fisheries*

INTRODUCTION

Clupeids are most preferred food fishes and hilsa is important representative. Mature fishes are lipid rich (10 %), contains ω-3 and other PUFAs. Hilsa fisheries was most important in the estuaries and associated coastal regions due to its high economic returns. However, except some specific years of bumper catch, the fishery is gradually declining in India (37,000 ton in 2020-2021 to 44,011 ton in 2017). In Bangladesh, a steady increase in catch reported (>5,50,000 ton) after successful implementation of conservation measures, strict enactment of fishing ban, etc. Understanding future scenario, a comprehensive project was conceived by the researchers of the fisheries Institutes of ICAR for domestication of hilsa. With the leads obtained, the second phase of the project was in operation during 2020-2023 emphasizing captive culture, gonadal maturation and its breeding possibilities. The participating Institutes were ICAR-CIFRI, ICAR-CIBA, ICAR-CIFA and ICAR-CIFE.

MATERIALS AND METHODS

To develop the captive stock, the ready to breed hilsa fishes were collected from Gadakhali stretch of river Hooghly. Fertilization performed by dry stripping, eggs transported for hatching and post larval care. Initial stages of growth maintained in freshwater. Gradually fry and fingerlings produced. Growout culture performed in 3 locations - completely fresh water system at Rahara, ICAR-CIFA, fresh water system at Kolaghat (1.2 ppt salinity in summer) and brackish water systems at Kakdwip, ICAR-CIBA. Stocking density 2000 numbers/ha. Maintained good phyto- and zoo-planktons levels. Specially designed feeds also given. CIBA and CIFA prepared feed for different life stages of hilsa. CIBA also designed slow sinking feed to increase its acceptability by cultured fishes.

RESULTS AND DISCUSSION

Hilsa is a slow growing fish and it grows 150-200 g in the first year. Growth up to 500 g takes about 1.5-2 years. In the present culture, similar growth pattern was recorded. The reported maximum size from Kolaghat site was 689 g, 43.6 cm after rearing of 36 months. Along with vegetative growth, gonadal developments also studied. It was done initially with sacrifice of fish and histological studies. At Kakdwip, maturity assessed with cannulation in live fish. Gradually noninvasive ultrasonic method standardized by ICAR-CIFE team. Thus, gonadal maturity was assessed with USG after anaesthetizing the fish. Fishes were recovered and returned to their respective environment. Anaesthesia technique has also been standardized by the ICAR-CIFE team.

Highest recorded freshwater pond reared hilsa 689 g, 43.6 cm from Kolaghat after 36 months of rearing (left) and gonad maturity assessment of live hilsa by USG (right)

Efforts were also made to breed the fish with matured broods collected from the captive stock. After fertilization however, growth was recorded to stop within 3-4 hours. Some success has also been achieved in use of cryopreserved milt in the breeding process. Here the broods were collected from nature.

CONCLUSION

From the present set of research, it has been established that captive rearing of hilsa is feasible with the spawns produced from naturally collected broods. Once the breeding becomes successful with the captive stock then culture of hilsa will become a reality and it will be possible to revive the depleted stock by ranching i.e. with the adoption of the conservation aquaculture techniques. The table size fish produced from aquaculture practices will also be able to meet the demand of the market.

ACKNOWLEDGEMENT

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REFERENCES

Project Completion Report. 2023. Captive Breeding of Hilsa, *Tenualosa ilisha*: Phase II. National Agricultural Science Fund, Indian Council of Agricultural Research, New Delhi. p. 109.

Inv-02T2D1

The state of fisheries in river Narmada – From origin to sea mouth

S. K. MANNA[1*], D. BHAKTA[1], P. GOGOI[1], M. H. RAMTEKE[1], C. JOHNSON[1], P. DEBROY[1], S. P. KAMBLE[2] and b. K. DAS[1]

[1]ICAR-Central Inland Fisheries Research Institute, Kolkata – 700120, West Bengal, India

[1]ICAR-Central Inland Fisheries Research Institute, Vadodara – 390021, Gujarat, India

E-mail: drsanjibmanna@gmail.com; sanjib.manna@icar.gov.in;

***Key Words**: Narmada River, Fish catch, Diversity, Livelihood*

INTRODUCTION

River Narmada is one of the major and sacred rivers of India and is lifeline of millions of people in Central India. The river has rich fish diversity. Although different researchers have studied fisheries in discrete stretches (Rao *et al.* 1991; Vyas *et al.* 2007; Sharma *et al.* 2014; Bhakta *et al.* 2018) ichthyofaunal diversity of the whole river is lacking. The present study investigated fish catch, catch structure and fishing efforts for the whole river to assess the river's state of fisheries and its contribution in fishers' livelihood.

MATERIALS AND METHODS

Comprehensive fisheries resource assessment surveys were conducted based on structured and pre-validated questionnaire on fish landings, catch structure, and the socio-economic status of fishers in fishing villages along the course of River Narmada from Annupur to Bharuch.

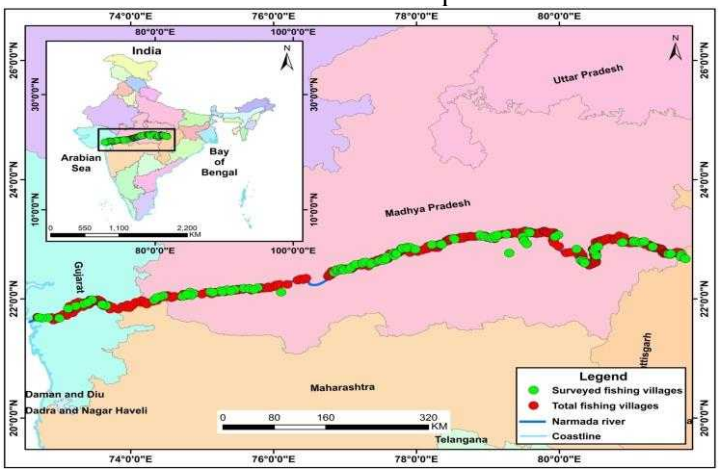

***Fig. 1.** Map showing the river Narmada stretches*

RESULTS AND DISCUSSION

Surveys in more than 150 villages estimated annual fish catch of 8308.05 tonnes from river Narmada with major catch harnessed in districts like Bharuch in the estuarine stretch and Narmadapuram in the upper stretch. There were wide variations in fish catch at different districts, but overall, the lower stretch was most productive. Highest catch was reported in the monsoon season.

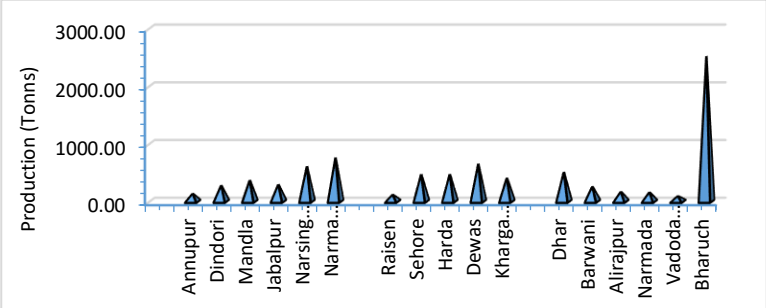

***Fig. 2**. Fish catch in different districts along the course of river Narmada*

The commercial catch was dominated by *Rita* spp., *Clupisoma garua*, *Systomus sarana*, *Tor tor* but with significant variations from place to place. Catch per unit effort (CPUE) was lowest at Annupur (2.93 Kg/person/day) in upper stretch and highest in Bharuch (6.33 Kg/person/day) in lower stretch. Fishing was the primary occupation for 33.33% fishers in upper stretch and for 60% fishers in middle stretch. Income from fisheries was minimum in the upper stretch (range: ₹ 2,500 - 4,500) and highest in lower stretch (₹ 5,000 to 10,000).

CONCLUSION

Overall, the fisheries in river Narmada was vibrant providing quality nutrition and moderate level of livelihood support to the local populace.

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REFERENCES

Bhakta, D., Meetei, W.A., Vaisakh, G., Kamble, S., Das, S.K. and Das, B. K. (2018). Finfish Diversity of Narmada Estuary in Gujarat of India. *Proceedings of the Zoological Society*. **72**: 257–262.

Rao, K. S., Chatterjee, S. N. and Singh, A. K. (1991). Studies on the pre-impoundment fisheries potential of Narmada River in the western zone. *Journal of the Inland Fisheries Society of India.* 23(1): 34–51.

Sharma, J.A., P.B. Parashar, R.K. Gar. (2014). Ichthyo-Faunal Divergence of Narmada River in Hoshangabad Region and Their Conservation Measures. *International Journal of Applied Biore-search.* 22: 5–11.

Vyas, V., Parashar, V., Bara, S and Damde, D. (2007). Fish Catch Composition of River Narmada with Reference to Common Fishing Gears in Hoshangabad Area. *Life Science Bulletin.* 4 (1&2): 1-6.

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Tilapia nilotica and *Anabas testudineus* as climate resilient species for jute slurry-based fish culture in micro-pond: a possible solution of jute retting pollution impacting wetland fisheries

R.K. MANNA[1], ASIM CHAKRABORTY[2], NILEMESH DAS[1], ABHIJITA SENGUPTA[1], RABAN CHANDRA MANDI[1], PRITIJYOTI MAJHI[1] and BASANTA KUMAR DAS[1]

[1]ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata, India

[2]ICAR-Central Research Institute for Jute and Allied Fibres, Barrackpore, Kolkata, India

E-mail: rkmanna@yahoo.com

Abstract

The utilization of fish species as climate-resilient options in jute slurry-based fish culture systems presents a promising strategy to address the environmental challenges posed by jute retting pollution in wetland fisheries. Jute retting, a process essential for fibre extraction, significantly deteriorates water quality, leading to increased turbidity and nutrient loading, which adversely affects aquatic ecosystems and fish health (Murshed-e-Jahan *et al.,* 2010; Zorn *et al.,* 2012). The introduction of resilient fish species, such as *Tilapia nilotica,* and *Anabas testudineus*, into a system utilizing jute-retting slurry, may enhance the adaptability of fish culture practices to fluctuating environmental conditions, thereby promoting sustainable fish production while mitigating the negative impacts of jute processing (Jayasinghe *et al.,* 2018; Neori & Mendola, 2012). The traditional jute retting process, which

involves submerging jute plants in water to decompose the fibrous material, has been shown to significantly degrade water quality, adversely affecting aquatic life and fish health. Studies indicate that the microbial activities during retting lead to increased total dissolved solids (TDS) and electrical conductivity (EC), while decreasing pH and dissolved oxygen (DO) levels, which are critical parameters for fish survival and growth (Ali *et al.,* 2022; Sarker *et al.,* 2022). Thorough research has documented a decline in native fish species diversity in areas subjected to traditional retting practices, highlighting the detrimental effects on aquatic ecosystems (Ghosh, 2015; Sarker *et al.,* 2022). Studies indicated that species like *T. nilotica* and *A. testudineus* exhibit remarkable tolerance to varying water quality parameters, making them suitable candidates for integration into jute slurry systems (Cinner *et al.,* 2013; Comte & Olden, 2016). Their ability to thrive in nutrient-rich environments can be leveraged to improve fish yields while simultaneously aiding in the bioremediation of polluted waters (Williams et al., 2014). Furthermore, the cultivation of these fish species in micro-ponds containing jute-retting slurry can facilitate a symbiotic relationship with jute farming, where jute retting by-products can serve as a nutrient source for fish, thus optimizing resource utilization and enhancing food security for local communities (Fujita *et al.,* 2013; Radinger *et al.,* 2017). These species are known for their adaptability to varying water quality conditions, which may provide a buffer against the fluctuations caused by jute retting (Rana *et al.,* 2020). Moreover, the socio-economic implications of adopting such integrated aquaculture systems are significant. Community-based fish culture initiatives have demonstrated that collaborative approaches to aquaculture can lead to improved income, food security, and employment opportunities in rural areas (Ojea *et al.,* 2016; Torres-Corral & Fernández-Álvarez, 2019). By fostering resilience in both fish populations and farming communities, this integrated model not only addresses the immediate challenges of jute retting pollution but also contributes to the long-term sustainability of wetland fisheries (Rhyne *et al.,* 2012; Hare *et al.,* 2016). In conclusion, the strategic incorporation of climate-resilient fish species into jute slurry-based fish culture systems offers a multifaceted solution to the environmental and socio-economic challenges posed by jute retting. This approach not only aims to restore aquatic health and biodiversity but also enhances the livelihoods of local communities, thereby promoting a sustainable and resilient fish culture framework in the face of climate change (Xu *et al.,* 2023; Arnenda, 2023).

REFERENCES

Ali, M., Kabir, E., Shawon, M., Hussain, M., Islam, M., & Alam, M. (2022). Effect of conventional retting of jute on the quality of water and jute fibre. *Progressive Agriculture*, 32(2), 151-161. https://doi.org/10.3329/pa.v32i2.58405

Colvin, S., Sullivan, S., Shirey, P., Colvin, R., Winemiller, K., Hughes, R., … & Eby, L. (2019). Headwater streams and wetlands are critical for sustaining fish, fisheries, and ecosystem services. *Fisheries*, 44(2), 73-91. https://doi.org/10.1002/fsh.10229

Ghosh, D. (2015). Impact of jute retting on native fish diversity and aquatic health of roadside transitory water bodies: an assessment in eastern india. *Journal of Ecological Engineering*, 16, 14-21. https://doi.org/10.12911/22998993/59342

Mandal, M., Dey, A., Roy, A., & Siddique, G. (2020). Ecosystem services of chariganga and arpara beel in Nadia district, west bengal: a geographical enquiry. *Space and Culture India*, 8(2), 155-167. https://doi.org/10.20896/saci.v8i2.742

Mukherjee, S. and Kumar, M. (2011). Economic valuation of a multiple use wetland water system: a case study from india. *Water Policy*, 14(1), 80-98. https://doi.org/10.2166/wp.2011.120

Rana, K., Biswas, P., & Salam, M. (2020). Evaluation of jute leaf as substitute of fish meal in the diet of mrigal (Cirrhinus cirrhosus) fingerlings. *International Journal of Agricultural Research Innovation and Technology*, 10(1), 117-122. https://doi.org/10.3329/ijarit.v10i1.48103

Roy, M., Roy, P., Samal, N., & Mazumdar, A. (2012). Socio-economic valuations of wetland based occupations of lower Gangetic basin through participatory approach. *Environment and Natural Resources Research*, 2(4). https://doi.org/10.5539/enrr.v2n4p30

Sarker, B., Paul, S., Kibriya, G., Banik, P., Saha, D., & Majumdar, P. (2022). Traditional jute (corchorus spp.) retting process: a significant threat to fish health and fish biodiversity in Chandpur district, Bangladesh. *Survey in Fisheries Sciences*, 8(2), 63-79. https://doi.org/10.18331/sfs2022.8.1.6

Arnenda, G. (2023). Growth performance of hatchery-reared mahseer (tor soro) based on different cultural periods. E3s Web of Conferences, 442, 02016. https://doi.org/10.1051/e3sconf/202344202016

Cinner, J., Huchery, C., Darling, E., Humphries, A., Graham, N., Hicks, C., … & McClanahan, T. (2013). Evaluating social and ecological vulnerability of coral reef fisheries to climate change. *Plos One*, 8(9), e74321. https://doi.org/10.1371/journal.pone.0074321

Comte, L. and Olden, J. (2016). Evolutionary and environmental determinants of freshwater fish thermal tolerance and plasticity. *Global Change Biology*, 23(2), 728-736. https://doi.org/10.1111/gcb.13427

Fujita, R., Thornhill, D., Karr, K., Cooper, C., & Dee, L. (2013). Assessing and managing data-limited ornamental fisheries in coral reefs. *Fish and Fisheries*, 15(4), 661-675. https://doi.org/10.1111/faf.12040

Hare, J., Morrison, W., Nelson, M., Stachura, M., Teeters, E., Griffis, R., … & Griswold, C. (2016). A vulnerability assessment of fish and invertebrates to climate change on the northeast U.S. continental shelf. Plos One, 11(2), e0146756. https://doi.org/10.1371/journal.pone.0146756

Jayasinghe, U., Athula, J., Silva, S., & Amarasinghe, U. (2018). Cattle and water buffalo densities wading into small village reservoirs of Sri Lanka impact on yields on the culture-based fisheries thereof. *Sri Lanka Journal of Aquatic Sciences*, 23(1), 67-75. https://doi.org/10.4038/sljas.v23i1.7547

Murshed-e-Jahan, K., Ahmed, M., & Belton, B. (2010). The impacts of aquaculture development on food security: lessons from Bangladesh. *Aquaculture Research*, 41(4), 481-495. https://doi.org/10.1111/j.1365-2109.2009.02337.x

Neori, A. and Mendola, D. (2012). An anaerobic slurry module for solids digestion and denitrification in recirculating minimal discharge marine fish culture systems. *Journal of the World Aquaculture Society*, 43(6), 859-868. https://doi.org/10.1111/j.1749-7345.2012.00603.x

Ojea, E., Pearlman, I., Gaines, S., & Lester, S. (2016). Fisheries regulatory regimes and resilience to climate change. *Ambio*, 46(4), 399-412. https://doi.org/10.1007/s13280-016-0850-1

Radinger, J., Essl, F., Hölker, F., Horký, P., Slavík, O., & Wolter, C. (2017). The future distribution of river fish: the complex interplay of climate and land use changes, species dispersal and movement barriers. *Global Change Biology*, 23(11), 4970-4986. https://doi.org/10.1111/gcb.13760

Rhyne, A., Tlusty, M., Schofield, P., Kaufman, L., Morris, J., & Bruckner, A. (2012). Revealing the appetite of the marine aquarium fish trade: the volume and biodiversity of fish imported into the United States. *Plos One*, 7(5), e35808. https://doi.org/10.1371/journal.pone.0035808

Torres-Corral, Y. and Fernández-Álvarez, C. (2019). High-throughput identification and quantification of vagococcus salmoninarum by sybr green i-based real-time pcr combined with melting curve analysis. *Journal of Fish Diseases*, 42(10), 1359-1368. https://doi.org/10.1111/jfd.13053

Williams, S., Janetski, N., Abbott, J., Blankenhorn, S., Cheng, B., Crafton, R., … & Trockel, D. (2014). Ornamental marine species culture in the coral triangle: seahorse demonstration project in the Spermonde islands, Sulawesi, Indonesia. *Environmental Management*, 54(6), 1342-1355. https://doi.org/10.1007/s00267-014-0343-6

Xu, E., Niu, R., Lao, J., Zhang, S., Li, J., Zhu, Y., … & Liu, D. (2023). Tissue-like cultured fish fillets through a synthetic food pipeline. *NPJ Science of Food*, 7(1). https://doi.org/10.1038/s41538-023-00194-2

Zorn, T., Seelbach, P., & Rutherford, E. (2012). A regional-scale habitat suitability model to assess the effects of flow reduction on fish assemblages in Michigan streams1. *Jawra Journal of the American Water Resources Association,* 48(5), 871-895. https://doi.org/10.1111/j.1752-1688.2012.00656.x

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Relevance of farm made feed for aquaculture production

T. K. GHOSHAL*

ICAR- Central Institute of Fisheries Education, Kolkata Centre, Kolkata-700091, West Bengal, India

E-mail: tkghoshal@cife.edu.in

***Key Words**: Aquaculture, Fish Nutrition, Farm-Made Feed, Livelihood Upliftment*

INTRODUCTION

Nutritionally balanced feed is vital for fish culture and feed cost accounts for 50–60% of aquaculture expenses. But commercial feeds are costly and often unavailable, particularly for small-scale farmers. The total fish production in India is 17.45 MT during 2023-24 out of which production from aquaculture is 13.13 MT (Handbook of Fisheries Statistics, 2023). At present, the country is using only about 2.8 MT of commercial aquafeed while, small and marginal farmers are mostly relying on farm-made feed which is about 8.0 to 9.0 MT prepared through mixture of available feed ingredients or through the use of small feed mill machineries. Till date majority of culture of Indian major carps like

Catla, Rohu and Mrigal and other minor carps or exotic carps is based on farm made feed produced by farmers or small-scale entrepreneurs. Farm-made feeds, whether moist dough or simple pellets, provide a cost-effective alternative.

MATERIALS AND METHODS:

Farm-made feed can be prepared using plant-based ingredients like wheat, rice, maize flour, oil cakes, and brewery wastes, along with animal-based ingredients such as fish meal, poultry by-products, blood meal, and shrimp meal. Feed types include mash, semi-moist, and dry pellets, depending on facilities and cultured species.

For preparation of farm made feed the following methods is to be followed-

Grinding: Ensure uniform particle size using a grinder or sieve to remove foreign materials. Weighing: Accurately measure ingredients, especially micronutrients.

Mixing: Blend ground ingredients (excluding vitamins and minerals). Large batches may use a mixer.

Mixing of oil: Add and mix warmed oil or an emulsion for even distribution.

Addition of water: Gradually mix water to achieve 45-55% moisture for good pellet formation.

Steam cooking: Cook at 100°C for 5-10 minutes to gelatinize starch and sterilize the feed.

Incorporation of Vitamin-Mineral mixture: Blend micronutrients into the cooled mixture for even distribution.

Pelletization: Extrude the mixture through a pellet machine, cutting pellets to suitable sizes (1, 2, or 3 mm).

Drying: Reduce moisture below 10% using an oven, drying cabinet, solar dryer, or sun drying.

Storage: Store in sealed containers to prevent pests and moisture contamination. Use fresh feed to maintain quality.

RESULTS AND DISCUSSION:

The advantages of farm-made feed include the ability to formulate diverse fish feed based on ingredient availability and cost, minimizing overall feed expenses. Farmers can prepare the feed on-site, ensuring cultured fish receive fresh, high-quality nutrition. Additionally, nutrient loss, particularly vitamins and minerals, can be minimized during preparation, maintaining the feed's nutritional value. The drawbacks of farm-made feed include poor water stability, which can pollute pond water if not consumed immediately, and variability in raw material quality, leading to inconsistent nutrient composition and digestibility. Additionally, large-scale aquaculture using farm-made feed is not feasible. Inappropriate feeding strategies and inadequate monitoring can cause feed wastage, negatively impacting production. Proper feed delivery is essential to minimize waste, as underfeeding reduces production while overfeeding leads to waste and deteriorates water quality. A serious decline in water quality can ultimately result in stock losses.

Limited information on local feed ingredient supply, costs, quality, and optimal inclusion rates hinders effective farm-made feed formulation. Farmers and small-scale feed manufacturers need up-to-date data on ingredient availability, costs, and usage rates to make informed decisions. Without this, ingredients may be excluded or used at suboptimal or excessive levels. Additionally, a lack of training on basic feed-making machinery and inadequate storage and handling systems often lead to feed spoilage and nutrient loss.

CONCLUSION:

Research is needed to explore locally available, low-cost ingredients like tapioca flour, mango seed kernel, and sesame oil cake to reduce farm-made feed costs and improve efficiency. Species-specific feed formulations should be developed, and farmers require updated information on ingredient availability, costs, and inclusion rates. Advancing indigenous feed processing technology can enhance digestibility, while refining feeding management in polyculture can improve sustainability by minimizing waste. Standardizing optimal stocking densities and incorporating compatible species based on feeding ecology can boost production and efficiency. Additionally, the environmental impact of polyculture using low-cost feed should be studied, with feed formulations adjusted for sustainability.

REFERENCES:

Fisheries statistics division (2023), *Handbook of fisheries statistics* Ch-1: p 2

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Perspective of small-scale fisheries: Illuminating the socio-economics, livelihood and resilience of the fishers of Chilika lagoon

ARUN PANDIT, A. EKKA and B.K. DAS
ICAR-Central Inland Fishery Research Institute, Barrackpore, Kolkata, W.B., India
E-mail: arunpandit74@gmail.com

Abstract

Chilika, is an eco-wonder which provides habitat to a wide range of freshwater, brackishwater and marine water organisms. It is the largest brackish water lagoon in Asia, falls in eight blocks of three districts (Puri, Khurda and Ganjam) of Odisha. The study conducted during 2018-19 covering 225 fishermen spread across the four sectors of the lake shows that there were 23,115 fishermen households in and around the Chilika lagoon and their population was 1.46 lakh (2011 census). The majority of these belong to the lowest strata of the society and the poorest of the poor. The study revealed that *Koibarta* (also known as *Keuta* or *Khatia*) was the predominant fishing caste among the fishers in the lagoon. District collectors, FISHFED, Primary Fishermen Cooperative Societies, Asst. Register of Cooperative Society, Revenue Deptt, District Fishery Office, Chilika Wildlife Division, Asst. Director of Fisheries and Chilika Development Authority were the major stakeholders in Chilika fisheries. Around 30% of fisher's household possessed agricultural land in northern, central and southern sectors. Fishing was the primary occupation to around 73% of the households. The overall yearly income from all sources was estimated around Rs.73000 across the sectors and fishing in Chilika contributed around 78% of the total income. The income was significantly lower for 'fishing labour' group who did not possess any boats. Around 65-70% of the fishermen households owned boats across different sectors. Overall, among the boat owners, around 36% households possessed motorized boats. Migration and occupational diversification were also practiced to supplement the livelihood. The fishing and disposal of fishes were operating in a system where the fishermen were in disadvantageous position. The investigation further revealed limited presence of formal credit institutions and a weak asset base of the fishers and hence fishermen are forced to take loans and advances from the middlemen (*Mahajan*). There has been fisher – non fisher conflicts since long, particularly after introduction of shrimp culture in 1984-85. There were 18 landing centres registered by CDA. Kalupadaghat, Bhusandapur and Sorona and Balugaon are the major four among the lot. These 4 centres handle 70% of the landing. The present level of exploitation in the lagoon is higher than the MSY, it would be much higher if the production from illegal prawn gherries are taken in to account. The annual maximum sustainable yield of the lake is 11,376 MT as estimated by ICAR-CIFRI. At this level of production, the lagoon can sustain 50% livelihood to the existing fishermen households. The study on impact of severe cyclonic storm, Fani (2019) in Chilika revealed that in outer channel and Chilka north sectors, 55% and 22% of the semi-*pucca* houses were partially damaged. Fishermen (around 48%) reported loss of fishing nets, the incident was highest in Chilika outer channel in Puri district, where 75% fishers reported net loss. Around 68% of the boats in the outer channel were severely damaged. The study identified nine indicators of resilience under the four livelihood capitals namely natural capital, physical capital, financial capital and human capital. It has been observed that out of the nine indicators, only three were in 'desirable' category. Under the financial capital, all the indicators were in 'crisis' category. Altogether, out of 12, six indicators of resilience six were 'in crisis', two were in 'stable', and only four indicators were 'desirable'. The study concluded that 50% of the indictors were in 'crisis' category, hence, serious efforts are needed to bring the indicators to 'desirable' from 'crisis' category.

To maintain the sustainable fisheries the authorities have to devise strategies to either divert 50% of fishermen to other professions or arrange supplementary income generating activities which can generate other 50% of their income. Eco-tourism, ice factory, fish processing facilities, marketing infrastructure, self-employment schemes like tailoring, carpentry, masonry work, e-rickshaws, small business opportunities may be provided. Capacity building of the fishermen, popularization of the traditional non-destructive fishing gears may be initiated. Suitable policy guidelines and strict implementation are necessary for sustainable management of this resource. These cooperatives should be revived and made active. Additionally, FPOs, SHGs may also be formed to put forth their problems, hardships and offer solutions to their problems

Key Words: *Chilika, fishers, socio-economics, livelihood*

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Sustainable brackish water aquaculture technologies to improve livelihood of Sundarban farmers

D. DE[1], B. MANDAL[1], K. K. LAL[2]
[1]Kakdwip Research Centre, ICAR- Central Institute of Brackishwater Aquaculture, Kakdwip, South 24 Parganas, 743347, West Bengal, India
[2] ICAR- Central Institute of Brackishwater Aquaculture, Chennai, 600028, Tamil Nadu, India
E-mail: debasis.de@icar.gov.in

Key Words: *Brackishwater Aquaculture, Integrated Farming, Species Diversification Sundarbans, Sustainable*

INTRODUCTION

India has vast brackishwater fisheries resources, including estuaries, coastlines, backwaters, mangroves, and lagoons. The country possesses approximately 3.9 million hectares of estuaries and 0.5 million hectares of coastal mangroves, along with an estimated 1.2 million hectares of potential brackishwater areas suitable for aquaculture. In India, Sundarbans, is a unique and ecologically sensitive region known for its mangrove forests with rich biodiversity worldwide. This area plays a crucial role in supporting both natural ecosystems and human livelihoods. Since ages, brackishwater aquaculture primarily shrimp and finfish farming, has been synonyms to traditional livelihood for many communities in the Sundarbans and provides economic support, particularly for small-scale and marginalized fishers. Over the years, the increasing demand for seafood and commercial aquaculture expansion has led to several challenges, including environmental degradation, loss of biodiversity, and conflicts over land and water resources. Unsustainable aquaculture practices along with extreme weather events have negatively impacted the delicate ecological balance of the Sundarbans that threaten both the local communities and aquatic ecosystems. Due to these challenges, there is a growing need to adopt sustainable brackishwater aquaculture practices which can balance economic growth with ecological conservation.

MATERIALS AND METHODS

Kakdwip Research Centre of ICAR-CIBA is strategically placed in near vicinity of Sundarbans focussing on developing sustainable brackish water aquaculture technologies for farmers of this region. This includes integrating eco-friendly methods such as culture of region-specific finfish and shellfish species, polyculture with compatible species, Integrated Livestock-Horti-Aquaculture, Integrated Multi-trophic Aquaculture- IMTA, periphyton based aquaculture, use of organic and biosecure farming practices, development and use of organic input in aquaculture, development of cost-effective feed for different species using locally available feed ingredients etc. This article explores such technologies developed by Kakdwip Research Centre (KRC) of ICAR-CIBA as a solution for a resilient aquaculture industry in the Sundarbans.

RESULTS AND DISCUSSION

Species Diversification:

Relying on a single species for aquaculture increases the risk of disease outbreaks and economic losses. Species diversification also helps in improving ecological balance, as different species utilize resources more efficiently, thereby reducing competition and environmental stress. KRC of ICAR-CIBA took serious efforts and successful demonstrated finfish farming in different place of Sundarbans which has given confidence to the farmers to adopt commercial culture of finfishes like Asian seabass, grey mullet, pearl spot and milkfish. Initiative has also been taken for propagation of Hilsa culture in Sundarban. Apart from shrimp and fish, crab culture is gaining momentum due to its high demand and export market.

Asian Seabass (Lates calcarifer) culture with farm made feed:

The Asian Seabass, locally known as ‘Bhetki’, is a popular euryhaline brackish water species in West Bengal. Hatchery produced fry can be reared in pond based hapa with formulated feed. During nursery rearing in hapa regular grading should be done to avoid cannibalism. Seabass culture with farm made feed in Sundarbans showed impressive result in terms of net profit and benefit cost ratio. Farmers can prepare cost effective feed easily by using locally available ingredients and can reduce the cost of seabass production. Seabass culture with farm made feed is only possible if hatchery produced weaned seed acclimatized to formulated feed is stocked. A production of 2-3 tons/ha can be achieved in 8-12 months.

Polyculture using cost effective feed:

Modification of traditional brackishwater polyculture through selection of compatible species for sustainable better production and profitability were tested by KRC of ICAR-CIBA involving tiger shrimp (*Penaeus monodon*), Grey mullet (*Mugil cephalus*), Parsia (*Liza parsia*), and Milkfish (*Chanos chanos*). For getting the best result in polyculture, selecting appropriate species and using cost effective feed are the keys to the success. Poly^{Plus}, a cost-effective polyculture feed developed by KRC, CIBA using locally available cheap ingredients resulted in a better growth of species in polyculture and high economic return. Brackishwater polyculture of *Mugil cephalus*, Liza *tade*, *Liza parsia*, *Scatophagus argus*, *M. gulio* and *P. monodon* (@ 0.25, 0.5, 0.5, 0.25, 3.0 and 0.25 nos/sqm) using Poly^{Plus} feed was reported to yield a production of 3.2-4.8 t/ha (De et al. 2018).

Integrated Multi-Trophic Aquaculture (IMTA):

IMTA involves the co-culture of species from different trophic levels to maximize resource utilization and minimize waste. In the Sundarbans, IMTA systems integrate shrimp, finfish, and filter-feeding shellfish to create a balanced ecosystem. This method reduces the accumulation of organic waste and enhances water quality. Farmers benefit from diversified production, reducing the risk of total crop failure and improving resilience against market fluctuations. Integrated multi-trophic aquaculture (IMTA) model involving mullets (*Mugil cephalus* and *Liza parsia*) and tiger shrimp (*Penaeus monodon*) as fed-species, and estuarine oyster (*Crassostrea cuttackensis*) and seaweed, *Enteromorpha spp*. as extractive species is a viable aquaculture option in brackishwater of the Indian Sundarban.

Periphyton-Based Aquaculture:

Periphyton farming involves the use of submerged substrates to promote the growth of natural biofilms, which serve as an additional food source for cultured species. Velon nets can be installed in ponds to develop the periphyton. This technique enhances productivity and reduces dependence on artificial feeds, making it a cost-effective and environmentally friendly practice. The use of periphyton has shown to reduce feed requirement to the tune of 30 % in polyculture and reduce FCR by 46 % in milkfish culture. Periphyton based shrimp farming model showed 17.9% gain in production and 22.3% reduction in FCR compared to the control ponds in *P. monodon* culture.

Integrated poultry-horti-aqua farming**:**

Integrated farming mainly adopts the circular economy concept and brings better overall profitability. Integrated farming combines various agricultural activities like poultry, livestock, horticulture and aquaculture and utilizes the waste generated in one activity as the input for the other. The poultry-horti-aqua can be practiced in a unit land area of 4000 sq. m. This farming model is ideal to be integrated with an aquaculture pond of size 3000 sq. m with 360 sq. m area for farming vegetables having local demand and with two floating poultry shed of 9 sq. m each for chick (50 nos.Rhode Island Red) and duck (50 nos. Khaki campbell). Species composition for aquaculture was *Chanos chanos*, *Liza tade*, *Mugil cephalus*, *Liza parsia*, *Etroplus suratensis*, *Oreochromis mosambicus*, *Mystus gulio* and *Penaeus monodon* stocked @ 0.5,0.25,0.25,0.25,0.5,0.75,0.5,1.0 per sq.m., respectively. In this model of integrated farming aquaculture production of 1-1.5 tonnes/unit could be achieved with a net profit of Rs 1,67,667.00/acre.

Modular hatchery of fish:

ICAR-CIBA at kakdwip has developed and popularised a cost effective, farmer friendly homestead modular tank based hatchery technology for Long whiskers cat fish, Pearlspot, other ornamental fish like orange chromide, Knight gobi etc. with improved breeding frequency and survival.

CONCLUSION

New brackishwater aquaculture technologies viz. polyculture with cost effective feed, Integrated Multi-Trophic Aquaculture (IMTA), integrated poultry-horti-aquaculture, sustainable shrimp farming with Plankton booster (Plankton ^{Plus}) and Chingudi ^{Plus} feed , organic aquaculture etc. developed by Kakdwip Research Centre of ICAR-CIBA are eco-friendly, cost-effective technologies which are helping farmers to increase productivity while minimizing environmental impact. Brackishwater aquaculture can become a sustainable, high-yield sector, contributing to food security, employment generation, by integrating these scientific technologies alongwith strategic policy support by government and farmer engagement.

REFERENCES

Biswas G, De D, Thirunavukkarasu AR et al (2012) Effects of stocking density, feeding, fertilization and combined fertilization-feeding on the performances of striped grey mullet (*Mugil cephalus* L.) fingerlings in brackishwater pond rearing systems. *Aquaculture*. 338–341:284–292

De, D., Ghoshal, T.K., Das,S., Kumar,P. and Das, U. 2022. Brackishwater Aquaculture: Options for Livelihood Improvement of Farmers in Indian Sundarban. In: Lama, T.D., Burman,D., Mandal,

U.K., Sarangi,S.K. and Sen, H.S. (Eds.), Transforming coastal zone for sustainable food and income security, Springer Nature, Cham, Switzerland, pp. 419-432. ISBN 978-3-030-95618-9

De, D., Biswas, G., Ghoshal, T.K.G., Ananda Raja, R., Shyne Anand, P. S., Kumar,S., Panigrahi, A.,Kumaraguru Vasagam,K.P., Ambasankar, K. and Vijayan, K.K.(2018) Poly ^{plus} - a cost effective feed for brackishwater polyculture. *CIBA Technology Series*, 15, pp 12.

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Emerging contaminants in the Hooghly estuary – Cause and effect on fisheries and aquaculture

SUBIR KUMAR NAG
Fishery Resource Assessment and Informatics Division
ICAR- Central Inland Fisheries Research Institute
Barrackpore, Kolkata – 700120
E-mail: s.nag@icar.gov.in

Abstract

Contamination of aquatic bodies with different chemical substances having toxicological implications is a major concern affecting the ecology and the environment. The lower part of the Hooghly river, which is the major deltaic off-shoot of River Ganga in its lower stretch and reaches the Bay of Bengal, forms the Hooghly River Estuary. The estuary flows through the densely populated and industrial towns and cities of 24 Parganas, Howrah, Hooghly district and Kolkata city in the state of West Bengal before merging with the Bay of Bengal at Ganga Sagar. The contamination in the estuary water arises from industrial wastes, sewage effluent, agricultural runoff, dumpling of garbage, and domestic wastes through large and small drains. As a result, it has become a receptor of diverse types of contaminants from several point and non-point sources of pollution. In addition to metals and pesticide residues, emerging micropollutants like micro and nanoplastics, plasticizer compounds phthalates and bisphenols, petroleum hydrocarbons including polyaromatics, pharmaceuticals and personal care products (PPCP), per and polyfluoroalkyl substances (PFAS) have been detected in water and sediments. Through bioconcentration and bioaccumulation, many of the contaminants get accumulated in fish and other aquatic animals. Several of these chemicals have potential ecolotoxicologial risks to the recipient organisms including endocrine disruption resulting in adverse effect on reproduction and decline in population. In addition, bioaccumulation of these chemicals in fish may also result in transfer to the higher trophic level and pose risks to human health.

Key Words: *Pollution, Emerging Contaminants, Toxicity, Fish, Hooghly Estuary*

Inv-03T2D2

White faecal syndrome (WFS) in shrimp and its control measures

DAS S[1], SATISH KUMAR, T[2], SUDHEER NS[1], MANNA S[1] and DE D[1]
[1]Kakdwip Research Centre, ICAR- Central Institute of Brackishwater Aquaculture, Kakdwip, India
[2]ICAR- Central Institute of Brackishwater Aquaculture, Chennai, India
E-mail: sanjoy.das1@icar.gov.in

Key Words*: WFS, EHP, Vannamei, Shrimp*

WHITE FECES SYNDROME (WFS)

Shrimp farming sector of India as well as whole world is a hughly profitable industry associated with high growth rate and export potential. During 2023-24, the seafood export value of India was Rs 60,254 crores, with frozen shrimp alone contributing 66.4% of the total exports (MPEDA, 2025). However very often, the shrimp farming sectors of India and other shrimp producing countries are severely affected by various diseases, often leading to complete production loss. White faecal syndrome (WFS) is one of the most important diseases of shrimp, causing severe economic loss to the shrimp farmers. In India, since 2015, the occurrences of WFS were very severe in *P. vannamei* grow-out farms. The disease can cause moderate to severe economic loss by reducing the shrimp survival by 20–30% compared to the normal ponds.

CLINICAL SIGNS OF WFS

The shrimp affected with WFS can exhibit clincial signs within 20-30 days of culture. The WFS affected shrimp shows white/golden brown intestine, excrete white fecal threads and show reduced feeding and retarded growth. Ponds affected with WFS shrimp show floating white fecal threads on the surface of the pond for 10 to 45 days or more and will have increased FCR, size variation/growth

retardation, loose shells and daily mortalities (Fig. 1). The animal affected with loose shell show loose exoskeleton and sluggish swimming activity at the pond surface (Satish Kumar et al., 2022).

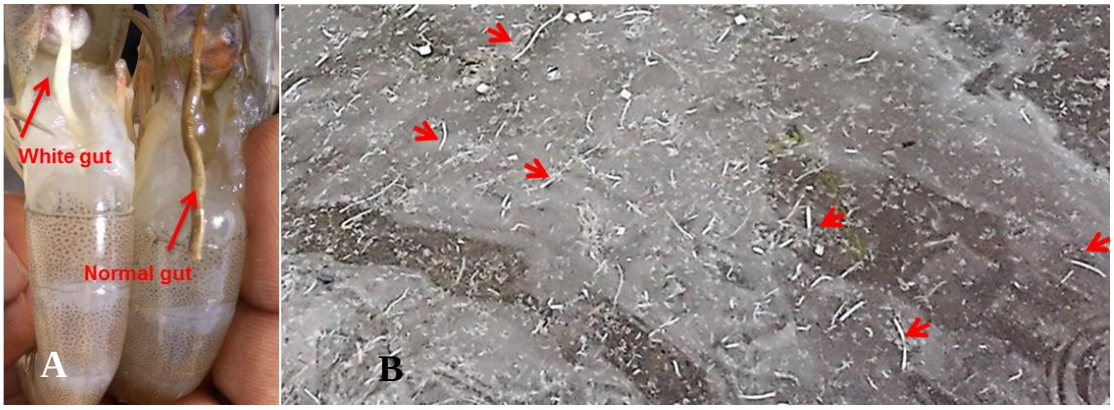

Fig 1 A*- Shrimp with normal gut and WFS shrimp with white gut. B – White fecal threads floating on the WFS affected shrimp pond surface.*

CAUSATIVE AGENT

WFS is multifactorial disease and is caused by more than one pathogen. EHP (*Ecytonucleospora hepatopenaei*) is the primary pathogen reported to be associated with the incidences of WFS. Other than EHP, WFS have been associated with gregarine worms, *Vibrios*, bacteria, fungi, and algae. However, white fecal strings are primarily composed of dense mature EHP spores, and vermiform bodies, sloughed-off epithelial cells, gut mucus, and rod-shaped bacterium. Few bioassay studies reproduced WFS under laboratory experimental conditions by challenging EHP and *Vibrio spp.*

MANAGEMENT

Effective management and proactive biosecurity measures on the farm can reduce the risk of transmission of WFS. Feed can be reduced during the WFS affected period in shrimp ponds. Floating white fecal strings can be frequently removed from the shrimp pond on day to day basis. Overfeeding should be avoided as energy spent in digestion will only weaken the shrimp. It is also recommended to provide high protein diet to the shrimp as it will boost the immunity of shrimp and aids in shrimp digestion capacity. As EHP is the primary cause of WFS, it is highly essential to stock shrimp pond with EHP-free post-larvae. Pond preparatory measures should be followed properly by drying and disinfection after every harvest. Quick lime (6 tons per hectare), potassium permanganate > 15 ppm and chlorine > 40 ppm can be used to inactivate the spores in the soil. 'CIBA EHP Cura I'- a unique phytobased therapeutic formulation can be used @ 50ml per kg of shrimp feed by top coating for 10-15 days. Use of shrimp toilet aids in reducing the organic load of the pond and reduces the risk of occurrence of WFS. Application of a good quality gut probiotics along with feed is recommended. Overstocking also potentiates the risk of WFS and hence, it should be avoided.

REFERENNCES

MPEDA (2025). Marine products exports. Marine products export development authority. Accessed through https://mpeda.gov.in/?page_id=438 on 1st February, 2025.

Satish Kumar, T., Makesh, M., Alavandi, S.V. and Vijayan, K.K. (2022). Clinical manifestations of White feces syndrome (WFS), and its association with Enterocytozoon hepatopenaei in Peneus vannamei grow-out farms: A pathological investigation. *Aquaculture*.547:737463.

Oral V1T2D1

Impact of increasing salinity levels on the abundance of Ganges River dolphins in the lower Ganga River: Challenges and conservation Perspectives

BASANTA KUMAR DAS*, DIBAKAR BHAKTA, CANCIYAL JOHNSON, MITESH RAMTEKE, SURAJ KUMAR CHAUHAN, ARCHISMAN RAY and ARGHA MANDAL
ICAR-Central Inland Fisheries Research Institute, Barrackpore, Monirampore, Kolkata-700 120, West Bengal, India.
E-mail: basantakumard@gmail.com

***Key Words**: Ganges River Dolphins, Increasing Salinity, Challenges, Conservations, Lower Ganga River*

INTRODUCTION

Ganges-Brahmaputra-Meghna River basins are home to the Ganges River dolphin (*Platanista gangetica*). As a key indication of riverine ecosystem health, the species helps preserve ecological equilibrium. However, anthropogenic and environmental pressures have been reducing Ganges River dolphin populations. Increasing salinity in freshwater habitats, particularly in the Ganga River's lower reaches, is a major but understudied hazard to the species (Choudhary *et al*., 2012). High salinity can change the aquatic food web, prey availability, and freshwater-dependent organisms' physiological functions. Despite extensive research on habitat destruction, pollution, and overfishing, salinity's effects on the Ganges River dolphin abundance and distribution are unknown. Despite substantial studies on Ganges River dolphin risks, few have examined salinity gradients and dolphin numbers. No region-specific research has examined the cumulative effects of salinity and other stresses in the lower Ganga River. To fill knowledge gaps, this study examines how salinity affects the Ganges River dolphin numbers in the lower Ganga River.

MATERILS AND METHODS

The study took place in the lower reaches of the Ganga River, extending from Nabadwip to Kakdwip and covering significant areas recognised for the presence of Ganges River dolphins. There are big changes in salinity in this area because less freshwater flows in, the tides move, and water is taken from sources upstream. Historical data on dolphin presence, their proximity to estuarine zones, and the observed variations in salinity levels informed the selection of survey sites. We used a combination of field surveys, water quality assessments, and prey abundance to examine the effects of salinity levels on dolphin populations. The investigation was carried out over the course of one year (2022-2023). The estimation of dolphin abundance was conducted through both boat-based and land-based visual surveys, employing the line-transect sampling method as outlined by Buckland *et al.* (2001). Data was collected on the number of individuals, group size, and location through GPS tracking. To reduce the potential for observer bias, protocols involving two observers were utilised. The study evaluated prey abundance by conducting fish sampling in the designated areas, utilising gill nets and cast nets for data collection. The assessment of water quality was conducted using standard methods (APHA, 2015).

RESULTS AND DISCUSSION

Salinity measurements in the lower Ganga River demonstrated notable spatial and temporal variability. Salinity levels ranged from 0.01 ppt to 12.23 ppt, and during the dry season, when freshwater inflow and tidal incursions are lower, salinity levels were higher. Looking back at old data showed that salinity has slowly been rising over the last twenty years, mostly in downstream areas. This is because of changes in the climate and the removal of water from upstream areas (Ghosh *et al*., 2021). The visual surveys documented a total of 39 individuals within the study sites, with the highest densities noted in freshwater-dominated upstream sections (Table 1). The presence of dolphins diminished notably when salinity levels surpassed 8.0 ppt, indicating a threshold for habitat suitability for the species. Regions exhibiting salinity levels exceeding 10.0 ppt consistently demonstrated the absence of dolphins. Seasonal variations in abundance demonstrated that dolphins migrated upstream during periods of elevated salinity.

Fish sampling indicated notable changes in prey composition across the salinity gradient. Certain fish species, such as *Labeo catla* and *Labeo rohita*, lived in areas with low salt levels. In contrast, *Tenualosa ilisha, Otolithoides pama, Odontamblyopus rubicundus, Cynoglossus cymoglossus,*

Setipinna phasa, Coilia dussumieri, Arius arius, Coilia ramcarati, which live in areas with high salt levels, were more common. The limited availability of prey in saline zones likely influenced the dolphins' avoidance of these regions (Das *et al*., 2018).

The findings indicate that salinity significantly influences the distribution and abundance of Ganges River dolphins. These dolphins, as obligate freshwater species, demonstrate physiological constraints in their ability to tolerate increased salinity levels, potentially interfering with osmoregulatory functions. The identified threshold salinity of 4-6 ppt corresponds with earlier research indicating the species' limited tolerance to saline conditions (Smith and Reeves, 2012).

Increased salinity in downstream regions has fragmented the dolphins' habitat, compelling individuals to migrate upstream. The diminished availability of prey likely intensifies the dolphins' challenges in thriving within saline environments (Das *et al*., 2018). The findings highlight the necessity of addressing salinity as a significant ecological factor in the conservation of Ganges River dolphins. Projections indicate that climate change will lead to increased salinisation of the lower Ganga River

because of rising sea levels and diminished freshwater inflows (Ghosh *et al*., 2021). In the absence of effective intervention, these trends may exacerbate habitat degradation and jeopardise the species' long-term survival.

Table 1. *Details of dolphin counts in the lower Ganga River with water parameters and major fish species abundance*

Stations	No. of dolphin counted	Salinity (ppt)	Major fish species abundance
Nabadwip	7	0.01	*Gudusia chapra, Salmostroma bacaila, Osteobrama cotio, Cirrhinus reba, Amblypharyngodon mola, Corica soborna, Glossogobius giuris, Puntius sophore*
Balagarh	14	0.03	*Channa punctata, Channa striata, Puntius chola, Pethia ticto, Puntius conchonius,*
Tribeni	6	0.04	*Eleotris fusca, Apocryptes bato, Gonialosa manmina, Mastacembelus armatus, Johnius gangeticus, Salmostoma bacaila, Setipinna phasa, Puntius chola*
Godakhali	5	0.05	*Setipinna phasa, Otolithoides pama, Odontamblyopus rubicundus, Arius arius, Tenualosa Ilisha, Rhinomugil corsula*
Diamond harbour	4	2.86	*Tenualosa ilisha, Otolithoides pama, Odontamblyopus rubicundus, Setipinna phasa, Coilia dussumieri, Arius arius, Coilia ramcarati*
Tyangra Char	3	8.05	*Polynemus paradiseus, Otolithoides pama, Tenualosa ilisha, Bregmaceros mcclellandii*
Kakdwip	0	12.23	*Coilia ramkarati, Harpadon nehereus, Osteomugil cunnesius, Coilia dussumieri, Terapon jarbua, Mystus gulio*

CONCLUSION

The Ganges River dolphin, a well-known and endangered freshwater species, is in severe jeopardy as salinity levels rise in the lower Ganga River. This study stresses the physiological and ecological challenges that dolphins face in saline environments. The results show the indirect effects of changes in salt levels on the availability of prey, as well as a new threshold for salt tolerance. Immediate conservation efforts are required to solve this issue, such as restoring freshwater flow, managing water resources sustainably, and protecting critical habitats. These initiatives, which reduce salinity levels and maintain ecological integrity, can help ensure the Ganges River dolphins' long-term survival in the face of increasing environmental and human stressors.

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REFERENCES

Buckland, S.T., Anderson, D.R., Burnham, K.P. and Laake, J.L. (2001). *Introduction to Distance Sampling: Estimating Abundance of Biological Populations*. Oxford University Press.

Choudhary, S., Dey, S., Sagar, V., Naird, T. and Kelkar, N. (2012). River dolphin distribution in regulated river systems: implications for dry-season flow regimes in the Gangetic basin. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 22: 11–25.

Das, K., Bhowmik, S. and Goswami, S. (2018). Effects of Salinity on Aquatic Biodiversity in Estuarine Ecosystems. *Aquatic Ecology Journal*, 52(3): 345-360.

Ghosh, S., Pal, S. and Dutta, A. (2021). Salinity Dynamics and Ecosystem Health in the Lower Ganga River. *Environmental Monitoring and Assessment*, 193(2): 112.

Smith, B.D. and Reeves, R.R. (2012). River Cetaceans and Habitat Change: General Threats and Conservation Approaches. *International Journal of Aquatic Conservation*, 22(1): 23-30.

Oral V2T2D1

Holistic perilous index-based environmental and human health risk appraisal of trace metals in a tropical urban estuary

AJOY SAHA[1]*, B. K. DAS[1], D. J. SARKAR[1], S. SAMANTA[1], SONALIKA SAHOO[2]; M. E. VIJAYKUMAR[2], M. FEROZ KHAN[2], TANIA KAYAL[1], CHAYNA JANA[1], VIKAS KUMAR[3], and PRANAB GOGOI[1]

[1]ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata - 700 120, India

[2]Regional Centre of ICAR-Central Inland Fisheries Research Institute, Bangalore - 560 089, India

[3]Regional Centre of ICAR-Central Inland Fisheries Research Institute, Prayagraj 211 002, India

E-mail: ajoysahacob@gmail.com

***Key Words**: Human Health; Hazard Index; Multivariate Statistics; Netravathi-Gurupur Estuary; Trace Metals*

INTRODUCTION

The Netravathi-Gurupur estuary, located in the coastal urbanized city of Mangalore, India, is formed by the confluence of the Netravathi and Gurupur rivers. Various small, medium and large-scale industries are situated on the banks of the Netravathi and Gurupur rivers. Either directly or indirectly, the waste of these industries is pumped into these rivers or, finally the estuary and a large volume of trace metals are accumulated in the estuarine environment. This estuary provides active fishery year-round. Hence, a holistic approach to analyze the impact of trace metals on the whole environment and on the biota is important. For these reasons, this study is focused on- (1) assessing the metal concentration in the water, sediment and fish, (2) assessing the environmental risks of metal pollution and (3) assessing the risks to human health.

MATERIALS AND METHODS

Study area: In Netravathi-Gurupur estuary, nine representative sampling sites were selected to collect sediment and water samples (Figure 1) with standard procedure during non-monsoon (February-2021) and monsoon (September-2021) period. Ten estuarine fish species (*Nematalosa nasus*, *Gerres filamentosus*, *Arius arius*, *Gerres erythrourus*, *Sardinella fimbriata*, *Caranx ignobilis*, *Etroplus suratensis*, *Mugil cephalus*, *Sillago sihama*, and *Euryglossa orientalis*) and two crab species (*Portunus pelagicus* and *Scylla serrata)* were also collected in non-monsoon period. After collection, samples were prepared through acid digestion method and analyzed in ICP-MS to determine the heavy metals concentrations. Geochemical and ecological risk indices: In order to assess the potential ecological risk posed by the trace metal present in the sediment, several well-established sediment quality indices like contamination factor (CF), degree of contamination (Cd) and modified degree of contamination (mCd), enrichment factor (EF), geoaccumulation index (Igeo), pollution load index (PLI), potential ecological risk factor (Er) and risk index (RI) were calculated. Human health risk assessment: Evaluated the potential health risk to humans by measuring target health hazard (THQ), hazard index (HI), estimated daily (EDI) intake and cancer risk (CR). Statistics: Multivariate statistical tools like Pearson's correlation analysis and principal component analysis were used for source identification of different pollutants and their association with physicochemical parameters of water and sediment. Statistical software like PAST, and SPSS were used for statistical analysis.

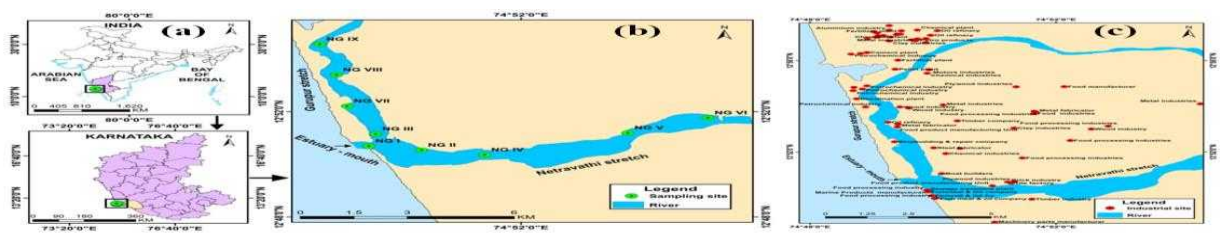

***Fig. 1.** Map of India and that of Karnataka State (a) along with a studied area with sampling locations in Netravathi-Gurupur estuary (b) and major industries around the estuary (c).*

RESULTS AND DISCUSSION

The descended order of studied metal concentrations (µg/L) in the water was Fe (592.71) > Mn (98.35) > Zn (54.69) > Cu (6.64) > Cd (3.24) > Pb (2.38) > Cr (0.82) and in sediment (mg/kg) was Fe (11396.53) > Mn (100.61) > Cr (75.41) > Zn (20.04) > Cu (12.77) > Pb (3.46) > Cd (0.02). The hierarchy of toxic metal content in studied fish species was Fe > Pb > Cr > Mn > Zn > Cu > Cd (Table 1). The concentration of heavy metals in fish species was distinctly lower than the threshold value as suggested by World Health Organization and Food Safety and Standards Authority of India, except for Cr and Pb in few species. Analysis of various sediment quality indices like EF, CF, PLI, Igeo, indicates that sediments were "low" to "moderately" impacted. Hazard index (< 1) and carcinogenic risk assessments suggest metal didn't pose any risk to humans exposed to sediment. However, the estimated mean HI values for heavy metals were > 1 for children, indicating they may be vulnerable to health risk due to continuous consumption of contaminated aquatic species from the study area. In contrast, the cancer risk for Cr, Cd, and Pb was also below the acceptable range. Principal component analysis (PCA) discerned nearby petrochemical industry, electroplating industry, pesticides and fertilizer from agricultural runoff, as the potential sources of metal bioaccumulation in different tissues. The heavy metal concentration in this study was far lower than the value reported for Netravathi-Gurupur estuary in previous studies where sampling was carried out in 2015-2019. Since Netravathi-Gurupur estuary is surrounded by numerous organized and industrial zones and various factories are operating, the area is exposed to huge industrial pollution. Improvement of water and sediment quality with reference to the heavy metal may be due to a decline in industrial activities due to COVID-19 imposed lockdown. During the lockdown period, a temporary suspension of various small- and large-scale industries and other commercial activities minimized wastewater emissions. The estuary was receiving relatively clean water and sediment due to restricted anthropogenic activities. This resulted in a notable reduction in the concentration of heavy metals in the Netravathi-Gurupur estuarine environment. Moreover, it was observed that the reduction in trace metal content was far higher in water than sediment. This indicates surface water is influenced much faster by industrial discharge than sediment. Tokatlı, 2023 also reported the improvement of Meriç-Ergene River sediment due to COVID-19 imposed lockdown. Several studies have shown the improvement of surface water quality of various water bodies all over the world due to the shattering of industrial activities during COVID-2019 imposed lock down (Buzzi et al., 2022). Water quality of several rivers (2020; Singh et al., 2022), coastal area (Arabian sea and Bay of Bengal) (Mishra et al., 2020) and estuaries [Hooghly River (Ganges)] (Chakraborty et al. 2021) in India showed significant improvement during lockdown periods.

Table 1. *Descriptive statistics of surface water and sediment and fish muscle heavy metals in Netravathi-Gurupur estuary.*

			Water					
		Cr	Mn	Fe	Cu	Zn	Cd	Pb
	Minimum	BDL	0.2	2.2	BDL	14.8	BDL	BDL
	Maximum	6.4	1598.9	8292.7	31.8	125.3	9.5	10
	Mean	6.4	799.55	4147.45	31.8	70.05	9.5	10
BIS (2012)		50	100	300	50	5000	3	10
WHO, 2017		50	400	NA	2000	5000	3	10
USEPA, 2021; Pérez-Cid et al., 2021; Shetaia et al., 2023	CMC	1100	100	300	4.8	90	33	210
	CCC	50	NA	50	3.1	81	7.9	81
			Sediment (mg/kg)					
		Cr	Mn	Fe	Cu	Zn	Cd	Pb
	Minimum	11.54	36.24	2776.76	2.34	2.65	BDL	1.12
	Maximum	141.56	213.26	22200	29.64	39.62	0.05	10.3
	Mean	76.55	124.75	12488.3	15.99	21.135	0.05	5.71
Background value (Turekian, and Wedepohl, 1961)		90	900	47200	45	95	0.3	20
			Fish muscle (mg/kg)					
		Cr	Mn	Fe	Cu	Zn	Cd	Pb

	Minimum	0.35	0.31	5.26	0.01	0.01	0.02	1.74
	Maximum	1.78	1.22	20.46	1.2	3.84	0.23	6.26
	Mean	1.18	0.61	12.83	0.19	0.52	0.08	3.19
	FAO, 1989		100	-	30	100	0.5	0.5
	FSSAI, 2011	12	-	-	-	-	0.3	0.3
	WHO, 1989	1	-	-	30	30	0.5	0.5
	EC (2014)				0.3			0.3

BDL: Below detection limit; CMC: Criterion maximum concentration; CCC: Criterion continuous concentration

CONCLUSION

Heavy metals were of least concern currently for sediment and water. Improvement in water/sediment quality during the study period might be due to COVID-19 imposed lockdown. Biggest concern would be fish samples as many people consume it on a daily basis. Awareness raising programs may be conducted among the locals. Therefore, regular monitoring of trace metal in both abiotic and biotic components, including aquatic species, is essential to evaluate the future trends of trace metal accumulation in aquatic food and their impact on human health and to support sustainable management of the coastal-estuarine ecosystem.

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REFERENCES

Tokatlı, C. and Varol, M. (2021). Impact of the COVID-19 lockdown period on surface water quality in the Meriç-Ergene River Basin, Northwest Turkey. *Environmental Research* 197, 111051.

Chakraborty, S., Sarkar, K., Chakraborty, S., Ojha, A., Banik, A., Chatterjee, A., Ghosh, S. and Das, M., (2021). Assessment of the surface water quality improvement during pandemic lockdown in ecologically stressed Hooghly River (Ganges) Estuary, West Bengal, India. *Marine Pollution Bulletin* 171, 112711.

Singh, B.P., Rana, P., Mittal, N., Kumar, S., Athar, M., Abduljaleel, Z. and Rahman, S. (2022). Variations in the Yamuna River water quality during the COVID-19 lockdowns. *Frontiers in Environmental Science* 10, 940640.

Buzzi, N.S., Menéndez, M.C., Truchet, D.M., Delgado, A.L. and Severini, M.F. (2022). An overview on metal pollution on touristic sandy beaches: Is the COVID-19 pandemic an opportunity to improve coastal management? *Marine Pollution Bulletin* 174, 113275.

Mishra, D.R., Kumar, A., Muduli, P.R., Equeenuddin, S.M., Rastogi, G., Acharyya, T. and Swain, D., 2020. Decline in phytoplankton biomass along Indian coastal waters due to COVID-19 lockdown. *Remote Sensing* 12(16), 2584.

Oral V3T2D1

Seasonal changes of nutrient stoichiometry and fluxes intensifying eutrophication in the ecologically stressed Hooghly River Estuary, India

A. SAHA, B. K. DAS *, S. CHAUHAN, D. SINGH, M. KUMARI, C.L JOHNSON, AND A. RAY

ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata - 700 120, West Bengal, India

* E-mail: basantakumard@gmail.com

Keywords: *Chlorophyll-a; Eutrophication; Hooghly River Estuary; Nutrients; Limiting factor*

INTRODUCTION

The lowermost tidal part of river Ganga is known as Hooghly estuary and is a tide dominated sink for large amounts of pollutants from various sources. This important estuary is subjected to various anthropogenic activities like agricultural runoff, industry, fishing activities, expansion of aquaculture field, port activities, and tourism which led to continuous deterioration of aquatic environment (Sarkar et al. 2007). Moreover this estuary is passing through the megacity Kolkata and hence it is experiencing a stress due to the large number of population settled on the bank of the river Ganga (Nair et al. 2025). Considering the importance of this estuary, very few studies are available for recent water quality status of the area, even though this ecosystem faces drastic anthropogenic changes which occurred in the ecosystem of the estuary (Mitra et al. 2018). Therefore continuous monitoring the aquatic environment

of this estuary is necessary for successful implementation of pollution abatement. For achieving this objectives, this study focused on spatio-temporal dynamics of physicochemical properties of the estuary water considering the Godakhali, Diamon Harbour and Fraserganj stretch. The database generated in this study will provide the information on nutrient stoichiometry, dissolved oxygen content, Chl-a content in the water and also to determine the factors influencing the water quality parameters through multivariate statistical analysis.

MATERIALS AND METHODS

Study area

In the lower deltaic plain of the estuary three different stations namely Godakhali (22.39321º N, 88.14256º E), Diamond Harbour (22.19873º N, 88.20229º E) and Fraserganj (21.58249º N, 88.25829º E) were selected for this study (Fig. 1).

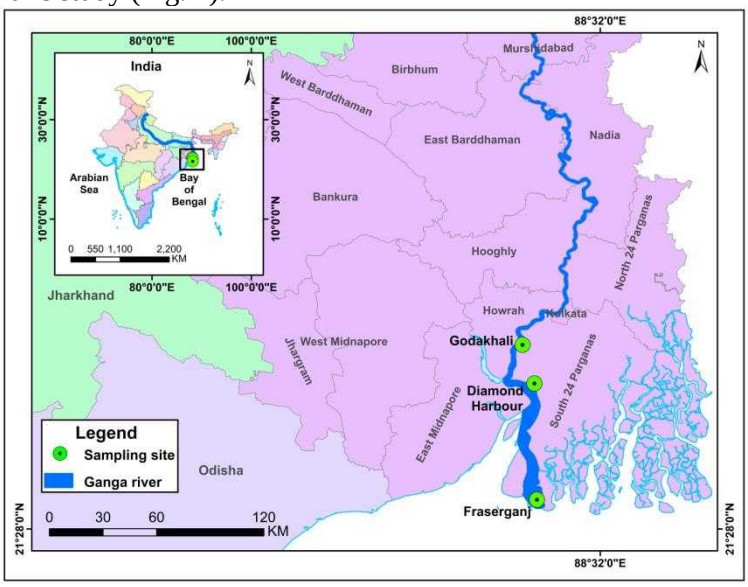

Fig.1: Map of the Hooghly Estuary showing sampling location

Sample collection for analysis of physicochemical, nutrient and chlorophyll-content in water

Samples were collected during three different distinct seasons *viz*. pre-monsoon, monsoon and post-monsoon season of the year 2023-2024. Sub-surface (below 0.3 m depth) water samples were collected by using water samples and stored at 4 ℃ before transported to laboratory. In-situ parameters like dissolved oxygen, pH, electrical conductivity, turbidity and water temperature were measured. The Secchi disk method was used to measure transparency of the system. Titrimetric method was used to measure the total alkalinity (TA), total hardness (TH), and chlorinity. Nutrient parameters were measured through spectroscopically. Chlorophyll-a (Chl-a) was extracted by aqueous acetone and measured as per the APHA method (2005).

RESULTS AND DISCUSSIONS

Average dissolved oxygen (DO) content was greater than 4.0 mg/l in all stations irrespective of season, indicating that the estuary is moderately oxygenated (Table 1). Low DO content in tropical areas is due to release of organic matter rich waste and their subsequent degradations. Water pH values ranged between 7.5 and 7.8 with an average value of 7.6 ± 0.17 during post-monsoon, between 7.92 and 8.34 with an average value of 8.18 ± 0.23 during monsoon; and between 7.1 and 7.17 with an average value of 7.17 ± 0.06 during post-monsoon period. Higher pH value during the rainy season might be due to leaching of nutrient rich runoff from agriculture ecosystem.

Monsoon runoff almost decreases the water hardness by 50% as compared to non-monsoon season. Similarly, salinity, total dissolved solid (TDS), conductivity values showed downward trend during monsoon season. Biological oxygen demand (BOD) showed moderate levels with an elevated level during monsoon season and corresponding low values during post-monsoon season. Similarly, high COD values were observed during monsoon season.

Chlorophyll-a (Chl-a) content varied from 0.05 to 11.25 µg/l (avg: 4.62 ± 5.88 µg/l), during post-monsoon season, from 0.02 to 13.84 µg/l (avg: 4.63 ± 7.97 µg/l) during monsoon, and from 0.03 to 15.51 µg/l (avg: 6.82 ± 7.91 µg/l) during pre-monsoon season. There was no specific seasonal or spatial variation of Chl-a content.

Main sources of nutrient pollution in Hooghly estuary are industrial and domestic sewage, agricultural run-off, aquaculture and many more. These kinds of sources of pollution are also causes of eutrophication in various water bodies. After monsoon flooding, total P in water increases considerably

during the post-monsoon season due to precipitation and land drainage. Lower concentration of total P during monsoon season might be due to dilution effect. Spatial and temporal pattern phosphorus and nitrogen profiling indicating that the system is nitrogen limited (Soro et al., 2023). Comparatively lower value of nitrogen in all the season might be due to utilization of it by plankton. Almost similar ratio of nitrogen and phosphorus was observed in all the stations. It might be due to the recycling of nutrients and utilization of secondary producers. Other land-based sources outside the estuary brought by coastal and flow tide currents were also the contributors.

CONCLUSIONS

Estuaries act as a trap to accumulate the nutrients from both natural and anthropogenic sources. The Hooghly river estuary acts as a nutrient trap and transfers the pollutants to the coastal areas of Bay of Bengal. Hence it is important to monitor the estuarine water quality of Hooghly estuary for effective management of coastal pollution. The implications of this study's findings are significant for various stakeholders, policymakers, and environmental organizations, involved in the conservation and rejuvenation of the River Ganga. The study emphasizes an urgent need to address pollution sources and implement targeted interventions in the regions.

REFERENCES

American Public Health Association (APHA). (2005). Standard Methods for the Examination of Water and Wastewater. 21th edition. American Public Health Association. Washington DC. USA.

Mitra, S., Ghosh, S., Satpathy, K.K., Bhattacharya, B.D., Sarkar, S.K., Mishra, P. and Raja, P. (2018). Water quality assessment of the ecologically stressed Hooghly River Estuary, India: A multivariate approach. *Marine Pollution Bulletin*, **126**: 592-599.

Nair, S.M., Gogoi, P., Bhakta, D., Manna, R.K., Jana, C., Sengupta, A., Manna, S.K., Samanta, S. and Das, B.K. (2025). Salinity variations drive the phytoplankton dynamics in the Gangetic estuary: insights from the modelling approach for species responses and pollution indicators along the longitudinal estuarine gradient. *Marine Pollution Bulletin*, **211**:117418.

Sarkar, S.K., Saha, M., Takada, H., Bhattacharya, A., Mishra, P. and Bhattacharya, B. (2007). Water quality management in the lower stretch of the river Ganges, east coast of India: An approach through environmental education. *Journal of Cleaner Production*, **15**(16), pp.1559-1567

Soro, M.P., N'goran, K.M., Ouattara, A.A., Yao, K.M. and Diaco, T. (2023). Nitrogen and phosphorus spatio-temporal distribution and fluxes intensifying eutrophication in three tropical rivers of Côte d'Ivoire (West Africa). Marine Pollution Bulletin, **186**: 114391.

Oral V4T2D1

Transforming Agri-wastes into microalgae culture media: An advanced technology for biodiesel production

S. DAS SARKAR*, V. SANTHANA KUMAR and B. K. DAS

ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata, West Bengal India

E-mail: soma.das@icar.gov.in

***Key Words**: Biodiesel, Garden Waste, Microalgae, Nutrient Media, Vermicompost*

INTRODUCTION

Agricultural residues contribute about 44% of the total waste and disposal needs approximately 20% of the municipal budget in case of developing countries (Luttenberger, 2020). Vermicomposting is one technique that converts solid agri-waste into stable organic fertilizers, but the solid manure is less costly. Furthermore, vermicompost extracts transfer soluble or particulate organic matter from solid to liquid form, which makes them suitable for microalgae growth and high value biodiesel production (de Medeiros et al., 2020). This supports the ever-growing demand for biofuels, especially considering the finite and non-renewable nature of petroleum. Therefore, agri-waste was first converted into vermicompost manure, and its extract was prepared by digestion (both aerobically and anaerobically) and tested as a nutrient source to enhance the growth performance and lipid production of the freshwater microalga *Graesiella emersonii* MN877773.

MATERIALS AND METHODS

A pure strain of Graesiella emersonii was isolated and maintained at 26±2ºC under a fluorescence lamp with a light intensity of 1300±400 lux, following a 14-hour light and 10-hour dark cycle, with an initial pH of 7.15±0.1. The extracts were added to the BG11 medium in different proportions (T1: 100 ml extract, T2: 80 ml extract + 20 ml BG11, T3: 60 ml extract + 40 ml BG11, T4: 50 ml extract + 50 ml BG11, Control: 100 ml BG11), and the experiment was carried out for 24 days. The cell biomass (using Neubauer Hemocytometer), growth, lipid content (using the Bligh and Dyer

method), and lipid productivity of the microalgae were analyzed. Following this, the best-performing media combinations were selected for studying the mineral content (using ICP-MS), fatty acid profiling (via transesterification and GC-MS), and biodiesel quality (Arora *et al.*, 2021).

RESULTS AND DISCUSSION

The mixotrophic cultivation of microalgae in anaerobically digested vermicompost extract at 1:1 combination with BG11 medium enhanced the cell abundance (Fig 1) cell biomass (0.64 g d. wt. L-1) and lipid productivity (3.18 mg L-1day-1) of microalgae by two times. FAME profile of G. emersonii showed dominance of unsaturated fatty acids – dominated by Methyl linolenate - increases the oxidative stability. SFA contributes 31.5-56% SFA of the total FA- Methyl palmitate -denotes high-quality biodiesel. Lesser Oleic acid in T4-prevents the faster volatility. Vehicular properties of biodiesel complies with the vehicular properties of biodiesel standard provided by India, the USA, and Europe except the cold filter plugging property (Table 1). Anaerobic digestion yielded higher macronutrients in microalgae (Mg and Ca) than aerobic.

Physical properties	T4	Control	BS I	BS A	BS E
Saponification value (mg KOH/g)	130.63±1.0 c	135.31±1.1 b	NA	NA	NA
Iodine value (g Iodine/100g)	126.43±0.4 d	117.90±0.7 e	NA	NA	≤120; ≤130*
Cetane number	55.84±1.32 a	56.57±0.74 a	NA	≥47	≥51
Degree of unsaturation (% wt)	90.50±0.95 c	74.50±1.0 d	NA	NA	NA
Long chain saturation factor (% wt)	11.91±0.78 b	17.98±1.07 a	NA	NA	NA
Cold filter plugging properties (°C)	24.22±0.50 b	44.96±0.54 a	NA	NA	≤5≤-20
High heating value (MJ/kg)	42.18±0.65 a	42.11±0.79 a	NA	NA	≥35*
ln (Kinematic viscosity) (mm²/sec)	6.14±0.52 a	6.22±0.42 a	2.5-6.0	1.9-6.0	3.5-5.0
Density (g/cm³)	0.95±0.08 a	0.90±0.03 a	0.86-0.9	0.86-0.89	0.86-0.9
Oxidative stability (h)	5.73±0.73 a	6.46±0.29 a	≥6	>3	≥6; ≥4*

Table 1: *Biodiesel quality of G. emersonii in test media and Control; BS I- Biodiesel Standard India; BS A- Biodiesel Standard ASTM D6751-02; BS E- Biodiesel Standard EN 14213*& 14214. (Source: Kumar et al., 2022)*

CONCLUSIONS

Anaerobically processed vermicompost extract was found effective for microalgae. The 1:1 combination medium vermicompost extract: BG11—higher biomass, lipid content (16.97%) and lipid productivity of *G. emersonii* in laboratory culture conditions. The microalgae grown in this combination produced desirable fatty acids (methyl palmitate and oleic acid). The biodiesel obtained was majorly fulfils the vehicular properties as per the Indian, the American and European standards. The present media combination was found to be an eco-friendly and more economical way of producing quality biodiesel from microalgae by reducing the use of chemical fertilizers.

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REFERENCES

Arora, N., Gulati, K., Patel, A., Pruthi, P.A., Poluri, K.M. and Pruthi, V. (2017). A hybrid approach integrating arsenic detoxification with biodiesel production using oleaginous microalgae. *Algal Research* 24: 29-39.

de Medeiros, V.P.B., Pimentel, T.C., Varandas, et al. (2020). Exploiting the use of agro-industrial…medium. *Food Research International* 137: 109722.

Kumar, V.S., Das Sarkar, S., Das, B. K. et al. (2022). Sustainable biodiesel vermicompost. *Science of The Total Environment 807*: p.150995.

Luttenberger, L.R. (2020). Waste management Croatia. *Journa of Cleaner Production* 256: 120495.

Oral V5T2D1

Induced spawning and egg incubation protocol for seed production technology of Bengal Yellowfin seabream *Acanthopagrus datnia* in captivity

BABITA MANDAL[1], BIJU I.F.[1], SUDHEER N.S.[1], SANJOY DAS[1], DEBASIS DE[1], KULDEEP K. LAL[2]

[1]Kakdwip Research Centre of ICAR-CIBA, Kakdwip, South 24 Parganas, 743347 W.B., India

[2]ICAR-Central Institute of Brackishwater Aquaculture, 75, Santhome High Road, MRC Nagar, Chennai, 600028 Tamil Nadu, India

E-mail: babita.mandal@gmail.com; babita@icar.gov.in

***Key Words**: Bengal bream, Broodstock, Egg incubation, Seed production*

INTRODUCTION

The Sparidae, commonly called breams and porgies, is a family of the order Perciformes and includes about 115 species, mainly marine coastal fish, of high economic value, exploited and farmed for human consumption, as well as for recreational purposes. Bengal Yellowfin Seabream (*Acanthopagrus datnia*) inhabits in the mangrove-fringed, estuarine, and coastal areas of the Bay of Bengal and considered endemic to this region. The Bengal Yellowfin Seabream has attracted attention as a potential promising species for the diversification of aquaculture production, due to its excellent growth, acceptability in the domestic market, premium flesh quality, and ability to withstand wide variations in salinity and temperature, acceptance of formulated feed etc. Traditional farming of *A. datnia* largely depends on natural seed collection due to the unavailability of hatchery-produced seed. Hence, efforts on broodstock management in brackishwater ponds and gonadal maturation were initiated at Kakdwip Research Centre. The current study aims to develop the optimized spawning and seed production methodology in captivity.

MATERIALS AND METHODS

Ninety adult of body weight ranging 100-425 g broodstock were procured from nearby estuarine bheries and transported to Kakdwip Research Centre of ICAR Central Institute of Brackishwater Aquaculture (CIBA) in oxygen packed polythene bag. Standardization of hormone dose for induced breeding experiment was conducted during December to January months. One week prior to hormone induction, oozing males (mean length: 100±20.19 mm; mean weight: 130±22.5 g) and mature females (mean length: 285±5.00 mm; mean weight: 279±30.5 g; OD: >420 µm) were selected. Two treatments hCG dose 1000 IU/kg body weight (T1) and 2000 IU/kg body weight (T2) were trailed with duplicates in experiment 1. Females were injected with a single dose of hCG and males received single dose of hCG of 500 IU/kg body weight. Fish were left to spawn spontaneously and were not disturbed for seven days following treatment. Post spawning, pelagic buoyant eggs were collected via an overflow pipe into egg collection net to retain the eggs but allowing water exchange. Total five salinities 20 (S1), 25 (S2), 27(S3), 30(S4), 35(S5) ppt) in experiment 2 at 20 °C temperature and temperature (14(T1), 16(T2), 18(T3), 20(T4), 22(T5) °C) in experiment 3 at 25 ppt salinity was trailed to find optimum levels of both factors for egg incubation.

RESULTS AND DISCUSSION

Female Bengal Yellowfin Seabream induced with 2000 IU/kg body weight (T2) was more efficacious than treatment 1 (1000 IU/kg body weight). Latency period was significantly short (1.12 days) in treatment 2 whereas pairs spawned almost 5 days post injection to low hCG dose which further impacted the total egg production. Significantly highest total egg count (183251 ± 13116.3) was observed in all replicates of treatment 2. Fertilization (93.32 ± 4.70 %) and hatching (93.22 ± 3.71) percentage were highest in treatment 2 compared to treatment 1. Pairs in treatment 2 spawned 4 – 5 times post hormone injection compared to only 1 – 2 times in treatment 1.

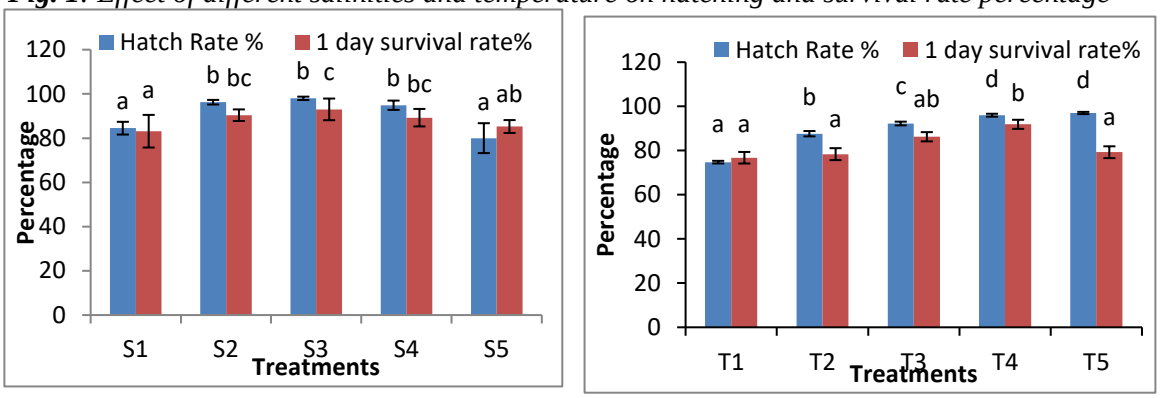
***Table 1:** Effect of two hCG doses on spawning and hatching rate in Female Bengal Yellowfin Seabream*

Parameter	T1 (1000 IU/kg body weight)	T2 (2000 IU/kg body weight)
Latency period (days)	5^{a}	1.12^{b}
Spawning events	1.5^{a}	4.75^{b}
Total eggs	72553.75 ± 13060.5^{a}	183251 ± 13116.3^{b}
Fertilization %	35.34 ± 27.51^{a}	93.32 ± 4.70^{b}
Hatching rate (%)	10.03 ± 7.83^{a}	93.22 ± 3.71^{b}

In this study inverse relationship was found between both abiotic factors (i.e. salinity and temperature) and incubation time of fertilized eggs. The number of viable embryos at hatch was dependent of salinity and temperature. Incubation time was 18 hours at 25 ppt salinity (S2) in experiment 2 and 14 hours in

22 °C temperature (T5) in experiment 3. The significant highest proportion of hatch rate was observed in the salinity range of 25 – 30 ppt whereas significantly (P≤0.05) highest hatch percentage of 97 ± 0.5 was observed at 22 °C in T5. 24 hour survival rate was significantly higher (93 ± 3.1) in 27 ppt whereas 91.87 ± 2.05 survival percentage was observed in replicates at 20 °C (T4). There were no significant (P>0.05) difference observed of salinity and temperature on Notochord length which were almost similar in all the replicates. Significantly highest Oil Droplet Volume were found when temperature was 22 °C (T5).

***Fig. 1**: Effect of different salinities and temperature on hatching and survival rate percentage*



CONCLUSION

In present study hCG dose of 2000 IU/kg body weight yielded better spawning performance with maximum spawning events. New hatched larval survival and hatch rate was highest for *Acanthopagrus datnia* within the range of 18 –20 °C temperature and salinity range of 25 - 30 ppt. Hence can be recommended to commercial hatcheries for seed production of Bengal yellowfin seabream.

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REFERENCES

Benjamin James Black, Margie Black (2013). Efficacy of two exogenous hormones (GnRHa and hCG) for induction of spontaneous spawning in captive yellowfin bream, *Acanthopagrus australis* (Sparidae) and influence of sex ratio on spawning success. *Aquaculture*. 416–417: 105-110.

Hasan M.E., Durand J.D., Iwatsuki Y. (2020). *Acanthopagrus datnia* (Hamilton, 1822), a senior synonym of *Acanthopagrus longispinnis* (Valenciennes, 1830) (Perciformes: Sparidae). *Zootaxa*. 4750: 151-181.

Oral V6T2D1

Sustainable spawn collection from sundarbans estuarine systems: Challenges and pathways for coastal aquaculture development

DIBAKAR BHAKTA*, CANCIYAL JOHNSON, MITESH RAMTEKE, ARCHISMAN RAY and BASANTA KUMAR DAS

ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata-700 120, West Bengal, India.
E-mail: dibakar.bhakta@icar.gov.in

***Key Words**: Spawn Collection, Indian Sundarbans Estuary, Challenges, Management Measures*

INTRODUCTION

India possesses an extensive coastline, measuring 8,118 kilometres, along with extensive coastal wetlands. A substantial area of the coast comprised estuaries and backwaters, including mangroves, mudflats, and bays. Barbosa *et al.* (2012) assert that estuary ecosystems rank among the most productive habitats globally, offering optimal conditions for the development and survival of marine and estuarine organisms. The Ganges and Brahmaputra River systems have established a diverse estuarine habitat along India's eastern coastline. Estuarine fisheries are characterised by food and revenue-generating resources that hold both ecological and commercial significance. Estimates indicate that India's estuarine fish production yields average between 45 and 75 kg ha^{-1} (Jhingran, 1991; Sugunan, 2010). Finfish and shellfish species require interdependence between adjacent marine and estuarine zones to complete their life cycles. Estuarine fishes can be classified into two broad groups based on their breeding habitats: those that breed in estuary systems and those that breed in the ocean. The expansion of brackish water

aquaculture associated with coastal area development has led to an increasing demand for collections of fin and clam spawn. The World Bank (2002) reports that approximately 0.42 million individuals in India collect prawn seeds from coastal and estuarine environments.

METHODS AND METHODS

The Sundarbans estuarine system, which consists of a network of tidal rivers, creeks, and mangrove forests, served as the study's location. Critical areas for sustainable spawn collection were determined through the analysis of historical records and insights from the local fishing community.
Over the course of two years, from January 2021 to December 2023, structured interviews and focus groups were held with local fishermen to learn about their traditional ways of collecting spawn, the types of gear they use, and how these things affect juvenile populations and bycatch. Interactive cartography supplemented field surveys to identify critical habitats and hotspots for sustainable collection. Specific gears are utilised for the collection of finfish seeds and post-larval shellfish, and these methods have been documented. Spawn samples were identified to the lowest taxonomic level to evaluate the ecological effects of spawn collection practices.

RESULTS AND DISCUSSIONS

The selection of species for seed collection typically varies based on local demands for brackish water aquaculture and differs from state to state. For the bheris (estuarine fish farms) in the coastal districts of West Bengal, the species that are wanted are fin fish like *Mystus gulio, Terapon jarbua, Lates calcarifer, Chelon parsia, Mugil cephalus, Scatophagus argus, Sillago sihama, and Rhinomugil corsula*; prawns like *Penaeus monodon* and *Macrobrachium rosenbergii*; and crabs like *Scylla serrata* or *Scylla olivacea*. Fish and prawn seed availability calendar at Hooghly-Matlah estuarine systems are provided in Table 1. *Penaeus monodon, Penaeus indicus, Metapenaeus brevicornis*, and *M. monoceros* were some of the commercially important species seeds that De and Sinha (1997) looked for in the Hooghly-Matlah estuarine systems. They also looked for fin fish seeds from *Chelon parsia, C. planiceps*, and *Lates calcarifer*.

Table 1. *Fish and prawn seed availability calendar at Hooghly-Matlah estuarine systems (as per De and Sinha, 1997)*

Name of the species (length in mm)	Centre and month of maximum seed availability (net^{-1} hour^{-1})		Maximum seeds collected during peak months (net^{-1} hour^{-1})		
	No. of seed	Month	Centre	Max nos. of seed (range)	Peak months of availability
Penaeus monodon (9-17)	2,332	May	Fraserguni	64-2,332	Mar-Jun
P. indicus (10-71)	8,940	Mar	Sagar	9-8,940	Feb-May
Metapenaeus brevicornis (10-45)	2,240	Jun	Fraserguni	43-2,240	Apr-Jun
M. monoceros (9-31)	1,386	May	Fraserguni	18-1,386	Apr-May/ Sep
Chelon parsia (9-35)	456	Jan	Fraserguni	14-456	Jan-Apr
Macrobrachium rude (15-44)	32	Jul	Uluberia	4-32	Jul-Sep
M. mirabile (13-37)	485	Sep	Uluberia	22-485	Aug-Oct

CONCLUSIONS

The Sundarbans estuaries are significant resources, as they sustain substantial populations of brackish water species and migratory species. Deforestation, destruction of mangrove forests, and reduction of catchment areas have significantly diminished breeding and nursery grounds. The rising demand for natural seeds in coastal aquafarming has led to an increase in the number of collectors engaged in seed culture ventures, resulting in the overexploitation of these resources. Stopping the collection of natural seeds by artificially breeding targeted species and giving people who collect natural seeds other ways to make a living could be beneficial ways to restore estuarine fishery resources.

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REFERENCES

Barbosa, N.D., Rocha, R.M. and Fredou, F.L. (2012). The reproductive biology of *Plagioscion squamosissimus* (Heckel, 1840) in the Para´ River estuary (Amazon Estuary). *Journal of Applied Ichthyology*, 1–6, doi: 10.1111/j.1439-0426.2012.02040.x.

Bhoumik, U. and Mitra, A. (2013). Impact of Lunar periodicity on availability of fin and shellfish seed with special reference to *Penaeus monodon* in the estuarine systems of Sunderbans, West Bengal. *International Journal of Research in BioSciences*., 2: 63-74.

De, D.K. and Sinha, M. (1997). Seasonal abundance of the seed of commercially important prawns and fishes in the Hooghly-Matlah estuary during post-Farakka period. *Indian Journal of Fisheries*, 44(2): 201-209,

Jhingran, V. G. (1991). Fish and Fisheries of India, 3rd Edition, *Hindustan Publishing Corpn*. (India), Delhi, 727 pp.

Sugunan, V.V. (2010). Inland Fisheries Resource enhancement and conservation in India. In: *Inland fisheries resource enhancement and conservation in Asia, (eds.)* Weimin, M., Silva, S. D. and Davy, B., RAP Publication 2010/22, pp. 35-60.

Oral V7T2D1

Mass production of live fish food organisms in outdoor system

R. N. MANDAL[1]*, KABYASHREE BALA[2], T. K. GHOSH[2], A. DAS[1], and PUJADEBI BERA[2]

[1]Regional Research Station, ICAR-CIFA, Rahara, Kolkata 700118

[2] West Bengal University of Animal and Fishery Science, Chakgaria, Kolkata 700094

E-mail: rnmandal1964@gmail.com

***Key Words**: Live Foods, Graesiella, Rotifer, Cyclops, Moina*

INTRODUCTION

Live food organisms play a crucial role in the diet of cultured fish larvae including spawn, fry, fingerlings and advanced fingerlings, especially when raising fish larvae in commercial aquaculture. In recent times, significant progress has been made in rearing techniques for different fish species due to availability of commercial exogenous feed. However, suitable exogenous feed is yet to develop to rear fish larvae. Still, larval rearing, by and large, depends on live fish food organisms (Chattopadhyay, et al., 2022a, 2022b, 2023). A wide variety of phytoplankton and zooplankton species can be found in freshwater environments, which are suitable food to fish larvae. The primary objective of this experiment is to develop the protocol of mass production of selective live foods in outdoor system as farmers' practice.

MATERIAL AND METHODS

Four different live foods were cultured. Growth of *Graesiella emersonii*in was experimented with three different treatments (GT1: light intensity range, 60,000- 2,00,000 lux, temperature, 32-36^{O}C; GT2: light intensity range 6000 -8000 lux, temperature - 26-30^{O}C; GT3: light intensity range, 150-210 lux, Temperature, $\leq$ 26^{O}C). *Brachionus plicatilis* was reared with different manures and their combinations: 1. yeast & *Graesiella*, 2. yeast, 3. *Graesiella*, 4. mustard oil cake (MOC), 5. mustard oil cake MOC) & raw cattle dunk (RCD), 6. ground nut oilcake (GOC), & mustard oilcake (MOC), 7. ground nut oil cake (GOC), 8. Ground nut oil cake (GOC) & raw cattle dunk (RCD). *Cyclops vicinus* was reared with different manures and their combinations: 1. yeast & *Graesiella* (5.4 $\times 10^4$ at 6th day), 2. RCD (5.2 $\times 10^4$ at 6rh day), 3. MOC) & RCD (5.1 $\times 10^4$ at 6th day), 4. GOC & MOC (4.9 $\times 10^4$ at 6th day), 5. GOC (4.9 $\times 10^4$ at 6th day), 6. yeast (4.5 $\times 10^4$ at 5th day), 7. GOC & RCD (4.5 $\times 10^4$ at 6th day) , 8. MOC (4.4 $\times 10^4$ at 6th day). Production of *Moina macrocopa* was carried out using four selective manures: 1. RCD, 2. RCD & MOC, 3. RCD & GOC, 4. Bread & tubifex & meat.

RESULTS AND DISCUSSION

The growth of GT1 started showing higher growth compared to GT2 and GT3 treatments at day 1, and this trend continued up to 2nd day. On 3rd day, all treatment showed significantly ($p < 0.05$) different among growth and this trend continued up to 12th day. The growth of Brachionus plicatilis were observed with different treatments. BT3 started showing higher growth at day 1 as compared to other treatments, but not significantly different and this trend continued up to 9th day. The experiment recorded 6th day of culture as the highest production time of Cyclops with different manures, except Yeast alone. The present study observed that when the combinations of carbohydrate and protein sources were used for feeding *Moina*, its production became highest as compared to other manures used.

CONCLUSION

Production of live food organisms using fertilizers and manures under varying environmental conditions is an easy method which farmers can adopt. This protocol on mass production of live foods promotes a sustainable aquaculture practice by reducing reliance on commercial feeds and minimizing environmental impact. With this protocol, farmers may be able to develop efficient and sustainable live food production to support aquaculture and improve food security.

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REFERENCE

Chattopadhyay, D. N., Chakraborty, A., Roy, P. K., Mandal R. N.,Das, A., Hussan, A., Adhikari, S., Paul, B. N., Pillai, B. R. and S. K. Swain. (2023). Culture of hilsa, *Tenualosa ilisha* in freshwater ponds: Progress and prospects in farming practice. *Aquaculture Asia*. 27 (1), 6-12.

Chattopadhyay, D. N., Mandal R. N.,Chakraborty, A., Roy, P. K., Das, A., Hussan, A., Adhikari, S., Pillai, B. R. and S. K. Swain. (2022a). Green water Technology as an essential support to larval rearing of hilsa shad. *Aquaculture Asia*, 9-14.

Chattopadhyay, D. N., Adhikari, S., Paul, B. N., Mandal R. N.,Saha, G. S., Pillai, B. R. and S. K. Swain. (2022b). Magical role of live foods in boosting spawn survival of climbing perch: a success in the farmer's field. *Aquaculture Asia*, 22-27.

Oral V8T2D1

Nutrient profiling of commercially important food fishes from the coastal zone of the river Ganga, India

S. GANGULY, A. RAY, S. DAS GUPTA, S. KUNDU, S NANDI, A. KUNUI, S. DUTTA, P. MALAKAR, A. K. TALUKDER and B. K. DAS*

NMCG Laboratory, ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata 700 120, West Bengal, India

E-mail: basantakumard@gmail.com

Key Words: *Coastal Zone, Nutrient Profile, River Ganga,*

INTRODUCTION

Fish contains vital nutrients, including high-quality animal proteins and omega (ω)-3 polyunsaturated fatty acids (ω-3 PUFAs), primarily eicosapentaenoic acid (EPA) and docosahexaenoic acid. The River Ganga is rich in fish diversity, which differs depending on the geographical area, such as freshwater, brackish-water, marine, and so on. The overall chemical composition, amino acids, and fatty acids of fish are critical for determining their nutritional and economic value. Fish are a great source of high-quality protein, essential amino acids like leucine and lysine, and ω-3 PUFAs (Mohanty *et al*. 2019). These nutrients promote muscle growth, cardiovascular health, and cognitive function. The composition changes according to species, environment, and diet, affecting nutritional profile and market value (Mohanty et al., 2016). Understanding these components is critical for promoting sustainable aquaculture and improving consumer health outcomes.

MATERIALS AND METHODS

Freshly caught fishes are collected from river Matla (*Hilsa keele, Pisodonopsis boro* and *Parastometus niger*), river Haldi (*Setipinna phasa*, *Mystus gulio* and *Notopterus notopterus*) and river Ichamati (*Arius arius*, *Cynoglossus aral* and *Mugil cephalus*) and brought to the laboratory in ice.

Gross chemical composition in terms of moisture, crude protein, crude lipid and ash were analysed following AOAC (2016). The amino acid composition of the fish samples was analysed following the method of Ishida et al. (1981) using UPLC, Waters. Fatty acid composition analysis was done using GC/MS (ITQ-900, Thermo Scientific). The total lipid was extracted following Folch *et al*. (1957) and fatty acid methyl esters (FAME) were prepared following Metcalfe *et al*. (1966).

RESULTS AND DISCUSSION

In this investigation, the highest moisture content was found in *Parastometus niger* (82.54%), while the lowest was found in *Mystus gulio* (66.03%). *Pisodonopsis boro* had the highest protein levels (18.39%), while *Setipinna phasa* had the lowest (9.83%). *Arius arius* had the highest amount of ash (5.75%), whereas *Mystus gulio* had the highest amount of fat (13.52%) (Table 1).

Table 1*. Gross chemical composition of 9 important food fish species*

Fish Species	Moisture	Crude Protein	Crude Fat	Ash
Hilsa keele	74.77±0.73	17.17±0.49	3.53±0.35	1.44±0.10
Pisodonopsis boro	74.77±0.46	18.39±0.27	4.71±0.37	1.60±0.31
Parastometus niger	82.54±0.21	13.93±0.27	0.63±.12	2.58±0.06

Setipinna phasa	75.61±0.12	9.83±0.56	6.76±0.76	1.27±0.05
Notopterus notopterus	79.17±0.19	13.98±0.08	1.57±0.26	0.80±0.29
Mystus gulio	66.03±0.73	16.94±0.33	13.52±0.36	3.32±0.44
Cynoglossus oral	80.50±0.35	15.49±0.53	0.54±0.14	2.22±0.40
Mugil cephalus	73.16±1.77	17.17±0.58	4.27±0.63	3.50±0.29
Arius arius	73.52±1.05	11.16±0.42	6.01±0.91	5.75±0.53

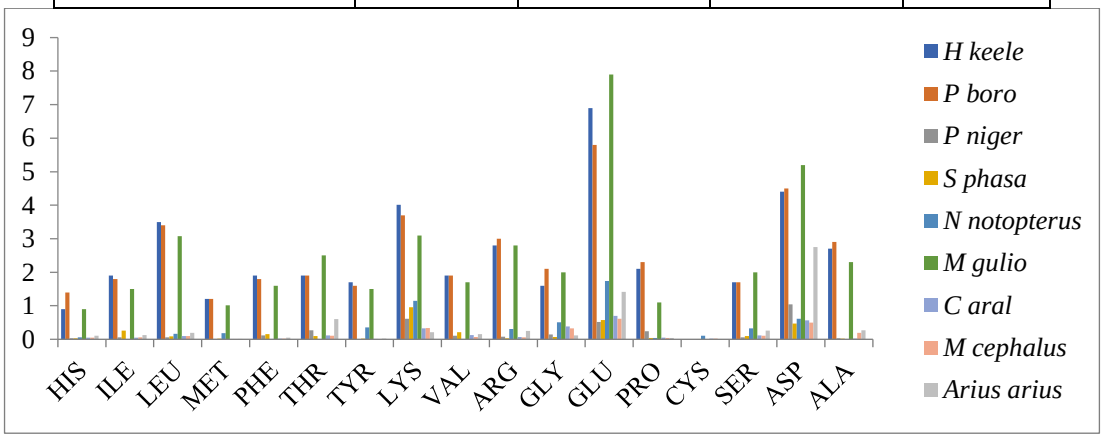

Fig 1. *Amino acid composition of 9 food fishes*

Pisodonopsis boro has higher levels of lysine (LYS) and proline (PRO), while *Mystus gulio* has higher glutamic acid (GLU). The diversity of amino acid levels among the examined fish highlights the abundance of both essential and non-essential amino acids, reflecting species-specific nutritional profiles (Fig. 1).

Saturated fatty acids (SFAs), monounsaturated (MUFAs), and PUFAs varied among the nine fish species whose fatty acid composition was examined using GC/MS. The predominant SFAs in *Hilsa keele* were myristic acid (C14:0) and palmitic acid (C16:0), while the main MUFA was palmitoleic acid (C16:1) and the main PUFA was DHA (C22:6). Similar patterns were seen in *Pisodonopsis boro*, where the predominant SFA was palmitic acid (C16:0), the dominating MUFA was oleic acid (C18:1), and the main PUFA was DHA. The main SFAs for *Parastometus niger* were myristic acid (C14:0) and palmitic acid (C16:0), the main MUFA was oleic acid (C18:1), and the PUFAs were dominated by DHA. Palmitic acid (C16:0) and myristic acid (C14:0) were the most common SFAs in *Setipinna phasa*, while palmitoleic acid (C16:1) and DHA were the most common MUFA and PUFA, respectively. A similar profile was followed by *Mystus gulio* and *Notopterus notopterus*, indicating species-specific differences in the content of fatty acids.

CONCLUSION

Fish species-specific differences in moisture, ash, and fatty acid composition were highlighted in this study. *Parastometus niger* had the highest moisture content, while *Mystus gulio* excelled in fat and glutamic acid, *Pisodonopsis boro* displayed high levels of protein and lysine. The study also identified fishes rich in ω-3 PUFAs. The present study highlighted the nutritional diversity of fishes collected from different coastal zones of the river Ganga and bolstered their role in diet optimization and aquaculture development. Further, the nutritional information generated in the present study could be used for meeting the daily nutritional requirements of the human body.

ACKNOWLEDGEMENT

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REFERENCES

AOAC International. (2016). Official methods of analysis of AOAC International (20th ed.). Gaithersburg, MD: AOAC International.

Folch, J., Lees, M., and Sloane-Stanley, G.H. (1957). A simple method for the isolation and purification of total lipids from animal tissues. *Journal of Biological Chemist* 226:497-509.

Metcalfe, L.D., Schmitz, A.A., and Petha, J.R. (1966). Rapid preparation of fatty acid esters from lipids for gas chromatography analysis. *Analytical Chemistry* 38: 514-517.

Mohanty, B. P., Sankar, T.V., Ganguly, S., Mahanty, A., Anandan, R., Chakrabarty, K., et al. (2016). DHA, EPA content and fatty acid profile of 39 food fishes from India. Biomed Research International, 2016.

Mohanty, B.P., Mahanty, A., Ganguly, S., Mitra, T., Karunakaran, D., Anandan, R. (2019). Nutritional composition of food fishes and their importance in providing food and nutritional security. *Food Chemistry* 293: 561-570.

Oral V9T2D1

Socio-Economic Status of Fishers in the Estuarine Regions of West Bengal

GITASHREE THENGAL*, B. K. DAS, D.C. YATEESH, LITON PAUL, ANURAG SINGH, MONISHA MOLLA

ICAR-Central Inland Fisheries Research Institute, Kolkata - 700 120, India

E-mail: tgitashree@gmail.com

***Key Words**: Socio-Economics, Estuary, Fisheries*

INTRODUCTION

West Bengal, is home to India's largest coastal estuaries, features rich biodiversity, and supports significant fisheries. This study investigates fish catch and the socio-economic conditions of fishers in the state's estuarine regions, focusing on education, household structure, occupations, fishing experience, income, and livelihood improvements. Small-scale fisheries, often characterized by poverty, face social, economic, and political challenges, and a limited understanding of fishers' socio-economic conditions hampers effective fisheries management (Devi et al., 2012; 2014). These analyses serve as a valuable guideline action to enhance fishers' livelihoods while considering the broader socio-ecological context (Chakraborty et al., 2024). However, not enough data and information are present on the socio-economic state of fishers in the estuarine part of West Bengal, which could contribute to enhancing fishers' quality of life. Therefore, such socio-economic analyses are essential for evaluating the effects of different activities, identifying priorities, and crafting policies to optimize societal benefits from natural resources.

MATERIALS and METHOD

A combination of methodologies was utilized to gather comprehensive data for this study. These included direct observation, household surveys incorporating semi-structured interview schedules, and Focused Group Discussions involving key informants. A total of 470 fishers were interviewed during the survey. The study was conducted using a mixed approach method for both Qualitative and Quantitative data during January to December, 2024. The present survey was designed to study the social, cultural, and economic aspects of the fishing community, specifically those who are involved in fishing activities in the estuarine regions of West Bengal. To complement this, fish catch estimation was conducted.

The socio-economic variables include age, education, occupation, experience in fishing, income level of fishers, and ownership of fishing craft, all measured through direct questioning of respondent fishers along the region.

The study was conducted along selected estuarine regions of West Bengal. A significant number of the fisher population depend on the fisheries to sustain their daily livelihood and nutritional security. The study was conducted on the river Matla, Rupnarayan, Haldi, and Icchamati stretches.

RESULTS and DISCUSSION

The socio-economic status of fishers along the Icchamati, Matla, Rupnarayan, and Haldi Rivers reflects their dependence on traditional fishing practices, with limited access to modern techniques and infrastructure. Age is important in fisheries activity (Sharma et al., 2018). Most fishers are middle-aged (30–59 years), comprising 66% in Icchamati, 76% in Matla, 79% in Rupnarayan, and 82% in Haldi, while a smaller percentage are younger (15–29 years) or older (60+ years). Fishing remains a male-dominated occupation, with men forming 84% in Icchamati, 76% in Matla, 94% in Rupnarayan, and 100% in Haldi, while women engage in supporting activities such as shrimp seed collection and crab harvesting, particularly in Matla and Icchamati. Education is an important socio-economic factor that is responsible for understanding and adopting new technologies in the fishing sector (Gautam et al., 2020). Education levels are low, with illiteracy rates at 31% in Icchamati, 45% in Rupnarayan, and 28% in Haldi, while in Haldi, 39% have only primary education and just 12% have completed secondary schooling. The majority of fishers belong to marginalized communities, with Scheduled Castes forming

88% in Icchamati, 58% in Matla, and 83% in Rupnarayan, while Haldi fishers mostly belong to Other Backward Classes (OBC) or Scheduled Castes. Fishing experience varies, with many fishers having decades of experience, 47% in Haldi have over 20 years in the profession. Housing is one of the components of physiological need, and the mode of housing actually depicts the level of quality of life (Udoh, 2008). Housing conditions are poor, with most fishers living in semi-pucca or kutcha houses, except in Haldi, where 37% reside in pucca houses. Family size is a significant socioeconomic indicator since it impacts household income, food consumption, and socioeconomic well-being (Hossain et al., 2022). Family structures vary, with nuclear families being common in Matla (55%) and Icchamati, while larger households (6–9 members) are frequently observed in Rupnarayan and Haldi, where 48% live in joint families. Fishing is the primary source of livelihood, often supplemented by small-scale farming, livestock rearing, labor work, and crab collection. Fishing gears differ by region—fishers in Icchamati commonly use cast nets and drag nets, while those in Matla and Rupnarayan rely on gill nets and drag nets. Haldi fishers use a combination of gill nets, cast nets, and drag nets. Daily fish catches vary, with Icchamati and Rupnarayan fishers catching 1–10 kg, Matla fishers catching 11–15 kg, and Haldi fishers reporting diverse catch levels. Monthly incomes mostly range from ₹8,001 to ₹14,000, though some Haldi fishers earn up to ₹20,000. Fish consumption is an essential part of their diet, with families consuming around 4–5 kg weekly. Access to drinking water varies—Matla and Rupnarayan fishers primarily use municipal pipelines, whereas those in Icchamati and Haldi depend on private borewells, ponds, or Panchayat taps. Electricity access is widespread, though reliability varies. Communication tools such as smartphones and televisions are common across all regions, enabling better connectivity, though low literacy levels limit the effective use of digital tools for skill development.

CONCLUSION

Fishing is the primary livelihood for communities along these estuarine regions, yet they face challenges like poor housing, low education, unstable incomes, and limited modern fishing access. Strengthening infrastructure, skill-building, and better fishing technology can improve their socio-economic conditions. Ensuring clean water, biodiversity conservation, river ranching, etc., can further support fishers, requiring expanded government and fisheries sector collaboration.

REFERENCES

Chakraborthy, C., Dutta, S., and Katiha, P., 2005, Fishery co-operatives inWest Bengal: A socio-economic appraisal. Environ. Ecol., 23: 50-57. Devi, N.B.L., Ngangbam, A.K. and Sheela, I., 2012. A study on existing fisheries management system and the problems faced by the fishers in Loktak Lake of Manipur. *Journal of agriculture and veterinary science*, 1(5), pp.22-28.

Devi, N.B.L., Ngangbam, A.K. and Biswal, N.N., 2014. A review on the current fisheries management system in Manipur with special reference to Loktak Lake. *Journal of agriculture and veterinary science*, 7(4), pp.44-76.

Gautam, P., P.SAnanthan, M. Krishnan and V. K. Tiwari, 2020. Socio-economic status of fish farmers in selected regions ofUttar Pradesh. *Environ Microbial*, 68: 6036-6042.

Hossain, A.B.M.A., Mahdi, G.M.A. and Azad, A.K., 2022. Zag Fishing (Fish Aggregating Device-FAD): Threating Activities against Indigenous Fish Species in the Meghna River Estuary". *EC Veterinary Science*, 7(7), pp.19-20.

Sharma, S., R. Kumar, M. Kumar, S. Gupta, P. K. Maurya and P. Singh, 2018. A study on socio-economic status of fishermen of Amethi district, Uttar Pradesh, India. *Int. J. Fish. Aquat. Sci.*, 6: 49-54

Udoh A J (2008) Assessment of quality of life of the fishing settlements in Ibaka and James Town communities in Nigeria. *Indian Res. J. Ext. Edu*. 8(1), 76-78.

Oral V01T2D2

Trends of craft and gear during fishing activity in Chilika Lake

SUMAN MISHRA[1] and A. K. DAS[2]
Mahatma Gandhi Kashi Vidyapith, Varanasi-221010
Central Inland Fisheries Research Institute, Barrackpore, Kolkata-700120
E-mail: mishra.suman12@gmail.com

***Key Words**: Lake, Craft, Gear, Jala, Fisheries, Ecology.*

INTRODUCTION

Chilika Lake is a brackish water lagoon, spread over the Puri, Khurda and Ganjam districts of Odisha state on the east coast of India, at the mouth of Daya river, flowing into the Bay of Bengal,

covering an area of over 1100km^2. It is the largest coastal lagoon in India and the second largest coastal lagoon in world. Chilika lagoon is one of the main sources of capture fisheries of Odisha and supports food and livelihood security to more than 0.2 million fisher folk living in and around the lagoon. As one of the direct use benefits of Chilika ecosystem, fisheries output shares more than 71% of its economic value. Chilika Lake also supports the state economy to a large extent by earning valuable foreign exchange to the extent of about 200 million rupees. Fish production of the lagoon significantly increased after opening of the New Mouth on the east coast of the Lagoon in September 2000. However, the amount of the production has been showing a declining trend from the peak in the year. Again, the fisheries and biodiversity of the lagoon suffered the most, both due to natural and man-induced perturbations.

MATERIALS AND METHODS

Fisheries ecology of Chilika Lake was investigated during 2010-2012 along with the status of fish and fisheries which were recently reviewed in 2020- 21 through a rapid survey. Documentation of crafts and gears in Chilika Lake of India is scanty.

RESULTS AND DISCUSSION

This paper is an attempt to record the fishery related indigenous technological knowledge in terms of fishing crafts and gear used in Chilika Lake. The flat-bottomed keel-less craft known as nauka or danga is the only traditional craft found in Chilika Lake. It is found suitable for the environment of Chilika. There are 13 different gears were encountered during the seasonal survey of Chilika Lake. The gear were Masari jale, Khanda jala, Zero net, Sahal jala, Panu khande, Drag net, Boby jala, Bhakata jala, Menjee jala, Gawa Jala, Dub jala, Disco jala and Star jala. The survey of fishing gears and craft used in Gbedikere Lake Kogi State, Nigeria was carried between October 2006 and September 2008. Artisanal fishery is the main type of fishing practiced occupationally by the fishermen in Gbedikere Lake. No form of mechanized fishing has so far been introduced to the fishermen in this area. (Segun, 2009). An attempt was made to study about the fishing gears used in Chilika lagoon during January-December, 2009. A total of 1819 fishing boats were sampled among which 670 boats from northern sector, 535 boats from central sector, 330 boats from southern sector and 284 boats from outer channel sector. In sector wise as well as seasonal distribution of fishing gears is concern, the variation clearly visible. (S. Parida, 2013)

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REFERENCES

Segun Adeyemi, 2009, Fish Gear Survey of Gbedikere Lake, Bassa, Kogi State, Nigeria, Research gate.

S. Parida, 2013, Distribution of Fishing Gears in India's Largest Brackish Water Lagoon, India, *Bulletin of Environment, Pharmacology and Life Sciences.* 2(7), 62-64.

Oral V2T2D2

Optimizing stocking density for sustainable *Heteropneustes fossilis* (Stinging catfish) aquaculture: Growth, yield, and economic insight

RINCHEN NOPU BHUTIA, SONALI MALLICK, UTTAM KUMAR MANDAL and DHIMAN BURMAN

ICAR: Central Soil Salinity Research Institute, RRS, Canning Town, West Bengal-743329, India

E-mail: rinchenacademia@gmail.com

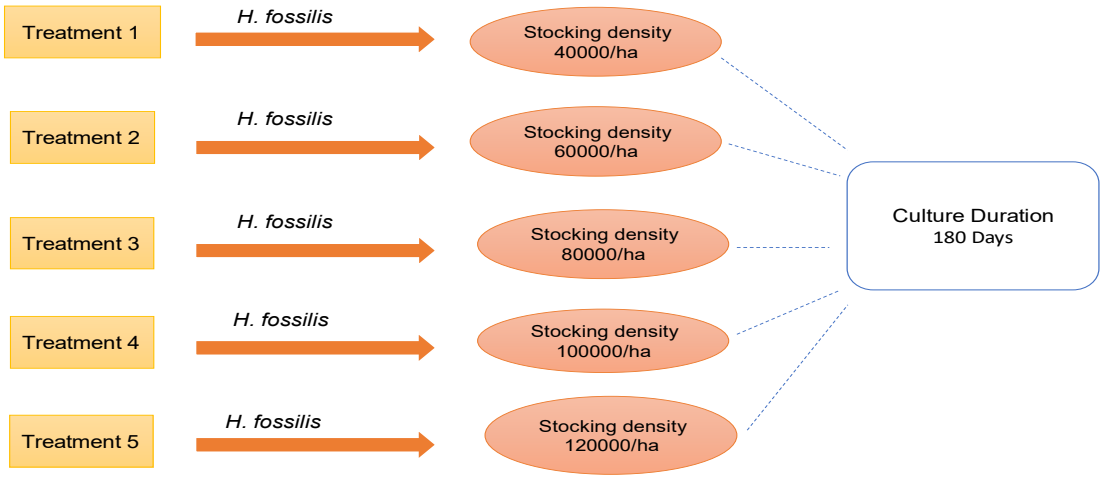
Key Words: *Stocking Density, Growth Performance, Economic Analysis*

INTRODUCTION

Aquaculture plays a key role in food security and economic growth, with *Heteropneustes fossilis* (stinging catfish) being highly valued in South and Southeast Asia for its market demand, nutrition, and adaptability. Optimal stocking density is crucial for maximizing yield while minimizing stress and environmental impacts. High densities can reduce growth, while low densities waste resources. *H. fossilis* also integrates well with Indian major carps in ponds, making it a promising species for sustainable aquaculture and species diversification.

MATERIALS AND METHODS

A study was conducted during the year 2024 to evaluate the effects of different stocking densities on the growth and production performance of *H. fossilis*. Five different stocking densities of H. fossilis (@40000/ha, @60000/ha, @80000/ha, @100000/ha and @120000/ha) were tested in farmer's field. Layout of the experiment on stocking density is given in Fig. 1



RESULTS AND DISCUSSION

Stocking density is a key factor influencing fish growth, survival, and production (Backiel and LeCren, 1978). Higher densities typically reduce growth and survival while increasing FCR and competition for food and space (Powell, 1972). The growth parameters of *H. fossilis* under five stocking density treatments (T-1 to T-5) are given in table 1. The growth parameters such as absolute weight gain, specific growth rate and performance index in T1, T2, and T3 were not significantly different ($p > 0.05$) to each other, while T4 and T5 are significantly different from T1, T2, and T3, but not from each other. Final weight gain ranged from 42.53 ± 4.29 g in T-1 to 26.2 ± 1.53 g in T-5, indicating that higher stocking densities led to reduced growth performance. Absolute weight gain followed a similar trend, decreasing from 40.03 g in T-1 to 29.53 g in T-5. The decline in fish growth rate and feed utilization with increasing levels of stocking densities was also observed by Samad and Bhuiyan (2017). The specific growth rate (SGR) was highest (1.57%) in T-1 and T-2 and progressively declined to 1.31% in T-5, reflecting reduced growth efficiency with increased density. Performance index (PI) showed a similar decline, from 17.79 in T-1 to 11.64 in T-5. However, fish yield per hectare over six months was lowest in T-1 (1361.06 ± 137.17 kg) and highest in T-4 (2530.66 ± 286.24 kg), indicating that intermediate densities optimized yield despite reduced individual growth.

Table 1: *Growth parameters and production performance of Heteropneustes fossilis under different stocking densities*

Growth parameters	**Treatments**				
	T-1	**T-2**	**T-3**	**T-4**	**T-5**
Initial weight (g)	2.50	2.50	2.50	2.50	2.50
Final weight (g)	42.53 ±4.29	42.13±3.26	37.86±2.90	31.63±3.57	26.2±1.53
Absolute weight (g)	40.03	39.63	35.37	29.13	29.53
SGR	1.57	1.57	1.51	1.41	1.31
PI	17.79	17.61	15.72	12.95	11.64
Fish yield (kg/ha/6 months)	1361.06 ±137.17	2022.4 ±156.48	2423.46 ±185.66	2530.66 ±286.24	2515.2 ±148.93

***PI, Performance index; SGR, specific growth rate%.

***Sample size (n)= 10

The economic analysis is given in table 2 and it revealed a progressive increase in total input costs (₹ ha^{-1} $crop^{-1}$) from ₹333,000 in T-1 to ₹768,000 in T-5. Total production also shows an initial increase, peaking at 2,530.667 kg ha^{-1} $crop^{-1}$ in T-4, before slightly declining to 2,515.2 kg ha^{-1} $crop^{-1}$ in T-5. Correspondingly, the net return (₹ ha^{-1} $crop^{-1}$) increases from ₹347,533.3 in T-1 to a maximum of ₹658,733.3 in T-3, followed by a decline in T-4 and T-5. This trend highlights that while increasing input costs and production initially drive higher net returns, diminishing returns set in after T-3, likely

due to reduced efficiency or other constraints. The benefit-cost (BC) ratio reflects this dynamic, starting at 2.04 in T-1, rising to a peak of 2.28 in T-2, and then gradually declining to 1.63 in T-5. This indicates that the economic viability decreases with higher input costs and production levels beyond a certain point. Therefore, while moderate investment levels (T-2 and T-3) yield the best economic outcomes, excessive input costs (T-4 and T-5) may not justify the returns, emphasizing the importance of optimizing input use for sustainable profitability.

Table 2: *Economic analysis of Heteropneustes fossilis culture under different stocking densities*

Economic analysis	**T-1**	**T-2**	**T-3**	**T-4**	**T-5**
Total input costs (Rs ha^{-1} $crop^{-1}$)	333000	443000	553000	658000	768000
Total production (Kg ha^{-1} $crop^{-1}$)	1361.067	2022.4	2423.467	2530.667	2515.2
Net return (Rs. ha^{-1} $crop^{-1}$)	347533.3	568200	658733.3	607333.3	489600
BC ratio	2.04	2.28	2.19	1.92	1.63

CONCLUSIONS

Based on the findings of the study on evaluation of five stocking densities of *Heteropneustes fossilis*, a stocking density of 60,000–80,000/ha is recommended for optimal growth and profitability.

REFERENCES

Backiel T and LeCren ED (1978), Some density relationship for fish population parameters In: Ecology of freshwater fish production, Ed. Gerking SD, Blackwell Scientific Publication, Oxford, pp 279-302.

Samad, M.A. and Bhuiyan, A.S., 2017. Stocking density of threatened cat fish Heteropneustes fossilis (Bloch, 1792) in seasonal ponds of Rajshahi, Bangladesh. *Bangladesh journal of scientific and industrial research*, *52*(4), pp.253-262.

Samad, M.A. and Bhuiyan, A.S., 2017. Stocking density of threatened cat fish Heteropneustes fossilis (Bloch, 1792) in seasonal ponds of Rajshahi, Bangladesh. *Bangladesh journal of scientific and industrial research*, *52*(4), pp.253-262.

Oral V3T2D2

Ecological significance of molluscan diversity in the estuarine ecosystem of the river Ganga

R. BESRA, B.K. DAS, R. JAISWAL, S. ROY, S. KUNDU

ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata-700120, India

E-mail: basantakumard@gmail.com

Key Words*: Ecology, Mollusc, Diversity*

INTRODUCTION

Molluscs are the second-largest phylum of invertebrates, surpassing only arthropods. In estuarine ecosystems, they occupy various roles within the food web, including predators, herbivores, detritivores, and filter feeders. Their diversity makes them vital for maintaining the ecosystem's functionality and productivity. Molluscs also contribute to organic matter decomposition through their feeding activities (Kabir et al., 2014; Tavares et al., 2015) and have economic value. For example, the meat of the *Strombus* genus is a consumable food source (Suwignyo, 2005; Rosady et al., 2016), while their shells are frequently used to create decorative items (Supusepa, 2018). As development progresses, it is essential to focus on their protection and conservation. There is a lack of existing data on the molluscan diversity within the estuarine stretch of the river Ganga. Hence, this study aims to explore the present status, and role of molluscan diversity, particularly its impact on the physicochemical properties of sediment.

MATERIALS AND METHODS

The sampling was performed in three study areas along the estuarine stretches of the River Ganga: Godakhali, Fraserganj, and Diamond Harbour. Samples were collected quarterly throughout 2024, covering the pre-monsoon (March-May), monsoon (June-August), and post-monsoon (September-November) seasons.

Benthos samples were collected using a grab sampler, placed in a bucket of water, and thoroughly mixed. The samples were then sieved through a 63 µm mesh for meiobenthos sampling and a finer sieve (<63 µm) for macrobenthos. The sieved samples were preserved in a 4% formalin solution for subsequent taxonomic identification. Sediment quality was determined by collecting samples using a Peterson grab (15.2 cm × 15.2 cm). Numerical abundance was determined by first counting the individuals and then

applying the following formula to convert the count to a 1 m² area (Welch, 1948; Meena et al., 2019). Sediment physicochemical parameters such as soil organic carbon (OC) were analysed following the standard methods and protocols outlined by Jackson (1964) and Piper (1966).

RESULT AND DISCUSSION

Result showed abundance of different macro benthic organism (Table: 1). *Idiopoma dissimilis* showed highest abundance among the three stations and also the only species that has been observed in Godakhali. On the other hand, Fraserganj showed more diversity than other sites. *Telescopium telescopium* (303 individual/m²) was the dominant species and *Nassarius sp.* (43 individual/m²) the least abundant one. The soil organic carbon result also showed higher (0. 76 %) in Fraserganj which is essential for good health of benthic communities also indicates more productive environment than Diamond Harbour (0.69%) and Godakhali (0.42%).

Family	Species	Godakhali	Diamond Harbour	Fraserganj
Viviparidae	*Idiopoma dissimilis*	390		
Muricidae	*Indothais lacera*			43
	Indothais sacellum			43
	Murex Linnaeus.			87
Neritidae	*Nerita balteata*		87	
	Cerithidea obtusa			303
Potamididae	*Telescopium telescopium*			216
Nassariidae	*Nassarius sp.*		43	
Ancillariidae	*Ancilla ampla*		87	

Table 1*: Showing number of identified molluscan macroinvertebrates (individual m⁻²) observed in the estuarine stretch of river Ganga*

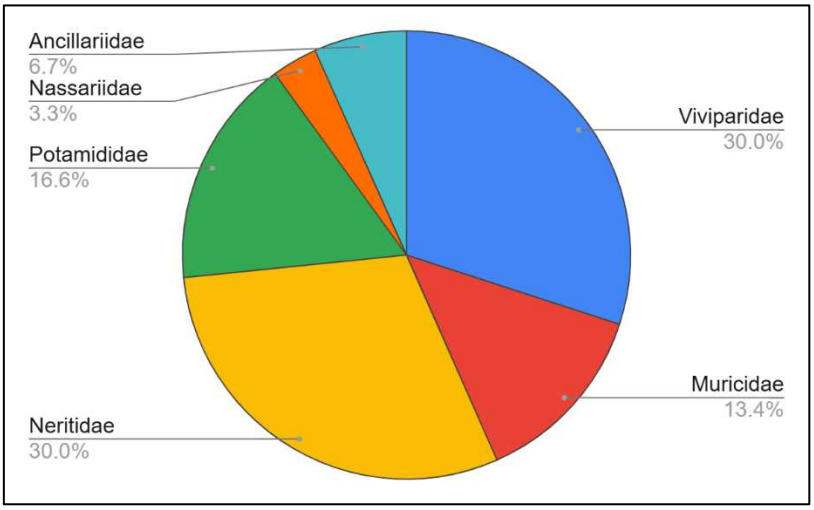


Fig 1: *Showing dominated molluscan families observed in the estuarine stretch of river Ganga*

CONCLUSION

In conclusion, Fraserganj shows greater diversity and abundance of macro benthic organisms, with *Telescopium telescopium* being the most prevalent species. The higher soil organic carbon content in Fraserganj compared to Diamond Harbour and Godakhali indicates a more productive environment, points to a more productive environment, making Fraserganj a more suitable habitat for benthic communities.

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REFERENCE

Jackson ML (1964) Soil chemical analysis, Prentice Hall Inc4, 448.

Kabir, M., Abolfathi, M., Hajimoradloo, A., Zahedi, S., Kathiresan, K., & Goli, S. (2014). Effect of mangroves on distribution, diversity and abundance of molluscs in mangrove ecosystem: a review. *Aquaculture, Aquarium, Conservation & Legislation*, *7*(4), 286-300.

Meena, D. K., Lianthuamluaia, L., Mishal, P., Swain, H. S., Naskar, B. K., Saha, S., ... & Das, B. K. (2019). Assemblage patterns and community structure of macro-zoobenthos and temporal

dynamics of eco-physiological indices of two wetlands, in lower gangetic plains under varying ecological regimes: A tool for wetland management. *Ecological Engineering*, *130*, 1-10.

Rosady, V. P., Astuty, S., & Prihadi, D. J. (2016). Kelimpahan dan kondisi habitat siput gonggong (Strombus turturella) di Pesisir Kabupaten Bintan, Kepulauan Riau. *Jurnal Perikanan Kelautan Vol. VII No*, *35*, 44.

Welch, P. S. (1948). Limnological methodsß Mc-Graw-Hill Book Co. *Inc., New York*, *381*.

Oral V4T2D2

Plankton and periphyton as a pollution indicator in the lower Gangetic region

A. MONDAL, A. WODEYAR., T.R. MOHANTY, P. MALAKAR, S.K. CHOUHAN, B.K.DAS*

ICAR- Central Inland Fisheries Research Institute, Barrackpore, Kolkata-700120

E-mail: basantakumard@gmail.com

Key Words: *Bioindicators, Water Quality, Plankton & Periphyton, Pollution Monitoring*

INTRODUCTION

The lower Gangetic region, a vital ecosystem supporting a large population, faces increasing pollution threats. Effective water quality monitoring is crucial for sustainable management. Plankton and periphyton communities, integral parts of aquatic ecosystems, serve as sensitive bioindicators of pollution. These microscopic organisms exhibit spatial and temporal variations in composition and abundance, reflecting the influence of pollutants. Changes in dominant species, diversity, and the presence of indicator organisms can signal shifts in water quality, providing early warnings of ecosystem degradation. This study investigates plankton and periphyton communities as bioindicators in the lower Gangetic region, examining their dynamics in relation to key water quality parameters. The findings will contribute to understanding the ecological health of this crucial river system and inform strategies for its protection.

MATERIALS AND METHODS

To evaluate water quality and plankton diversity, three locations per river were sampled seasonally from February 2023 to March 2024 across nine sites. At each site, 50 L of subsurface water was filtered using a 20 µm plankton net, preserved in 4% neutral buffered formalin, and stored in polyethene containers. Water samples were taken from 15 cm below the surface in the mid-river region between 7:00 and 10:00 AM and kept in acid-cleaned autoclaved bottles. Key physicochemical parameters, including pH, electrical conductivity, and transparency, were measured on-site using a YSI-Pro DSS probe and a Secchi disc. Additional parameter such as dissolved oxygen, alkalinity, free CO_2, hardness, chloride, and nutrient levels were analyzed following APHA (2017) guidelines, while salinity and silicate samples were preserved for laboratory analysis. Plankton diversity data were processed using Microsoft Excel, and Canonical Correspondence Analysis (CCA) in CANOCO 4.5 was used to examine relationships between plankton communities and water quality. Results were visualized using Cano-Draw triplots, with statistical significance assessed through a 500-run Monte Carlo permutation test. Bioindicator genera were identified using R Studio, following Dufrene & Legendre's methodology, where Mean Abundance (A) and Frequency of Occurrence (B) were calculated. The Indicator Value (INDVAL) was determined using the formula $INDVAL_i = A_i \times B_i \times 100$.

RESULTS AND DISCUSSION

This study examined the use of plankton and periphyton communities as bioindicators of pollution in the lower Gangetic region. Samples were collected seasonally from sites such as Buxar, Patna, Bhagalpur, Farakka, Godakhali, Fraserganj, Berhampore, and Balagarh between 2023 and 2024. The findings revealed significant spatial and temporal variations in community composition, reflecting changing pollution levels and environmental conditions. In 2023, phytoplankton communities were dominated by Dinophyceae (*Peridinium*) and Coscinodiscophyceae (*Coscinodiscus*), but by 2024, Bacillariophyceae (*Nitzschia*, *Fragilaria*) and Cyanophyceae (*Microcystis*, *Oscillatoria*) became

dominant, particularly in Buxar and Patna. This rise in Cyanophyceae, known for producing toxins, signals increasing ecological stress. Similarly, periphyton communities showed temporal shifts, with Bacillariophyceae (*Navicula*, *Cyclotella*, *Diatoma*) prevailing in 2023 and Cyanophyceae increasing in 2024, notably at Godakhali and Fraserganj. The Palmer Index, used to measure organic pollution, identified Bhagalpur as the most polluted site, with high abundances of *Oscillatoria*, *Euglena*, and *Nitzschia*, while Berhampore and Balagarh exhibited lower pollution levels, indicating relatively better water quality. The estuarine sites displayed unique community compositions, with the presence of *Pseudo-nitzschia*, a producer of domoic acid, linked to high temperatures, salinity, and silicate levels.

The proliferation of cyanobacteria (*Microcystis*, *Phormidium*, *Aphanizomenon*) further reflected poor water quality and elevated nutrient concentrations. In contrast, freshwater regions exhibited indicator species like *Tabellaria*, an indicator of eutrophication, and *Pediastrum*, a paleoenvironmental marker. The presence of *Aulacoseira granulata*, a diatom adapted to stressful conditions, signaled further environmental degradation.

Canonical Correspondence Analysis (CCA) provided deeper insights into the relationships between environmental parameters and plankton communities across sites. Variables such as dissolved oxygen (DO), pH, turbidity (TUR), and total alkalinity (TAL) were strongly correlated with genera like *Spirogyra* and *Pandorina*, which favor oxygen-rich and stable pH environments. Conversely, nutrient-related factors such as total nitrogen (TN), salinity (SAL), and chlorinity (CHL) were associated with genera like *Nitzschia*, *Oscillatoria*, and *Microcystis*, indicating their preference for nutrient-enriched, polluted waters, often linked to eutrophication. Additional variables, including total suspended solids (TSS) and conductivity (CON), influenced localized distributions of certain genera, reflecting the impacts of suspended particulates and pollution. The influence of silicate (SIL) and TN highlighted niche-specific adaptations, with genera such as *Oscillatoria*, *Cymbella*, and *Cladophora* clustering near nutrient-related variables, emphasizing their roles as bioindicators of water quality.

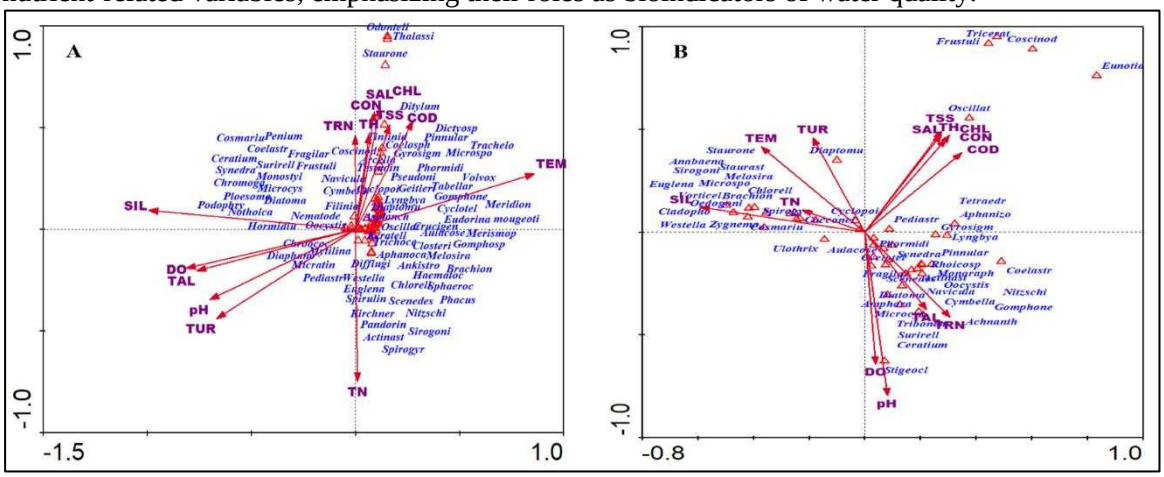

Fig. 1. *CCA analysis of A. Plankton and B. Periphyton with water quality parameters of lower Gangetic region*

CONCLUSIONS

This study highlights the value of plankton and periphyton as complementary bioindicators for assessing water quality in the lower Gangetic region. Shifts in community composition, particularly the rise in harmful cyanobacteria, emphasize the need for continuous monitoring and targeted pollution management strategies to safeguard aquatic ecosystems. Elevated chlorinity, salinity, and turbidity at specific sites indicate critical areas requiring intervention. The findings underscore the importance of environmental monitoring to manage algal blooms and maintain ecological health. Overall, plankton and periphyton communities serve as cost-effective and ecologically relevant tools for understanding and addressing pollution in freshwater and estuarine ecosystems.

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REFERENCES

Leblad, B.R., Amnhir, R., Reqia, S., Sitel, F., Daoudi, M., Marhraoui, M., Abdellah, M.K.O., Veron, B., Er-Raioui, H. and Laabir, M., 2020. Seasonal variations of phytoplankton assemblages in relation to environmental factors in Mediterranean coastal waters of Morocco, a focus on HABs species. *Harmful Algae*, *96*, p.101819.

Akter, S., Nama, S., Wodeyar K, A., Deshmukhe, G., Nayak, B.B., Jaiswar, A.K., Landge, A.T. and Ramteke, K., 2024. Unravelling tropical estuary health through a multivariate analysis of spatiotemporal phytoplankton diversity and community structure in relation to environmental interactions. *Aquatic Sciences*, *86*(4), p.109.

Klisch, M., & Häder, D. P. (2008). Mycosporine-like amino acids and marine toxins-The common and the different. *Marine drugs*, *6*(2), 147-163.

Gogoi, P., Sinha, A., Das Sarkar, S., Chanu, T.N., Yadav, A.K., Koushlesh, S.K., Borah, S., Das, S.K. and Das, B.K., 2019. Seasonal influence of physicochemical parameters on phytoplankton diversity and assemblage pattern in Kailash Khal, a tropical wetland, Sundarbans, India. *Applied Water Science*, *9*, pp.1-13.

Rastogi, R. P., Sinha, R. P., & Incharoensakdi, A. (2014). The cyanotoxin-microcystins: current overview. *Reviews in Environmental Science and Bio/Technology*, *13*, 215-249.

Oral V5T2D2

Waves of Change: Exploring the Limnological Symphony Shaping Plankton and Hilsa Populations in West Bengals Coastal Currents

P. MALAKAR, A. MONDAL, T. R. MOHANTY, A. RAY, S. PAUL, B. K. DAS*

ICAR- Central Inland Fisheries Research Institute, Barrackpore, Kolkata-700120, West Bengal, India

E-mail: basantakumard@gmail.com

Key Words: *Hilsa migration, limnological Factor, Plankton Community*

INTRODUCTION

Plankton, microscopic organisms in fresh and saltwater, are vital to aquatic ecosystems. Phytoplankton act as primary producers, while zooplankton serve as key consumers, supporting the entire food chain and fish production. Their abundance and diversity indicate water quality, influenced by factors like seasonal changes, water levels, and organic load. Understanding plankton composition is crucial for effective water management and economic policies (Panikkar et al. 2022).

The Ganga River and its tributaries, Haldi and Rupnarayan, are key breeding grounds for Hilsa, an economically significant fish. The Bhagirathi–Hooghly stretch yields India's highest Hilsa catch, supporting millions in the Ganga-Brahmaputra-Meghna basin. As Hilsa primarily feed on plankton, particularly diatoms, rotifers, and copepods, studying plankton diversity is crucial for fisheries science (Sarkar et al. 2023). This study examines plankton species influenced by limnological parameters in the Ganga River and its tributaries during Hilsa's breeding season.

MATERIALS AND METHODS

To assess water quality and plankton diversity, three locations were selected in each river seasonally from February 2023 to March 2024 at nine sites. At each site, 50 L of subsurface water was filtered through a 20 µm plankton net, preserved in 4% neutral buffered formalin, and stored in polyethylene containers. Water samples, collected at a 15 cm depth from the mid-river region (7:00–10:00 AM), were stored in acid-cleaned, autoclaved bottles. Key parameters (pH, electrical conductivity, transparency) were measured in situ using a YSI-Pro DSS probe and Secchi disc, while dissolved oxygen, alkalinity, free CO_2, hardness, chloride, and nutrients followed APHA (2017). Salinity and silicate were preserved for lab analysis.Plankton diversity was analyzed in Microsoft Excel. Canonical Correspondence Analysis (CCA) in CANOCO 4.5 assessed plankton-water quality relationships, visualized in Cano-Draw triplots, with significance tested via a 500-run Monte Carlo permutation. Pearson correlation and heatmap analyses were conducted using Python 3.12.

RESULTS AND DISCUSSION

A total of 50 plankton genera (38 phytoplankton, 12 zooplankton) from 11 taxonomic classes were identified across nine sites. Coscinodiscophyceae had the highest phytoplankton diversity, while Crustacea dominated zooplankton. The highest phytoplankton diversity (21 taxa) was recorded at Balagarh (G2), while zooplankton peaked at Geonkhali (R3). *Aulacoseira* spp. was the most abundant phytoplankton, and *Tintinnids* spp. dominated zooplankton. Rupnarayan River had the highest plankton abundance (62,046 unit/L), while Haldi River had the lowest (433 unit/L).

Ganga and Rupnarayan rivers were well-oxygenated, while Haldi had low DO due to nutrient accumulation and organic matter decomposition. Transparency was lowest in Haldi (1.90–2.4 cm) and highest in Rupnarayan (11–15 cm). Specific conductivity was highest in Rupnarayan (461–668 µS/cm) due to industrial discharge and tidal influence. COD levels were elevated near estuarine sites, with the highest at Godakhali (116 mg/L), Haldia (128 mg/L), and Geonkhali (80 mg/L), linked to industrial effluents. High nutrient concentrations indicated anthropogenic stress, impacting aquatic ecosystems.

CCA analysis revealed that plankton growth was influenced by nutrient load. Bacillariophyceae and Cyanophyceae species thrived in phosphate-rich waters, while other taxa correlated with specific conditions like high total phosphorus, nitrogen, COD, and conductivity. Heatmap analysis (Fig. 1) showed significant correlations between plankton classes and water quality parameters. Bacillariophyceae correlated positively with DO (R=0.74) and pH (R=0.54), while Coscinodiscophyceae was associated with conductivity (R=0.65) and hardness (R=0.66). Nutrient-rich conditions influenced Cyanophyceae (R=0.95 with available nitrogen), while Euglenophyceae correlated with free CO_2 (R=0.77). Zooplankton groups showed strong associations with total hardness, chloride, and alkalinity.

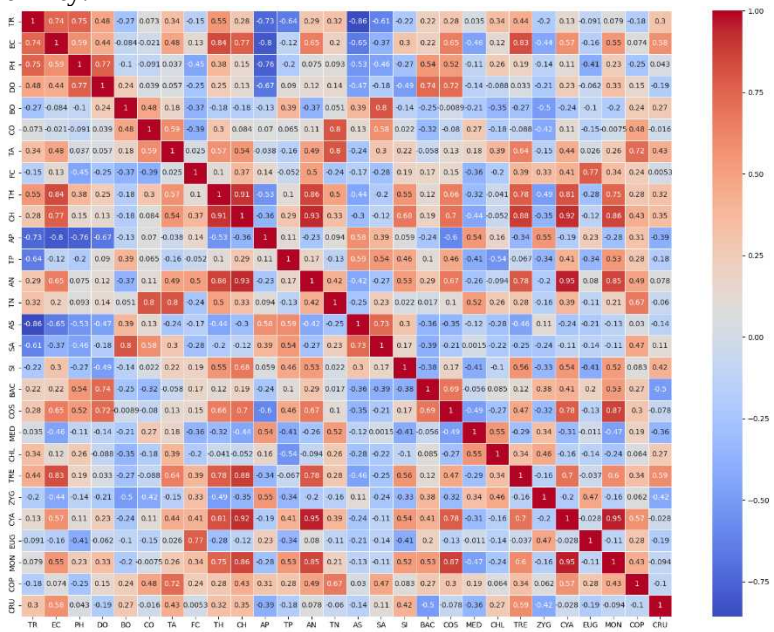

Fig. 1: *Heatmap analysis of water quality parameters and planktonic classes*

Plankton distribution varied due to water quality differences; the Haldi and Rupnarayan had higher COD levels from estuarine proximity and nutrient loads. CCA analysis linked plankton abundance to total phosphorus, alkalinity, BOD, COD, sulphate, and phosphate, with specific taxa responding to these factors. The Ganga had 29 species, dominated by Cyanophyceae (36%) and Chlorophyceae (31%), while the Haldi had 18 species, mostly Coscinodiscophyceae (39%) and Chlorophyceae (23%). The Rupnarayan hosted 25 species, mainly Coscinodiscophyceae (66%) and Cyanophyceae (32%). Plankton are vital to Hilsa diets, primarily comprising Bacillariophyta, Chlorophyta, Cyanophyta, Copepoda, and Cladocera. This study found 99.4% of plankton were phytoplankton, supporting previous research that Hilsa are planktonic filter feeders (Jones & Sujansingani, 1951). These rivers play a crucial role in Hilsa migration and feeding.

CONCLUSION

This study analyzed the impact of physico-chemical factors on plankton diversity across nine sampling stations in the Ganga, Haldi, and Rupnarayan rivers, establishing correlations using statistical tools. It provides the first detailed account of plankton composition in these rivers, which support migratory fishes like Hilsa. Plankton, as primary producers, are vital for aquatic life, and their diversity reflects river health. Pollution indicator species offer insight into water quality, though further research is needed on algal tolerance and plankton resilience. Seasonal plankton fluctuations along Hilsa migratory routes may hinder their movement, emphasizing the need for ecological conservation of these rivers.

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REFERENCES

Panikkar, P., Saha, A., Prusty, A. K., Sarkar, U. K., & Das, B. K. (2022). Assessing hydrogeochemistry, water quality index (WQI), and seasonal pattern of plankton community in different small and medium reservoirs of Karnataka, India. *Arabian Journal of Geosciences*, *15*(1), 82.

Sarker, M. J., Sarker, P. K., Cahoon, L. B., Dipty, A. K., Bashar, M. A., Hasan, M. M., ... & Sarker, M. M. (2023). Seasonal variation in the epibenthic feeding habits of hilsa shad (Tenualosa ilisha) in the Upper Meghna River Estuary, Bangladesh. *Fishes*, *8*(7), 335.

APHA, (2017). Standard methods for the examination of water and wastewater.
Jones, S., & Sujansingani, K. H. (1951). Hilsa fishery of Chilka lake. *J. Bombay nat. hist. soc. Bombay*, *50*, 264-280p.

Oral V6T2D2

Assessment of microplastic accumulation in benthic organisms from the estuarine zone of the Ganga River basin

S. DAS, B. K. DAS*, R. BESRA, D. MOHANTY, B. BAISAKHI, S. ROY, M. KUMARI and D. J. SARKAR
ICAR- Central Inland Fisheries Research Institute, Barrackpore, Kolkata - 700120.
E-mail: basantakumard@gmail.com

Key Words: *Ganga Estuary, Macro-Benthic Fauna, Microplastics*

INTRODUCTION

Microplastics, defined as plastic particles smaller than 5 mm, have emerged as a major environmental concern due to their persistence and potential toxicity. These pollutants originate from a variety of sources, including industrial discharges, urban runoff, and the breakdown of larger plastic debris. The Ganga River, one of the most significant and heavily polluted river systems, serves as a conduit for microplastic contamination, particularly in its estuarine zones. Understanding the extent and distribution of microplastic pollution in benthic organisms is crucial for developing targeted mitigation strategies. This study aims to investigate the spatial variations in microplastic accumulation in benthic organisms across selected locations (Godakhali, Diamond Harbour, and Fraserganj) in the Ganga estuary and assess its potential impact on aquatic biodiversity.

MATERIALS AND METHODS

Total of 100 individuals from each sampling sites were collected (Godakhali, Diamond Harbour, and Fraserganj) of the estuarine zone of the Ganga River for analysis. The specimens were anesthetized using clove oil (CAS No. 8000–34–8) then crushed in glass beakers for analysis. To break down the organic material, the samples were treated with 30% hydrogen peroxide (H_2O_2), following the method given by Gbogbo et al. (2020). The remaining residues were then filtered through 0.5 µm filter paper and collected in 2 ml Eppendorf tubes. The extracted microplastics (MPs) were stained using Nile Red, a hydrophobic fluorescent dye, as per previously established protocols (Shim et al., 2016; Sarkar et al., 2021). The stained particles were then examined under a fluorescence microscope.

RESULTS AND DISCUSSION

Bentic organisms evaluated in this study includes *Telescopium telescopium, Pirenella cingulata and Nerita balteata.* Highest concentration of fibers (543), fragments (403) and foams (210) were observed at Fraserganj in total 100 individuals. Diamond Harbour recorded intermediate levels, with 279 fibres, 316 fragments, 140 foams, and 121 films, highlighting urban and industrial contributions to microplastic load. In contrast, Godakhali showed relatively lower levels, with 90 fibres, 150 fragments, and 83 foams, and no detectable films as shown in Fig. 1. Fibres were the most abundant type across all locations, followed by fragments, foams, and films. Among three species *Telescopium Telescopium* exhibits maximum accumulation of microplastics. FTIR data confirmed that PP, PE, PS and PET are the basic types of polymers found in all the three genera. PET was highest about 33% followed by PE (28%), PS (16%), PP (14%) and others were 9%.

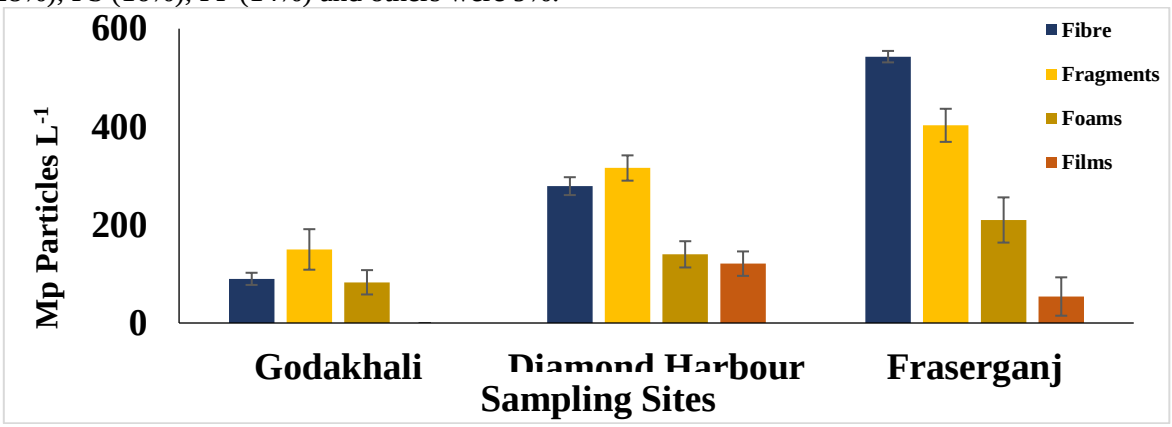

Figure 1: Accumulation of MPs in Estuarine Gastropods of Ganga River

The findings confirm that gastropods from the River Ganga are significantly affected by MP pollution. The detected MPs likely originate from anthropogenic sources, including plastic waste

disposal and industrial discharge. These results align with previous studies on MP accumulation in aquatic organisms. Further research is needed to assess the long-term ecological impacts of MP contamination.

CONCLUSION

In this study, maximum accumulation was observed in *Telescopium Telescopium.* and accumulation of fragments and fibers were significantly observed. *T. Telescopium* is a potential bioindicator species for microplastic accumulation in the estuarine region due to its maximum abundance has a quick and sensitive response to environmental fluctuations due to its sessile nature. This study highlights the widespread presence of MPs in gastropods from the River Ganga, emphasizing the urgency of addressing plastic pollution. Implementing waste management policies and promoting public awareness can help mitigate MP contamination in aquatic ecosystems.

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REFERENCES

Bellasi, A., Binda, G., Pozzi, A., Galafassi, S., Volta, P., & Bettinetti, R. (2020). Microplastic contamination in freshwater environments: A review, focusing on interactions with sediments and benthic organisms. *Environments*, *7*(4), 30.

Bagheri, T., Gholizadeh, M., Abarghouei, S., Zakeri, M., Hedayati, A., Rabaniha, M., ... & Hafezieh, M. (2020). Microplastics distribution, abundance and composition in sediment, fishes and benthic organisms of the Gorgan Bay, Caspian Sea. *Chemosphere*, *257*, 127201.

Shim, W.J., Song, Y.K., Hong, S.H., Jang, M., 2016. Identification and quantification of microplastics using Nile Red staining. *Mar. Pollut. Bull*. 113, 469–476.

Sarkar, D.J., Sarkar, S.D., Das, B.K., Praharaj, J.K., Mahajan, D.K., Purokait, B., Mohanty, T.R., Mohanty, D., Gogoi, P., Kumar, S., Behera, B.K., 2021b. Microplastics removal efficiency of drinking water treatment plant with pulse clarifier. *J. Hazard. Mater*. 413, 125347.

Gbogbo, F., Takyi, J.B., Billah, M.K., Ewool, J., 2020. Analysis of microplastics in wetland samples from coastal Ghana using the Rose Bengal stain. *Environ. Monit. Assess*. 192, 1–10.

Oral V7T2D2

Spatio-temporal dynamics of fish guilds and environmental influences on ichthyofaunal assemblage in the lower stretch of Rupnarayan River, West Bengal, India

D. SINGH, A. WODEYAR K, A. RAY, P. MAJUMDER, T.R. MOHANTY, S. K. CHAUHAN, T.N. CHANU, B.K. DAS*

ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata – 700120, India

E-mail: basantakumard@gmail.com

Key Words: *Estuarine Fishes, Functional Groups, Fish Diversity, Rupnarayan River*

INTRODUCTION

Estuaries, dynamic ecosystems influenced by tidal fluctuations and salinity gradients, support diverse fish assemblages across various life-history stages (Favero et al. 2019). Fish species in these environments can be classified based on trophic level, reproductive strategy, and habitat use. Guild-based classification, which groups species with similar ecological roles, provides insights into ecosystem functioning, species interactions, and environmental influences (Elliott et al. 2007). By analysing fish communities through a functional lens, researchers can better understand habitat connectivity, resource partitioning, and species responses to environmental changes (Roshni et al. 2022). Fish are categorized into guilds based on habitat preference, feeding behaviour, and reproductive traits (Ferreira et al. 2019). This study examines the fish assemblages and functional guilds in the lower Rupnarayan River, assessing spatial and temporal variations in species diversity. The findings will help understand seasonal patterns and environmental drivers shaping fish communities in this estuarine system.

MATERIALS AND METHODS

This study investigated fish assemblages and functional guilds in the lower stretch of the Rupnarayan River across spatial and temporal scales at four stations in the lower zone. Fish

specimens were collected seasonally from January to December 2024 using locally available fishing gear with different mesh sizes. Specimens were identified using taxonomic keys, measured for length (cm) and weight (g). Surface water parameters (temperature, salinity, dissolved oxygen, transparency) were measured in situ. Species richness and abundance were calculated for each site and season. Diversity indices, including Shannon-Weiner (H′), Margalef's richness (d), Pielou's evenness (J'), and Simpson's dominance (1 − λ), were estimated. Functional guilds were assigned following Elliott et al. (2007). Estuarine use guilds included anadromous (AN), catadromous (CA), amphidromous (AM), potamodromous (PO), freshwater migrants (FM), freshwater species (FW), marine migrants (MM), and estuarine stragglers (ES). Feeding guilds comprised carnivores (CR), herbivores (HV), zooplankters (ZP), omnivores (OV), zoobenthivores (ZB), and piscivores (PV). The conservation status of recorded species was assessed based on the International Union for Conservation of Nature (IUCN) Red List criteria.

RESULTS AND DISCUSSION

A total of 3,951 specimens were collected through experimental fishing, representing 47 finfish species from 24 families and 11 orders. The family Cyprinidae had the highest species count (seven), followed by Dorosomatidae, Danionidae, Mugilidae, and Bagridae, each with four species. The recorded species richness was higher than in previous reports, highlighting the diverse fish assemblage in the study area. Species were classified into different ecological guilds based on migratory behaviour, feeding habits, habitat preference, and reproductive traits. Potamodromous species were dominant (45%), followed by amphidromous (19%) and freshwater species (15%). Among feeding guilds, zoobenthivores constituted the largest group (42%), followed by omnivores (17%), carnivores (13%), and piscivores (13%). The dominance of potamodromous and zoobenthivorous species suggests the significance of riverine connectivity and benthic food availability in shaping the fish community structure.

Species diversity varied across different seasonal samples (PRM, MON, and POM). The highest species richness (S) and total individuals (N) were recorded in PRM samples, followed by MON, with the lowest in POM. Shannon-Wiener diversity index (H') was highest in PRM2, indicating greater species diversity, whereas POM4 exhibited the lowest richness and evenness. Margalef's index (d) peaked in POM1, suggesting higher species richness relative to abundance, while POM4 had the lowest value. Evenness (J') remained generally high across samples but was slightly reduced in POM4, reflecting species dominance. Simpson's index (1-λ') remained consistently high across samples, indicating even species distribution. The similarity matrix showed stable species composition in PRM and MON samples, while POM4 exhibited distinct distribution patterns, likely influenced by environmental factors. Similarity percentage analysis highlighted Tenualosa ilisha, Puntius sophore, Glossogobius giuris, and Amblypharyngodon mola as major contributors to species composition. The BIO-ENV analysis ($r = 0.69$) revealed a strong correlation between species composition and environmental variables. Transparency, specific conductivity, total nitrogen, and silicate ($r = 0.55$) were key factors influencing species distribution. Species such as Channa punctata, Channa marulius, Trichogaster fasciata, Xenontodon cancila, Polynemus paradiseus, and Mugil cephalus showed strong associations with these environmental parameters.

Seasonal variation in species richness and diversity may be attributed to hydrological changes, habitat availability, and nutrient dynamics. The post-monsoon period exhibited maximum species richness, likely due to favourable environmental conditions and increased recruitment. In contrast, monsoon samples showed lower diversity, possibly due to flooding and habitat disturbance. The distinct community structure observed in POM4 suggests localized environmental stressors affecting fish assemblages. The study highlights the dynamic nature of fish diversity in response to environmental changes. The findings emphasize the importance of habitat conservation and water quality management in sustaining fish populations, particularly potamodromous and zoobenthivorous species, which form a crucial part of the ecosystem.

CONCLUSION

This study examines seasonal variations in fish diversity and functional guild composition in the lower Rupnarayan River. A total of 47 finfish species were recorded, with potamodromous and zoobenthivorous species being dominant. Species richness peaked post-monsoon and was lowest during the monsoon, reflecting hydrological influences. Diversity

indices showed significant spatial and temporal differences, with PRM samples having the highest diversity and POM4 the lowest. BIO-ENV analysis identified transparency, conductivity, nitrogen, and silicate as key environmental drivers. These findings emphasize the need for habitat conservation and water quality management to sustain fish diversity and ecosystem balance.

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REFERENCE

Elliott M, Whitfield AK, Potter IC, Blaber SJM, Cyrus DP, Nordlie FG, Harrison TD (2007) The guild approach to categorizing estuarine fish assemblages: a global review. Fish Fisheries 8:241–268.

Favero F, Araújo I, Severi W (2019) Structure of the fish assemblage and functional guilds in the estuary of Maracaípe, Northeastern coast of Brazil. *Bol Inst Pesca* 45:417.

Ferreira, V., Le Loc'h, F., Ménard, F., Frédou, T. and Frédou, F., 2019. Composition of the fish fauna in a tropical estuary: the ecological guild approach. *Scientia Marina*, *83*(2), pp.133-142.

Roshni, K., Renjithkumar, C.R., Sreekanth, G.B., Raghavan, R. and Ranjeet, K., 2023. Fish community structure and functional guild composition in a large tropical estuary (Vembanad Lake, India). *Environmental Science and Pollution Research*, 30(11), pp.29635-29662.

Oral V8T2D2

High-resolution satellite data for monitoring water area variability using cloud computing: A time-series approach for Malampuzha dam, Kerala

B. BASAK, DR. B. K DAS, S. K. SAHU, T. KAYAL, S. MAHAPATRA

ICAR-Central Inland Fisheries Research Institute, Kolkata-700 120, West Bengal, India

E-mail: basantakumard@gmail.com

Key Words: *AWEI Index, Google Earth Engine, High-Resolution Data, Water Area Monitoring*

INTRODUCTION:

The delineation of water areas over time is crucial for understanding the dynamics of water bodies, particularly in regions like Malampuzha Dam, which are vital for local ecosystems, water resource management, and agricultural activities. Monitoring water body changes over time can provide insights into seasonal variations, drought impacts, and long-term water storage trends for sustainable management and planning. Google Earth Engine uses cloud-based parallel processing to handle large datasets quickly. GEE has been used to analyse water areas from Sentinel imagery from 2020 to 2024. The Automatic Water Extraction Index (AWEI) is applied for water detection, using Sentinel datasets to monitor water coverage over time. To optimize processing efficiency, the data is filtered by date and area of interest, and spatial aggregation techniques were applied to reduce computational time using remote sensing data.

MATERIALS AND METHODS

To estimate the water area of **Malampuzha Dam** using Sentinel-2 imagery with 10-meter resolution, the **AWEI (Automated Water Extraction Index)** is applied to extract the water body. The process begins by selecting relevant bands from the Sentinel-2 imagery: **Blue (B2), Green (B3), Near-Infrared (NIR - B8), SWIR1 (B11),** and **SWIR2 (B12).** The AWEI formula is then applied, which is calculated as: **Automated Water Extraction Index (AWEI) = (BLUE+2.5*GREEN-1.5*(NIR+SWIR1)-0.25*SWIR2),** Feyisa, G. L., *et al*. (2014).

RESULTS AND DISCUSSION

Water Level Area (Hectare)	Years				
	2020	2021	2022	2023	2024
Maximum	1921.49 (November)	1862.30 (December)	1861.83 (December)	1672.32 (January)	1972.54 (November)
Minimum	648.81 (May)	791.86 (April)	1091.15 (May)	684.82 (April)	643.88 (May)
Average	1324.02	1236.9	1457.09	1176.906	1218.34

Table 1. *Maximum, Minimum and Average Area in different years*

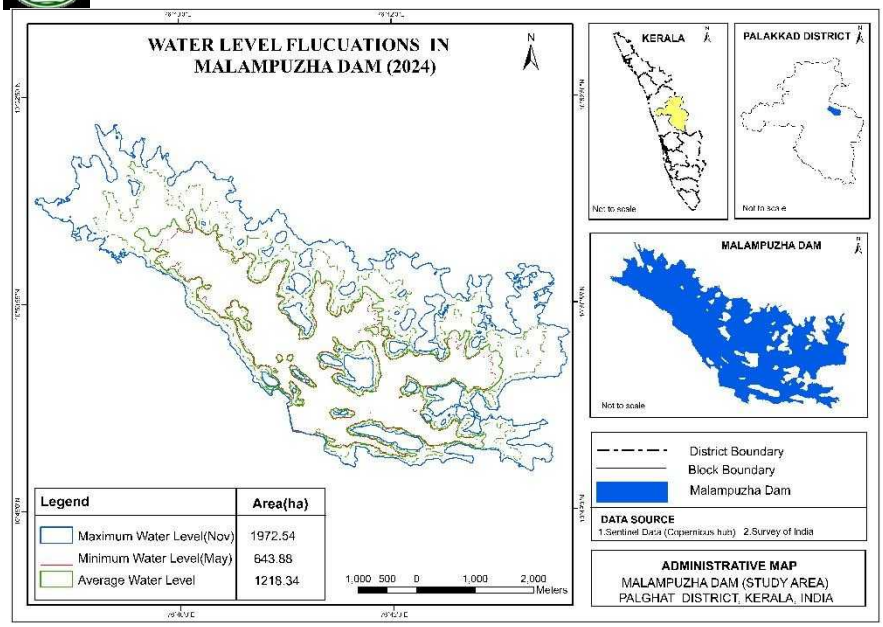

Fig. 1. *Water level fluctuation in 2024*

This study tracks the water area in hectares from 2020 to 2024, revealing notable fluctuations in water levels. November 2024 saw the highest area at 1972.54 hectares, while May 2024 had the lowest at 643.88 hectares. February and March had moderate levels, and April generally showed the lowest, particularıy ın 2021 and 2023. 2022 stood out with consistently high-water levels, likely due to favourable conditions like good rainfall and effective management. Monsoon months (October-January) typically had the highest water levels, with November and December showing significant peaks. The data highlights year-to-year variations, influenced by rainfall and water management.

CONCLUSIONS

The AWEI index, applied using Sentinel data via Google Earth Engine, proved highly effective for precise water area estimation. It offers an accurate, scalable solution for large-scale monitoring of water resources, highlighting the value of remote sensing in environmental practices.

ACKNOWLEDGEMENT

We extend our heartfelt thanks to ICAR-CIFRI (Indian Council of Agricultural Research - Central Inland Fisheries Research Institute) for support and guidance.

REFERENCES

Feyisa G.L., Meilby H., Fensholt R., Proud S.R. (2014). Automated water extraction index: A new technique for surface water mapping using Landsat imagery. *Remote Sens. Environ*. 140:23–35.

Zhuo, Y., et al. (2025). Spatiotemporal changes and influencing mechanisms of the coastline in the Yellow River Delta, China. *Frontiers in Marine Science*, 11.

Scheibel, C. H., et al. (2024). Characterization of water bodies through hydro-physical indices and anthropogenic effects in the Eastern Northeast of Brazil. *Climate*, 12(9), 150.

Oral V9T2D2

Assessing the ecosystem services of coastal wetlands of West Bengal based on climate change: A case study

BANDANA DAS GHOSH and BASANTA KUMAR DAS*
ICAR-Central Inland Fisheries Research Institute, Barrackpore-700120, India
E-mail: basantakumard@gmail.com

Key Words*: Coastal wetlands, Climate change, Ecological services, Stakeholders, Ecology*

INTRODUCTION

India coastal wetlands (CW) are among the most important ecosystems in the country, playing vital roles in biodiversity conservation, flood control, carbon sequestration, and sustaining the livelihoods of millions of people. These wetlands, ranging from mangroves to salt marshes, tidal flats, and mudflats, are found along the expansive 7,516 km coastline of India, which is bounded by the Arabian Sea, the Bay of Bengal, and the Indian Ocean. According to the National Wetland Atlas of India, released by the Indian Space Research Organization (ISRO), coastal wetlands cover approximately 2.4% of India's total land area (around 2.5 million hectares) and are home to a rich diversity of species, including several that are endemic or globally threatened. In the last two decades, the rise in global surface temperature was +0.99 °C, while in the last decade, it has risen to +1.09 °C (IPCC 2021). The loss of coastal wetlands could thus exacerbate climate change by releasing stored carbon back into the atmosphere. However, these wetlands are extremely vulnerable to the impacts of climate change, particularly rising sea levels, increased frequency of storms. The objective of the study

is to comparison assessment of the ecosystem services of the wetlands based on climatic parameters and provide insights that may inform future wetland management and wise use challenges.

MATERIAL AND METHODS

A total 10 coastal wetlands were selected from South 24 Pargana district of West Bengal. Time series climatic data (from 1985-2024) were collected from Indian Meteorological Department (IMD), Alipore, West Bengal. The stakeholder-based perception were asked about perceptions of local wetland ecosystem services. The Rapid Assessment Wetland Ecological Services (RAWES) technique has been used for developing the ecosystem service Index (ESI) following Fennessy et al. (2007) and Kotze et al. (2012) with modification.

$$ESI=\sum(n+2+n+1)+(n-2+-1)/\sum n_{total}$$

RESULT AND DISCUSSION

A total of 21 ecosystem services were identified in the coastal wetland and were summed up and divided by the number of services in the category (provisioning = 9, regulating = 5, cultural = 2, supporting = 5) as shown in table 1

Table 1: Types of ecosystem services provided by the different coastal wetlands

Ecosystem services category	Types of Services
Provisioning	Ecosystem to support a diversity of human needs, such as food, fiber and natural medicine, agriculture, grazing, energy sources, water supply
Regulating	Ecosystem maintaining balance such as pollination, water purification and climate moderation, salinity variation
Cultural	Tourism, recreation, spiritual interests, biological diversity, livelihood security, nutrient cycling
Supporting	Soil formation, photosynthesis of oxygen and habitat for wildlife

It has been found that the total values for provisional ecosystem services are much higher (16.6 %) followed by Supporting (13.2%), Regulating (11.2 %), and Cultural (3.2 %) ecosystem services. Based on Ecosystem service indices (ESI) Bakkhali (3.10%), Ramnanagar (3.0%), (2.90%) and less ESI in Chotto Mollakhali and Aamtoli (2.30%).

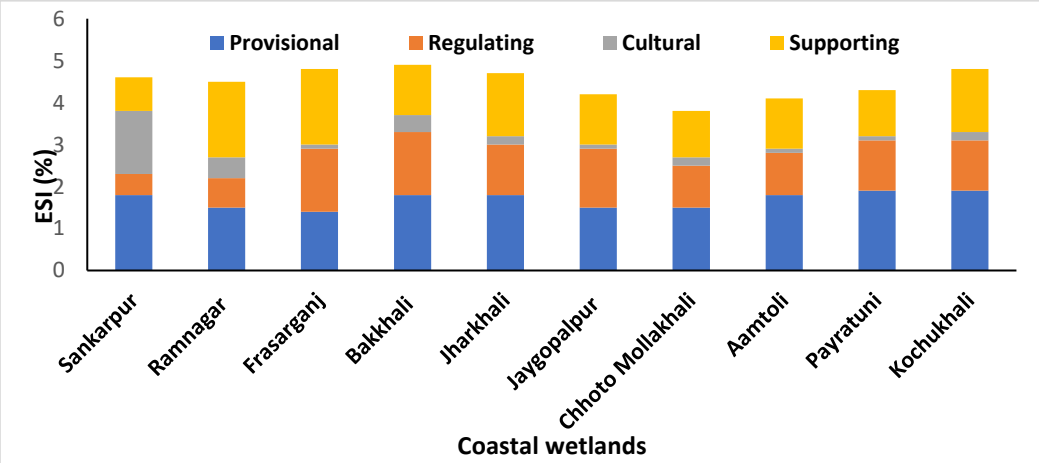

Fig.1 Ecosystem services of the coastal wetlands

The climatic parameters analysis over three decades showed a decreasing trend of annual rainfall but in last 5 years it shows deficit rainfall (between -19 and -60%of LPA). The atmospheric temperature showed increasing trend of (0.24°C) in South 24 Pargana. Climate variability is thought to have a significant negative impact on CWs (Mehvar et al. 2019). The climate of coastal region of West Bengal has a hot and humid. A total 32 fish species were recorded from the studied wetlands. Among the documented species, 73.12% belong to least concern, 9.41% to evaluated and 7.63% to the near threatened category. Earlier studies reported that 61-139 fish species recorded in and round the studied region (Sen 1975, Khan 2003, Naskar 2004, Debnath et al. 2024).

CONCLUSION

The coastal wetlands are vital ecosystems, providing a range of ecological, social, and economic benefits. However, their vulnerability to climate change poses significant challenges. Adaptation strategies, such as mangrove restoration, integrated coastal management, and community-based initiatives, can help reduce the impacts of climate change on these vital ecosystems. By prioritizing these measures and ensuring that both government and local communities are involved, India can strengthen the resilience of its coastal wetlands and safeguard their vital functions for future generations.

ACKNOWLEDGEMENT

The authors are highly acknowledging the support rendered by National Mission for Clean Ganga, Ministry of Jal Shakti, Government of India.

REFERENCES

Debnath, S., Sarkar, U.K., Kumari, S., Karnatak, G., Puthiyottil, M., Das, B.K., Das, A., Ghosh, B.D. and Roy, A. (2024). Exploring the vulnerability of the coastal wetlands of India to the changing climate and their adaptation strategies. *International Journal of Biometeorology* 68(4), pp.749-760.

IPCC (2021) Climate change 2021: the physical science basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press

Mehvar, S., Filatova, T., Sarker, M.H., Dastgheib, A., Ranasinghe, R. (2019). Climate change-driven losses in ecosystem services of coastal wetlands: a case study in the west coast of Bangladesh. *Ocean and Coastal Management* 169:273-283.

Oral V10T2D2

Prevalence and distribution of environmental bisphenol A: An ecological risk assessment of pollution in fish, water, and sediment from the coastal zone of the river Ganga, India.

S. KUNDU, S. DAS GUPTA, A. RAY and B. K. DAS*

NMCG Laboratory, ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata 700 120, West Bengal, India.

E-mail: basantakumard@gmail.com

Key Words: *BPA Toxicity, Fish, Water, Sediment, Risk Assessment*

INTRODUCTION

Bisphenol A (BPA), a ubiquitous environmental contaminant, has raised significant concerns due to its endocrine-disrupting properties and widespread presence in aquatic ecosystems. This study investigates the prevalence and distribution of eBPA in the coastal zone of the River Ganga, India, focusing on its ecological impact on fish, water, and sediment. As one of the most sacred and heavily polluted rivers in the world, the Ganga serves as a critical case study for understanding the ecological risks posed by eBPA in freshwater and coastal environments. The research aims to quantify BPA concentrations across these matrices, assess its spatial distribution, and evaluate potential risks to aquatic organisms and ecosystems. By integrating ecological risk assessment methodologies, this study provides insights into the sources, pathways, and ecological consequences of eBPA pollution, contributing to the development of mitigation strategies and policies to safeguard the River Ganga's biodiversity and water quality.

MATERIALS AND METHODS

This study randomly sampled pelagic, benthopelagic, and demersal fish of various ages, sizes, and sexes during commercial fishing for human consumption from Godakhali, Diamond Harbour, and Fraserganj. Pre-, monsoon, and post-monsoon river water and sediment samples were collected from all locations. BPA was isolated from water samples using solid-phase extraction, sand samples were dried and weighed, and fish tissue samples were extracted using our previous method (Kundu et al., 2024). BPA was detected using a sandwich-ELISA kit from My Biosource Inc. (San Diego, CA) (MBS2602664). The EDI and THQ are calculated using Barboza et al.'s (2020) approach. Statistical analysis was done using SPSS, and values are shown as mean ± SEM.

RESULTS AND DISCUSSION

The results reveal significant variability in eBPA concentrations across different species, reflecting their ecological niches and potential exposure to eBPA contamination. Among the Bentho-Pelagic species, *Macrognathus pancalus* exhibited the highest eBPA concentration at 87.90 ng/g-dw, followed by *Channa marulius* (64.93 ng/g-dw) and *Cirrhinus reba* (26.43 ng/g-dw). In contrast, species like *Channa gachua* and *Salmophasia bacaila* showed notably lower eBPA levels, at 0.60 ng/g-dw and 0.69 ng/g-dw, respectively. This suggests that BPA accumulation can vary significantly, possibly due to differences in feeding habits or habitat preferences even within the same trophic level. In the Demersal category, *Polynemus paradiseus* had the highest eBPA concentration (119.26 ng/g-dw), while *Apocryptes bato* had the lowest (4.78 ng/g-dw). The Pelagic species displayed even higher eBPA levels, with *Setipinna phasa* recording the highest concentration at 205.82 ng/g-dw, followed by *Rhinomugil corsula* (109.92 ng/g-dw) and *Gonialosa manmina* (104.51 ng/g-dw). The Pelagic-neritic species

Tenualosa ilisha also showed elevated eBPA levels at 88.01 ng/g-dw. The results indicate that Pelagic and Pelagic-neritic species tend to accumulate higher levels of eBPA compared to Bentho-Pelagic and Demersal species, likely due to their exposure to contaminated surface waters. The high variability in eBPA concentrations, as evidenced by the standard deviations (e.g., 51.09 for *Polynemus paradiseus* and 74.73 for *Tenualosa ilisha*), underscores the heterogeneous distribution of eBPA in the aquatic environment. These findings highlight the ecological risk posed by eBPA pollution in the River Ganga, particularly for species occupying higher trophic levels, and emphasize the need for targeted mitigation efforts to reduce eBPA contamination in this critical ecosystem.

The data in Table 1 shows seasonal variations in eBPA concentrations in surface water and sediment across three locations: Godakhali, Diamond Harbour, and Fraserganj- along the River Ganga. eBPA levels in surface water were highest during the post-monsoon season at all sites, with Diamond Harbour recording the peak concentration (664.32 ng/L). Sediment BPA concentrations also peaked post-monsoon, with Fraserganj showing the highest level (2494.5 µg/kg). Monsoon and pre-monsoon periods exhibited lower but significant BPA levels, indicating persistent pollution. These findings highlight seasonal and spatial variability in BPA contamination, emphasizing the need for targeted monitoring and mitigation efforts to address pollution in the River Ganga ecosystem. The results demonstrate significant variability in eBPA concentrations across fish species and seasons, reflecting differences in ecological niches, feeding habits, and exposure to contaminated environments. Pelagic and Pelagic-neritic species exhibited higher eBPA accumulation, likely due to prolonged contact with polluted surface waters. Seasonal peaks in eBPA levels, particularly post-monsoon, suggest increased contamination from runoff and anthropogenic sources. The heterogeneous distribution of eBPA in water and sediment underscores the ecological risks to aquatic organisms, especially higher trophic levels. These findings emphasize the urgent need for targeted mitigation strategies to reduce eBPA pollution and protect the River Ganga ecosystem

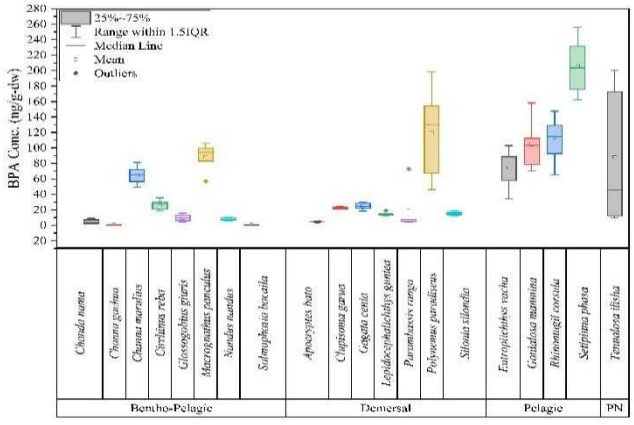

***Fig. 1**. eBPA concentration in fishes from different trophic levels*

	Pre-monsoon		Monsoon		Post-Monsoon	
	Surface Water (ng/L)	Sediment (µg/ KG)	Surface Water (ng/L)	Sediment (µg/ KG)	Surface Water (ng/L)	Sediment (µg/ KG)
Godakhali	259.3	2473.75	244.27	2273.75	293.68	2779.75
Diamond Harbour	568.4	2945.25	443.9	2612.25	664.32	3865.75
Fraserganj	380.2	2134.75	275.11	2012.75	429.59	2494.5

***Table 1**. eBPA concentration in surface water and sediment*

CONCLUSIONS

The study highlights significant eBPA contamination in the River Ganga, with higher accumulation in Pelagic species and post-monsoon peaks, underscoring the need for urgent mitigation to protect aquatic ecosystems and biodiversity.

ACKNOWLEDGEMENT

The authors are thankful to the National Mission for Clean Ganga (NMCG), Ministry of Jal Shakti, Government of India, for providing the necessary funding to carry out the study.

REFERENCES

Barboza, L. G. A., Cunha, S. C., Monteiro, C., Fernandes, J. O., & Guilhermino, L. (2020). Bisphenol A and its analogs in muscle and liver of fish from the North East Atlantic Ocean in relation to microplastic contamination. Exposure and risk to human consumers. *Journal of hazardous materials*, 393, 122419.

Kundu, S., Biswas, A., Ray, A., Roy, S., Gupta, S. D., Ramteke, M. H., ... & Das, B. K. (2024). Bisphenol A contamination in Hilsa shad and assessment of potential health hazard: A pioneering investigation in the national river Ganga, India. *Journal of hazardous materials*, 461, 132532.

Oral V11T2D2

Decoding the spatio-temporal dynamics of fish guilds and the influence of environmental parameters on ichthyofaunal assemblage in the Ichamati river, West Bengal, India

P. MAJUMDER, S. NANDY, A. KUNUI, A. WODEYAR K, S. JANA, A. RAY, B. K. DAS*

ICAR - Central Inland Fisheries Research Institute, Barrackpore, West Bengal, India, 700120

E-mail: basantakumard@gmail.com

Key Words: *Estuarine Fishes, Functional Groups, Fish Diversity*

INTRODUCTION

The Ichamati River connects the Sundarban in the south with the rivers in the north viz. Jalangi, Mathabhanga, Churni, etc. is the only significant river on the eastern bank of the Hooghly-Bhagirathi River (Mondal & Bandyopadhyay, 2014). The Ichamati River originates from Majdia (Krishnaganj Block) in Nadia district, India, and touches the Bangladesh border (for a brief distance), reaches the North 24 Parganas district at Bagdah block. The Ichamati River then flows through the eastern region of the 24 Parganas (north and south) districts before emptying into the Raimangal River, which flows towards the Bay of Bengal (Mondal et al., 2016). It is an important transboundary waterbody, supports diverse fish species and serves as a critical habitat for both migratory and resident fish populations. The study seeks to analyze fish assemblages across different seasons, classify them into functional groups, and assess their response to environmental factors. Understanding fish diversity, functional guild composition, and ecological interactions is crucial for sustainable fisheries management and conservation.

MATERIALS AND METHODS

The research was conducted over a period of one year from January 2024 to December 2024, covering pre-monsoon (PRM), monsoon (MON), and post-monsoon (POM) seasons. Fish samples were collected using standardized fishing gear, and species identification was performed using taxonomic keys. A total of 50 finfish and 5 shellfish species were recorded and categorized into different guilds based on their habitat use, feeding habits, and reproductive strategies. Each species was categorised into functional guilds (estuarine use guild and feeding guild) following the methodology outlined by (Elliott et al., 2007). The estuarine use guilds included estuarine residents (ER), marine stragglers (MS), marine migrants (MM), freshwater migrants (FM), freshwater stragglers (FS), anadromous (AN), and catadromous (CA). The feeding guilds encompassed detritivores (DV), herbivores (HV), zooplanktivores (ZP), omnivores (OV), zoobenthivores (ZB) and piscivores (PV). The study utilized statistical tools such as Similarity Percentage Analysis (SIMPER) to determine key contributors to seasonal similarity and BIO-ENV analysis to identify environmental variables influencing fish assemblage structure using PRIMER v6 software. Trophic categories were determined by predominant diet along with stomach contents for all relevant species. In cases where limited data was available, trophic and habitat preferences were inferred from information provided in FishBase (Froese and Pauly 2023). For each guild, the contribution to species richness and abundance (i.e., the number of individuals) were estimated across sample sites and seasons. Water quality parameters viz. Dissolved oxygen, Salinity, Turbidity, Water temperature, Total Suspended Solids (TSS), Total Nitrogen (TN), Available nitrogen (AN), Available phosphorous (AP) and Total Phosphorus (TP), were measured to understand their correlation with species composition.

RESULTS AND DISCUSSION

The study recorded a total of 55 fish species, over the period across seasons. The highest species richness was observed in the post-monsoon season, while the lowest was recorded during the monsoon period. The seasonal variation in species composition can be attributed to hydrological changes, salinity fluctuations, and breeding migrations. Fish species were classified into eight estuarine use guilds, five feeding guilds, six habitat guilds, and three reproductive guilds. Among estuarine use guilds,

amphidromous species (AM) dominated, followed by estuarine stragglers (ES) and catadromous species (CA) (Fig. 1). The prevalence of amphidromous species suggests a strong migratory influence on fish assemblages. True marine stragglers were found in low abundance, indicating limited marine influence. Feeding guild analysis revealed that zoobenthivores (ZB) were the most dominant group, followed by piscivores (PV) and zooplanktivores (ZP) (Fig. 2). This distribution suggests a well-structured trophic hierarchy, with primary and secondary consumers playing significant roles in maintaining ecological balance. Habitat guild classification showed a diverse range of ecological adaptations, with benthic and pelagic species coexisting in the Ichamati River.

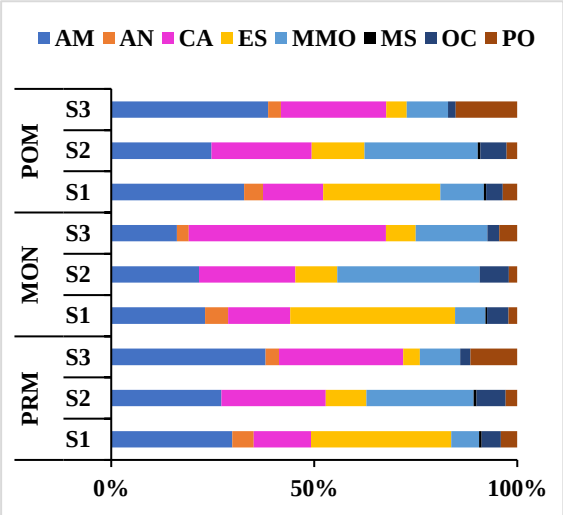

Fig. 1 *Estuarine use guild analysis of*

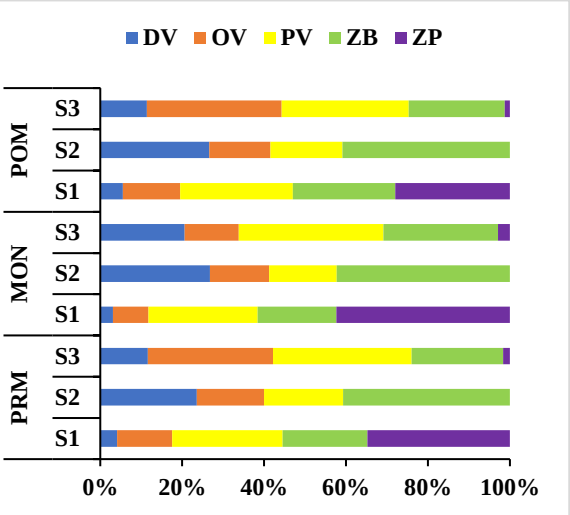

Fig. 2 *Feeding guild analysis of species*

SIMPER analysis identified *Exopalaemon styliferus* (15%), *Parapenaeopsis sculptilis* (13%), and *Trichiurus lepturus* (8.99%) as major contributors to seasonal similarity. These species exhibited a stable presence across different seasons, highlighting their ecological significance in the riverine system. Additionally, species such as *Lepturacanthus savala* showed notable seasonal variation, indicating possible migratory behavior.

BIO-ENV analysis revealed a significant correlation (r = 0.69) between species composition and environmental variables. Among the measured parameters, TSS, TN, and TP (r = 0.51) were found to be key influencers of fish assemblage structure. Elevated levels of nutrients and suspended solids can impact water quality and fish distribution, necessitating regular monitoring and management interventions.

CONCLUSION

This study provides valuable insights into the spatio-temporal dynamics of fish guilds in the Ichamati River and the influence of environmental factors on ichthyofaunal assemblages. The observed patterns in species composition, functional guild distribution, and environmental interactions highlight the complexity of riverine ecosystems. By integrating ecological research with conservation planning, policymakers and resource managers can develop effective strategies for maintaining the biodiversity and productivity of the Ichamati River. Future studies should focus on long-term monitoring and assessing the impact of climate change on fish populations to ensure sustainable fisheries management in the region.

ACKNOWLEDGEMENT

The authors are thankful to the National Mission for Clean Ganga (NMCG), Ministry of Jal Shakti, Government of India, for providing the necessary funding to carry out the study.

REFERENCES

Elliott, M., Whitfield, A. K., Potter, I. C., Blaber, S. J., Cyrus, D. P., Nordlie, F. G., & Harrison, T. D. (2007). The guild approach to categorizing estuarine fish assemblages: a global review. *Fish and fisheries*, 8(3), 241-268.

Froese R, Pauly D (2023) FishBase. https://www.fshbase.se/search. Accessed 12 Jan 2025.

Mondal, I., & Bandyopadhyay, J. (2014). Coastal zone mapping through geospatial technology for resource management of Indian Sundarban, West Bengal, India. *International journal of remote sensing applications*, *4*(2), 103-112.

Mondal, I., Bandyopadhyay, J., & Paul, A. K. (2016). Water quality modeling for seasonal fluctuation of Ichamati river, West Bengal, India. *Modeling Earth Systems and Environment*, 2, 1-12.

Oral V12T2D2

Spatial and temporal dynamics of fish guilds and the influence of environmental factors on species composition in the tropical Matla estuary

A. WODEYAR K, A. RAY, P. MAJUMDER, D. SINGH, P. MALAKAR, A. MONDAL, L. PAUL, D. BHAKTA, B. K. DAS

ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata-700 120, West Bengal, India.

E-mail: abhilashwodeyar@gmail.com

Key Words: *Estuarine Fishes, Functional Groups, Fish diversity, GAM model*

INTRODUCTION

Estuaries are among the most dynamic and ecologically significant ecosystems, yet they remain highly vulnerable to environmental changes and anthropogenic pressures. Tropical estuaries, influenced by monsoonal fluxes, support diverse biological communities but face challenges such as overexploitation, habitat degradation, pollution, and invasive species, impacting biodiversity and ecological stability (Human et al. 2016). These stressors can alter species composition, disrupt trophic interactions, and contribute to habitat loss and hypoxic conditions (Elliott and Whitfield 2011). The guild-based approach to studying fish assemblages provides valuable insights into ecological functions, habitat use, and community dynamics, supporting effective ecosystem-based management (Elliott et al. 2007). Despite the ecological significance of the Matla Estuary in the Indian Sundarbans, studies on fish assemblage structures remain limited. This study aims to assess spatial and seasonal variations in fish diversity and assemblage composition to better understand functional and ecological roles in response to environmental and anthropogenic influences.

MATERIALS AND METHODS

A quarterly sampling was conducted from January to December 2024 across four stations along an estuarine salinity gradient. Fish were sampled during daytime, encompassing high and low tides, using multiple gears to ensure species representation. Sub-sampling minimized bias by proportionally including rare and abundant species. Specimens were identified using taxonomic keys, measured for length (cm) and weight (g), and classified into ecological guilds (estuarine residents, marine migrants, freshwater species) and feeding guilds (herbivores, carnivores, omnivores, detritivores) following Elliott et al. (2007). Surface water parameters (temperature, salinity, dissolved oxygen, transparency) were measured in situ. Fish assemblages were analyzed spatially across three estuarine zones (upper, middle, lower) and temporally over three seasons: pre-monsoon (March–June), monsoon (July–October), and post-monsoon (November–February). Species richness, numeric catch, and biodiversity indices (Shannon-Weiner diversity, Margalef's richness, Pielou's evenness, Simpson's dominance) were calculated using PRIMER v6. Cluster analysis with the Bray-Curtis similarity index evaluated community relationships. Chi-squared tests assessed guild composition variations across sites, while trophic classifications were informed by regional dietary studies and FishBase. Guild proportions (species richness and abundance) were analyzed across sites and seasons, with visualizations created using ggplot2 in R.

RESULTS AND DISCUSSION

The study documented 64 finfish species in the Matla estuary, with *Escualosa thoracata* (18.62%) being the most abundant, followed by *Parastromateus niger* (6.58%) and *Harpadon nehereus* (5.94%). SIMPROF analysis revealed significant clustering patterns in species composition ($\Pi = 4.354$, $p < 0.001$). Bray-Curtis similarity indices indicated the highest similarity (72.05%) between stations M1 and M2 during the post-monsoon (PoM), while the lowest similarity (15.60%) was observed between M4 and M4 during the monsoon (MoN) and PoM. Non-metric multidimensional scaling (NMDS) analysis corroborated these findings, showing distinct seasonal and spatial groupings, albeit with moderate stress (0.1), suggesting environmental factors influenced the assemblage structure. Estuarine use guilds exhibited spatio-temporal variations. During the pre-monsoon (PrM), M4 was dominated by amphidromous (AM, 51.58%) and marine stragglers (MS, 45.80%), while M1 showed a notable presence of freshwater migrants (FM, 25%). In the monsoon, M4 was dominated by marine migrants (MMO, 52.19%) and oceanic species (OC, 41.76%), while PoM saw a dominance of potamodromous species (PO, 76.70%) at M4. Feeding guilds also varied spatially, with detritivores (DV) peaking at M4 (75.75%) and omnivores (OV) at M1 (29.47%) (Fig.1). BEST analysis revealed a strong correlation ($r = 0.87$) between species composition and environmental variables, highlighting the influence of abiotic factors on fish distribution. Key species contributing to this relationship included *Nuchequula blochii* and *Odontamblyopus rubicundus*. ANOSIM confirmed

significant spatial variation (Global R = 0.59, $p < 0.001$), emphasizing the estuary's dynamic biotic-abiotic interactions. The forward selection process identified the best-fitting Generalized Additive Model (GAM) for fish abundance as:

Fish abundance ~ s(SiO_4-Si) + s(SAL) + s(TUR) + s(TSS) -------(Table.1)

The final Generalized Additive Model (GAM) selected through forward selection for fish abundance includes silicate (SiO_4-Si), salinity (SAL), turbidity (TUR), and total suspended solids (TSS) as predictors. This model achieved an AIC of 515.37, indicating a good fit with minimal information loss. The model explains 65% of the variance ($R^2 = 0.65$) and captures 84% of the deviance, suggesting a strong explanatory power. These results align with the findings of previous studies (Rinchen et al. 2024, Sreekanth et al. 2019) suggesting that environmental factors exert strong influences on fish distribution and community structure in estuarine ecosystems

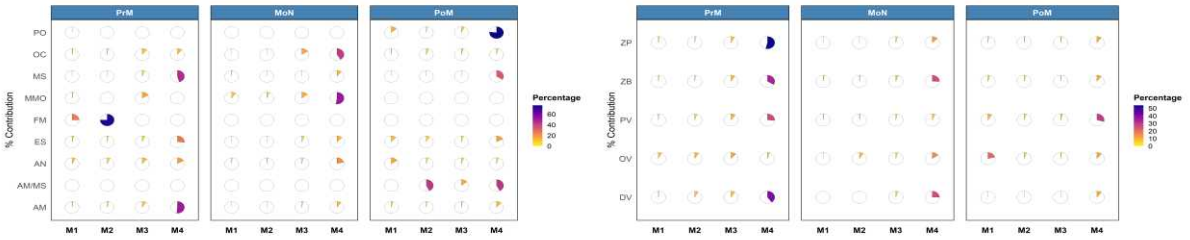

Fig.1. *A pie chart showing the use of estuarine fish guilds and feeding guilds across different seasons and stations*

Table 1. *Summary of GAM result*

Smooth Term	edf	Ref.df	F	p-value	Significance
s(SiO_4-Si)	8.21	8.796	4.472	$p<0.001$	**
s(SAL)	8.371	8.807	3.786	$p<0.001$	**
s(TUR)	1	1	5.631	$p<0.05$	*
s(TSS)	1	1	0.424	$p>0.05$	

CONCLUSIONS

The present study indicates the complex interplay between environmental variables and species distribution in the Matla estuary. The findings emphasize the need for continued monitoring of abiotic factors, as they play a crucial role in shaping the structure and dynamics of fish communities. The identified GAM provides a useful tool for predicting fish abundance and can aid in the management and conservation of estuarine ecosystems. Future studies should explore the potential effects of climate change and human activities on the estuary's biotic-abiotic interactions to ensure sustainable management of its resources.

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The researchers express their gratitude to the National Mission for Clean Ganga, under the Ministry of Jal Shakti, Government of India, for their financial support during the study period.

REFERENCES

Human, L.R.D., Snow, G.C., Adams, J.B. (2016). Responses in a temporarily open/closed estuary to natural and artificial mouth breaching. *South African Journal of Botany* 107: 39–48.

Elliott, M., Whitfield, A.K. (2011). Challenging paradigms in estuarine ecology and management. *Estuarine, Coastal and Shelf Science* 94: 306–314.

Elliott, M., Whitfield, A.K., Potter, I.C., et al. (2007). The guild approach to categorizing estuarine fish assemblages: a global review. *Fish and Fisheries* 8: 241–268.

Sreekanth, G.B., Jaiswar, A.K., Zacharia, P.U., Pazhayamadom, D.G., Chakraborty, S.K. (2019). Effect of environment on spatio-temporal structuring of fish assemblages in a monsoon-influenced tropical estuary. *Environmental Monitoring and Assessment* 191: 1–27.

Bhutia, R.N., Devadas, D., Bella, K., Sreekanth, G.B., Landge, A.T., Jaiswar, A.K., Deshmukhe, G., Mandal, U.K., Burman, D. (2025). Fish assemblage structure and functional guild composition of Matla Estuary, Indian Sundarbans. *Aquatic Sciences* 87(1): 1–14.

Oral V13T2D2

Spatial and temporal variations of ichthyofaunal diversity in the lower estuarine waters of the River Ganga, West Bengal

A. RAY*, B. K. DAS, ABHILASH W. K., S. PAUL, S. JANA, D. SINGH, C. JOHNSON and S. ROY
ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata-120, West Bengal
E-mail: basantakumard@gmail.com

***Key Words**: Estuary, River Ganga, Hooghly, Spatial Variation*

INTRODUCTION

The River Ganga possesses an important attachment to the cultural, heritage and economic values of India. The river traverses a long course of 2525 km from Gangotri to Gangasagar and is designated to be the longest river in the country. Estuarine fishes in particular, often act as a bioindicator susceptible to major alterations of the habitat. The first comprehensive report on Gangetic fish fauna was documented by Hamilton (1822) describing a total of 260 fish species. Subsequently, Francis Day (1888) enlisted 1340 fishes under 342 genera from India. Comprehensive studies were also advocated by Hora, 1929 to reshape the works of Hamilton 1822. However, no recent assessment has been reported from the large river on the Spatial and temporal variations of ichthyofaunal diversity of the estuarine zone of Ganga. The present paper provides information on the fish faunal diversity, distribution, abundance and production patterns of major fish group in lower Gangetic estuary.

MATERIALS AND METHODS

The study area is concentrated upon these stations observing the variety of fish species found as well as the abundance of fish species present at each sampling station along the river course. The entire estuarine course is divided into three sites S1 (Godakhali), S2 (Diamond Harbour) and S3 (Fraserganj) of West Bengal. Quarterly field campaigns and explorations were performed for the collection of fish faunal data within a span of four years from September 2017 to December 2022. The various selective and non-selective gear were utilized for the collection of the fishes from varied water depths. The identification of the fish specimen from various sites of River Ganga was conducted based on morphometric and meristic taxonomical measures (Talwar & Jhingran, 1991). Triplicate water samples was collected quarterly for various physico chemical analysis particularly water temperature (WT °C), Depth (DEP m), dissolved oxygen (DO mg/l), pH, Salinity (SAL ppt), total dissolved solids (TDS mg/l) and total hardness (TH mg/l) following APHA, 2017. Statistical software package R, was used for evaluating one way annova and Canoical Corresponding Analaysis (CCA) between season, water quality and fish family.

RESULTS AND DISCUSSION

A total of 70 taxa of finfishes were identified across the three sites, with Fraserganj showing the highest species richness (n = 66), followed by Diamond Harbour (n = 37) and Godakhali (n = 32). The study revealed that 45% of the species were euryhaline, 8% were freshwater, and 47% were brackish water species. The one-way ANOVA result of water quality parameters at three different sites (Godakhali, Diamond Harbour, and Fraserganj) exhibited that river depth ($p = 0.003$), conductivity ($p = 1.07E-13$), Total hardness ($p = 8.35E-12$), salinity ($p = 6.23E-28$), and Total dissolved solids ($p = 1.45E-07$) were significantly different ($p< 0.05$). The CCA plot illustrated that piscine families like Engraulidae are strongly associated with higher pH and DO, while Synodontidae and Pristigastridae are linked to areas with higher salinity (SAL), total dissolved solids (TDS), and total hardness (TH), as reflected by their proximity to these gradients. Fraserganj (S3) aligns with these parameters, suggesting it represents a harder and more saline water environment (Fig 1.). In contrast, Godakhali (S1) and Diamond Harbour (S2) are more neutral, with no strong associations to specific gradients. Site S3 (Fraserganj) is a high saline zone in close proximity of Bay of Bengal located nearly 10 kilometers away from the sea mouth. The site represented 66 different fish species mostly of marine habitat. The dominance of marine species in the estuarine zone signifies their exploration behaviour as a part of their life cycle (Das *et al*. 2023; Ferreira *et al*. 2019).

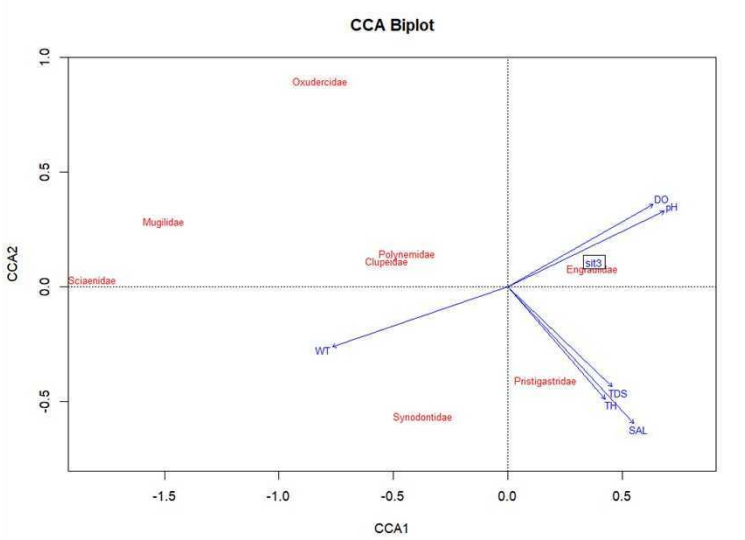

Fig 1*. CCA biplot between piscine family and environmental parameters*

CONCLUSION

Abundance, distribution and environmental parameters play an important role towards understanding a community structure of estuary. The result of this investigation favours the concept of positive correlation between environmental and fish species diversity. It is apparent from the above discussion that reduced flow, climate change along with the use of untimely raifall have impacted the estuarine fisheries of river Ganga. The study will help in formulating restoration programme of the important species with conservation significance of Gangetic estuary.

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REFERENCES

Das, B. K., Ray, A., Johnson, C., Verma, S. K., Alam, A., Baitha, R., Roy, S. & Sarkar, U. K. (2023). The present status of ichthyofaunal diversity of river Ganga India: Synthesis of present v/s past. *Acta Ecologica Sinica*, 43(2), 307-332.

Hamilton, F. (1822). An account of the fishes found in the river Ganges and its branches (Vol. 1). Archibald Constable.

Ferreira, V., Le Loc'h, F., Ménard, F., Frédou, T., & Frédou, F. (2019). Composition of the fish fauna in a tropical estuary: the ecological guild approach. *Scientia Marina*, 83(2), 133-142.

Talwar, P. K., & Jhingran, A. G. (1991). Inland fishes of India and adjacent countries (Vol. 2). CRC press.

Oral V14T2D2

Assessment of potentially toxic elements in the estuarine zone of the Ganga River: Insights from water and sediment contamination indices

S. JANA, A. BISWAS, S. ROY, B. K. DAS*

ICAR- Central Inland Fisheries Research Institute, Barrackpore, Kolkata-700120

E-mail: basantakumard@gmail.com

Key Words*: Ganga, Pollution Assessment, Potentially Toxic Elements*

INTRODUCTION

Worldwide, the contamination of river ecosystems with potentially toxic elements (PTEs) has emerged as a major environmental challenge due to their persistence, toxicity, bioaccumulation, biomagnification behavior and posing serious threats to both ecological equilibrium and human health (Kumar et al. 2024). Our present study focused on the estuarine zone of the Ganga River. The objectives of the study were to determine the concentration of PTEs in water and sediment and evaluating different contamination indices to understand the pollution status of the estuarine zone.

MATERIALS AND METHODS

Sampling was done at three different locations and seasons (pre-monsoon, monsoon and post-monsoon) along the estuarine zone of River Ganga during January, 2023 to December, 2024: Godakhali (GK - 22.399522 °N, 88.129569 °E); Diamond Harbour (DH - 22.187044 °N, 88.175369 °E) and Fraserganj (FG - 21.580322 °N, 88.3935 °E).

Surface water samples (250 ml) were taken in a pre-acid washed Tarson® HDPE bottle. A modified grab sampler was used to collect surface sediment samples from a depth of 10-20 cm, and mixed samples were obtained by integrating three to four subsamples from each site. Water samples (100 mL) were digested with HNO_3, diluted, and filtered, while dried sediment samples (1 g) were processed with a tri-acid mixture, digested, and filtered. Both were prepared using Milli-Q water. PTE concentrations in water and sediment were analysed using inductively coupled plasma mass spectrometry (ICP-MS).
The indexes used in this study for water samples were heavy metal pollution index (HPI), heavy metal evaluation index (HEI) and contamination index (CI). The sediment quality indices included in this study are the contamination factor (C_f^i), degree of contamination (C_d), enrichment factor (EF), geo-accumulation index (I_{geo}) pollution load index (PLI).

RESULTS AND DISCUSSION

Mean concentration of the PTEs in water and sediment samples are summarized in Table 1. Irrespective of seasons, the study revealed that the mean concentrations of PTEs in water (mg/L), followed the descending order of Cr (0.03) > As (0.016) > Pb (0.014) > Cd (0.0004), while in sediment (mg/Kg), the order was Cr (31.09) > Pb (6.43) > As (5.73) > Cd (0.26). Both the matrices revealed that accumulation of PTEs highest in pre-monsoon followed by post-monsoon and monsoon. Concentrations of metal in water fluctuate with seasonal changes due to factors like temperature, rainfall, and runoff. The lesser concentration of PTEs during M season can be attributed to the dilution of metal concentration in river water due to rainfall and influx of surface water from the catchment (Saddik et al. 2019). The mean level of PTEs were below the permissible level prescribed United States Environmental Protection Agency (USEPA) for drinking water (USEPA, 2024). In sediments, PTEs levels remained below the thresholds specified by the Canadian Interim Sediment Quality Guidelines (ISQGs). Contamination index of water revealed that all the area are categorized as low contamination level. Degree of contamination in sediment was less than 2 indicating low contamination, EF value lied between 0.2 to 2.5 revealing no to moderately enriched, pollution load index was less than 1 in each site during all the seasons indicating baseline pollution level. Geo accumulation index also revealed that the sediment is unpolluted except in Diamond Harbour (0.04) in pre-monsoon period. Based on the indices and ISQGs, the study disclosed that sediment was unpolluted, and no adverse effect on the bottom-dwelling organisms is anticipated due to the present level of contaminations due to PTEs.

Table 1. *PTEs concentration in water and sediment samples during different seasons*

	PTEs		Godakhali	D. Harbour	Fraserganj
Water (mg/L)	Cd	Pre-monsoon	0.0013 ± 0.0008	0.0006 ± 0.0005	ND
		Monsoon	0.1064 ± 0.0089	0.0637 ± 0.0057	0.0099 ± 0.0008
		Post-monsoon	0.0320 ± 0.0025	0.0255 ± 0.0019	0.0012 ± 0.0001
	Cr	Pre-monsoon	0.0661 ± 0.0053	0.0150 ± 0.0012	0.0064 ± 0.0005
		Monsoon	0.0005 ± 0.0004	0.0008 ± 0.0006	0.0001 ± 0.0001
		Post-monsoon	0.0079 ± 0.0007	0.0210 ± 0.0017	0.0069 ± 0.0005
	Pb	Pre-monsoon	0.0084 ± 0.0007	0.0192 ± 0.0015	0.0057 ± 0.0004
		Monsoon	0.0080 ± 0.0007	0.0112 ± 0.0010	0.0061 ± 0.0005
		Post-monsoon	ND	ND	ND
	As	Pre-monsoon	ND	ND	ND
		Monsoon	ND	ND	0.010579 ± 0.0009
		Post-monsoon	0.004673 ± 0.0004	0.007009 ± 0.0006	0.002337 ± 0.0002
Sediment (µg/g)	Cd	Pre-monsoon	0.444 ± 0.0375	0.465 ± 0.0393	0.106 ± 0.0092
		Monsoon	42.495 ± 3.5614	58.455 ± 4.8693	42.464 ± 3.5208
		Post-monsoon	6.876 ± 0.5343	10.155 ± 0.7956	9.740 ± 0.7632
	Cr	Pre-monsoon	5.548 ± 0.4278	8.961 ± 0.7221	7.180 ± 0.5784
		Monsoon	0.235 ± 0.0207	0.260 ± 0.0229	0.126 ± 0.0111
		Post-monsoon	12.977 ± 1.0891	25.326 ± 2.1125	20.698 ± 1.7273
	Pb	Pre-monsoon	2.387 ± 0.1992	5.503 ± 0.4591	6.394 ± 0.5315
		Monsoon	3.234 ± 0.2701	7.045 ± 0.5873	4.759 ± 0.3986
		Post-monsoon	0.373 ± 0.0329	0.217 ± 0.0191	0.117 ± 0.0103
	As	Pre-monsoon	15.960 ± 1.3325	23.874 ± 1.9954	37.640 ± 3.1417
		Monsoon	4.178 ± 0.3489	4.947 ± 0.4129	7.690 ± 0.6415

Post-monsoon	4.840 ± 0.4025	4.732 ± 0.3931	5.269 ± 0.4385

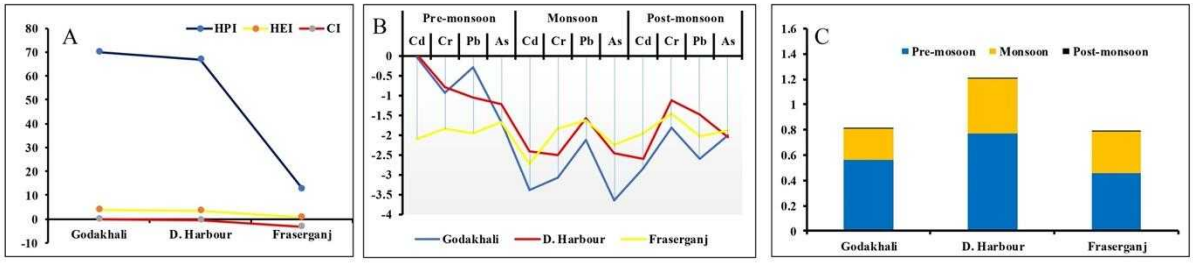

Fig. 1. *Heavy metal pollution index (HPI), Heavy metal evaluation index (HEI) and contamination index (CI) in water samples (A), Geo accumulation index (Igeo) (B) and Pollution load index (PLI) (C) in sediment samples of estuarine zone of River Ganga*

CONCLUSIONS

Our study revealed that anthropogenic activities contribute to the enrichment of certain metals in Ganga sediments. However, concentrations remained below ISQGs, indicating minimal risk to aquatic organisms. Ecological risk assessments, including EF, Igeo, and PLI indices, suggested metals mainly originate from natural sources with some human influence. The findings underscore the need for continuous monitoring and management, particularly during high contamination periods, to safeguard water quality and ecosystem health. Future research should focus on identifying pollution sources and developing effective strategies to mitigate heavy metal contamination in the Ganga River system.

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REFERENCES

Kumar, V., Swain, H. S., Upadhyay, A., Ramteke, M. H., Sarkar, D. J., Roy, S., & Das, B. K. (2024). Bioaccumulation of potentially toxic elements in commercially important food fish species from lower Gangetic stretch: Food security and human health risk assessment. *Biological Trace Element Research*, 202(3), 1235-1248.

Marine, Canadian water quality guidelines for the protection of aquatic life. Canadian Council of Ministers of the Environment. Available at: https://ccme.ca/en/res/debris-marine-en-canadian-water-quality-guidelines-for-the-protection-of-aquatic-life.pdf (accessed 12 December 2024).

Saddik, M., Fadili, A., & Makan, A. (2019). Assessment of heavy metal contamination in surface sediments along the Mediterranean coast of Morocco. *Environmental monitoring and assessment*, 191, 1-19.

USEPA (U.S. Environmental Protection Agency), 2024. National Primary Drinking Water Regulations. https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations#two (accessed 21 November 2024).

Oral V15T2D2

Challenges and sustainability in coastal winter migratory bagnet fisheries of Indian Sundarbans

SHREYA BHATTACHARYA[1,2], PRATEEP KUMAR NAYAK[2], C. M. ROSHITH[1], BASANTA KUMAR DAS[1]*, BANDANA DAS GHOSH[1], ARCHISMAN RAY[1], PRANAB GOGOI[1]

[1]ICAR-Central Inland Fisheries Research Institute, Kolkata - 700120, West Bengal, India

[2] School of Environment, Enterprise and Development, Faculty of Environment, University of Waterloo, Waterloo, ON N2L 3G1, Canada

E-mail: basantakumard@gmail.com

Key Words: *Catch, Climate Change, Dry Fish, Fish Diversity Vulnerabilities*

INTRODUCTION

The Indian Sundarbans region along with the lower reaches of the Hooghly (Gangetic) estuary experiences distinct fishing activities during the winter months from November to January (Pillay, 1960). A decrease in deep-sea fishing leads to 15 to 30 times higher abundance of fish in estuarine areas compared to the average availability throughout the year (Paul et al., 1997). Fishermen deploy bagnets from late October to early February in the lower estuarine area, referred to as Winter Migratory Bagnet Fisheries (WBNF) (Bhakta et al., 2018). The higher percentage of finfish diversity may be primarily due to bycatch reduction in the Hooghly-Matlah Estuary bagnet fishery (Biswas and Talwar, 2018). This

study focuses on the issues and sustainability of bagnet fisheries in the Sundarbans, considering their ecological, economic, and cultural significance. It comprehensively examines the fisheries' status as well as the multidimensional vulnerabilities associated with winter bagnet fisheries and the corresponding coping and adaptive response strategies.

MATERIALS AND METHODS

Data were collected from 2019 to 2024 in Frasergunj, Bakkhali, Khalisthan and Lalganj of South 24 Parganas, Sundarbans, West Bengal, India. The bagnets are generally operated near estuarine mouths up to 30 nautical miles from shore at depths of 20 meters. The catch entirely depends on tidal flow and full moon. The study continues for 7-10 days monthly from November to February every year to find out the fisheries vulnerabilities, fishermen's socio-economic status, fish marketing, and dry fish industry. The information was collected through individual interviews and group discussions with 336 local fishers and traders using semi-structured questionnaires by visiting the fishing camps. The selection of respondent is based on their long-term experiences in the fisheries sector. Primary data includes various aspects of bagnet fisheries i.e. details of the fish species encountered in the fishermen's catch, fish yield (Kg/ha) and catch per unit effort (CPUE), fishing technology applied and secondary data includes river basic information and climatic variables (temperature and rainfall). The fishers' perception-based method was obtained for the primary data on threats and challenges. The drivers used to calculate the positive or negative relationship with WBNF vulnerabilities are: education, depth of water, catch species, CPUE, number of gears, number of motorized boats, shift in fish reproduction period, temperature, changes in rainfall pattern and adaptation strategies.

RESULTS AND DISCUSSION

Species diversity and catch composition:

The fish species diversity entirely depends upon the fishing intensity and prevalent hydro-meteorological conditions. In the present study, 65 species of finfish belonging to 25 families have been recorded during the study period. The hilsa shad (*Tenualosa ilisha*) is generally not targeted by the WBNF operations as their stocks concentrate in areas at a distance of 50-75 km from the estuarine mouth. The high-priced species i.e. *Tenualosa* sp., *Polynemus* sp., *Eleutheronema tetradactylum*, *Pampus* spp., *Harpodon neherious, Etroplus suratensis, Johnius gangeticus, Sardinella longiceps* etc. generally transfer freshly to the wholesale and retail market. The other catches are traditionally sun-dried and marketed. Anchovy, Ribbon fish, Sole fish and croaker are mainly used for fish drying. Small fishes including pufferfish, small prawns and cuttlefish are dried and used for fish meal preparation. Analysis of the winter bagnet landings from 2019 to 2024 revealed that approximately 87% of the catch by weight consisted of finfish. Prawns accounted for roughly 6.5% of the total landings (Figure 1). However, the data shows that in Bakkhali, crabs made up around 5.8% of total catches.

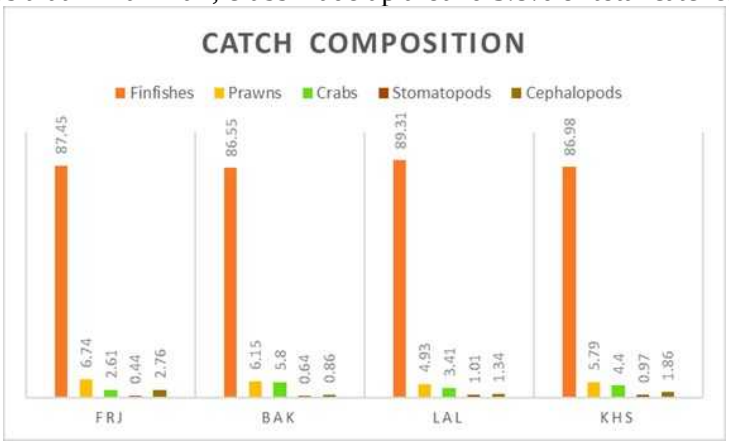

Fig. 1. *Percentage contributions of various catch components in bagnet landings (BAK-Bakkhali; FRJ-Fraserganj; LAL-Lalganj; KHS-Khalisthan)*

The key changes in WBNF over the last 25 years (1995-96 to 2019-20) are summarized in Table 1. There is a significant increase in the total catch from the WBNF that corresponds to an increase in fishing efforts since 1964-65, which reached a peak of 26809.3 tons in 1995-96 and an exceedingly high fishing effort of 680851 NT (net tides). However, this did not last long, and the catch was drastically reduced to 21970.1 tons during 2023-24. The CPUE steadily decreased with increased fishing efforts and reached its lowest recorded value of 26.53 Kg/NT during 2023-24. The total estimated estuarine winter migratory bag net landings fluctuated between 2080.6 to 35844.6 metric tons per season with an average CPUE of 93.72 to 53.12 kg during the period of 1994 - 2000 (Mitra et al., 2001).

Table 1*. The changing pattern of Bagnet fisheries of Sundarbans*

FISHERY CHARACTERISTICS	YEAR	
	1995-96	2023-24
CAMPS	24	62
FISHERMEN	449	5500
BAGNETS	213	950
FISHING BOATS	94	131
NON-MOTORIZED	54	-
MOTORIZED	40	131
TOTAL LANDINGS (TONNES)	26809.3	23706.1
FISHING EFFORT (NET TIDES)	584924	642469
CPUE (KG/NT)	27.88	26.53

Vulnerabilities:

The challenges for Bagnet fisheries in the Sundarbans area increasing day by day from both anthropogenic and environmental factors. Habitat degradation, extreme weather events, bottom trawling, bycatch issues, seasonal dependency, fluctuating fish prices, lack of cold storage, policy gap are the main challenges for the WBNF viability. All participants have relied on fishing since their early years and have observed a decrease in the depth of estuarine zone during the last 15 years. The average decrease in depth in Bakkhali was 4.52 meters. The respondent's perception of CPUE experienced a significant decline 15 years ago, dropping from 80-900 kg/boat/day to the current range of 24-200 kg/boat/day.

Sustainability:

To strengthen the winter bagnet fisheries and conserve the biodiversity of the Sundarbans ecosystem, following actions need to be implemented: Educating fishing communities, Restricted fishing crafts and gears, Restoration of mangrove forests, Early warning systems for natural disasters, Alternative livelihoods for fishing communities, Implementation of stronger policies and regulations, Providing climate change adaptation strategies etc.

CONCLUSIONS

The rapid depletion and degradation of natural resources and biodiversity threaten both the Sundarbans ecosystem and the livelihood of the rural fisherfolk community. The vulnerability assessment of WBNF highlights the need for mitigation measures to enhance fishermen's livelihood security. Protecting fish stocks, restoring habitats, addressing climate change impacts, and ensuring the livelihood security of local fishing communities are all interconnected objectives. A collaborative approach that engages multiple stakeholders and integrates traditional knowledge with modern conservation strategies is essential for securing a sustainable future for both Sundarbans' ecology and its people. To ensure the sustainability of this unique fishery system, a holistic and integrated approach is necessary.

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REFERENCES

Bhakta, D., Das, S.K., Talagunda Srinivasan, N., Behera, S., Chirwatkar, B.B., Das, A., Samanta, R. 2018. Winter migratory bag net fishery of Hooghly-Matlah estuary, west Bengal: An overview. National Seminar on “Advancement in Green Technology for Controlling and Managing Current Environmental Pollution”. https://doi.org/10.13140/RG.2.2.35402.88006.

Biswas, O. and Talwar, N.A. (2018). Observations on Catch Composition of Conventional Estuarine Set Bag Nets (CESBN) Operated in Hoogly - Matlah Estuary, West Bengal. *Int. J. Curr. Microbiol. App. Sci.* **7**(4): 2681-2691. doi: https://doi.org/10.20546/ijcmas.2018.704.306

Mitra, P.M., Karmakar, H.C., Ghosh, A.K., Mandal, N.C., Sen, H.K., Das, B.N. (2001). Fisheries of Hooghly Matlah Estuarine System – Further Appraisal (1994-95 to 1999-2000). Bull. Cent. Inl. Fish. Res. Inst. 109, 1-18.

Paul, S., Mitra, P.M., De, D.K., Sen, H.K., Mandal N.E. and Singh, P. (1997). Winter Migratory Bagnet Fishery of the Hooghly Estuary- An Economic Evaluation. ICAR-CIFRI, Bull. No. 76 N.

Pillay, T.V.R. (1960). The collection of estuarine capture fisheries statistics. *Sci. & Cult*., 26(3): 6-10.

Oral V16T2D2

Age-Specific variations in proximate composition, amino acids, and antioxidants of an anadromous Hilsa, *Tenualosa ilisha* (Ham, 1822) in coastal waters

H. CHAKRABORTY[1,2], B. K. DAS[1*], S. K. NANDY[1], A. KUNUI[1], A. K. TALUKDAR[1], A. K. SAHOO[1], J. MAITY[2]

[1]ICAR- Central Inland Fisheries Research Institute, Barrackpore, Kolkata, West Bengal – 700120

[2] Department of Fisheries Sciences, Vidyasagar University, Midnapore, West Bengal – 721102

E-mail: basantakumard@gmail.com

Key Words: *Hilsa, Proximate Composition, Amino Acids, Antioxidants*

INTRODUCTION

Hilsa (*Tenualosa ilisha)* is a nutritionally valuable fish, known for its high omega-3 fatty acids, protein, and micronutrients, supporting heart health, brain function, and overall well-being. In South Asia, its emphasizing the need for preserving its populations to ensure food security and public health. The biochemical composition of fish reflects its quality, condition, and environment, with factors like habitat, life stage, sex, and season influencing its nutritional value. Moisture, protein, carbohydrate, fat and ash determine the fish's proximate profile, with moisture content serving as an indicator of energy, protein, and fat levels. As fish grow, their lipid and ash content change, influenced by environmental factors. Fish protein is rich in amino acids and highly digestible. Antioxidants in fish help protect against oxidative stress and cellular damage caused by reactive oxygen species (ROS). While much research exists on Hilsa's proximate composition and amino acids, studies on its antioxidants are limited, prompting the current investigation into age- and sex-specific variations in Hilsa's composition and antioxidant activity.

MATERIALS AND METHODS

This study investigated the proximate composition, amino acid profile, and antioxidant capacity in different weight (50–400 g) and sex of Hilsa (N=30) collected from Gangasagar (21º25'13.13" N; 88º5'8.06" E). Desired length weight hilsa was collected and dissected to collect the muscle, stored at 4°C. Sex determination was conducted by examining morphometric traits, with males identified by milt release and females by egg extrusion upon abdominal pressure. Samples were analyzed for proximate composition following AOAC (2006) methods, with moisture determined by heating at 105°C, fat estimated using a Soxhlet apparatus, protein measured via the Kjeltec system, and ash content assessed by muffle furnace heating at 550°C for 6 hours. Amino acid profiling of Hilsa muscle was carried out followed by AOAC (2003) by using HPLC (1525, Waters). For antioxidant, 2, 2'-azinobis-[3-ethyl-benzothiazoline-6-sulfonic acid] (ABTS) and ferric reducing antioxidant potential (FRAP) to measure the scavenging activity were used.

RESULTS AND DISCUSSION

The study assessed the proximate composition, amino acid profile, and antioxidant activity of Hilsa (*Tenualosa ilisha*) across different weight groups in coastal region. Moisture content ranged from 55.59% to 71.03%, with crude lipid levels varying between 14.79% and 22.85%. Protein content ranged from 16.55% to 49.47%, ash content was between 0.98% and 1.89%, and carbohydrates ranged from 0.73% to 1.65%. Notably, the lower weight Hilsa group exhibited significantly higher protein content (>40%), while lipids exceeded 18% in the 200–300g weight group. Ash content was higher in females across all weight categories. Among 12 amino acids analyzed, Glutamic acid was the most abundant (0.536±0.27 g/100g protein), followed by Aspartic acid (0.331±0.14), Lysine (0.321±0.20), and Leucine (0.314±0.25). Male Hilsa (300–400 g) had higher amino acid concentrations than females, but no significant differences were observed in the lower weight groups. This finding supports Alam et al. (2012) that Hilsa is rich in amino acids. Antioxidant activity has gained increased attention recently due to its role in preventing various diseases and its anti-aging effects (Janaszewska et al., 2002). Antioxidant activity in Hilsa muscle exceeded 62%, with females demonstrating higher activity than males. A positive correlation between fish weight and antioxidant levels was observed in both sexes, with larger

Hilsa showing greater antioxidant capacity. These results align with Chen et al. (2019), which found similar trends in Nile tilapia, where larger fish exhibited higher antioxidant enzyme activity. This study highlights the nutritional richness of Hilsa, especially in coastal regions, and underscores the importance of sustainable management to preserve its health benefits and ecological significance.

CONCLUSION

Proximate composition analysis revealed that larger Hilsa fish are nutritionally superior, with higher antioxidant levels exceeding 50%, offering potential long-term health benefits. The amino acid profile is crucial for determining essential dietary requirements. This study highlights the nutritional richness of Hilsa, emphasizing its importance in human health, particularly in coastal regions. The findings call for further research to explore its health properties and underscore the need for conservation strategies to ensure sustainable utilization of this valuable species for both ecological and human health benefits.

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REFERENCE

Aebersold R, Mann M. (2003). Mass spectrometry-based proteomics. AOAC, Official Method of Analysis, Association of Official Analytical Chemists, Gaithersburg, Md, USA, 17th edition, Nature;422 (6928):198–207.

AOAC (2006). Official methods of analysis.18th edn. Association of Official Analytical Chemists, Gaithersburg, MD, USA

Alam, A. K. M. N., Mohanty, B. P., Hoq, M. E., & Thilsted, S. H. (2012). Nutritional values, consumption and utilization of Hilsa Tenualosa ilisha (Hamilton 1822). In Proceedings of the regional workshop on hilsa: potential for aquaculture (pp. 16-17).

Chen, X. Q., Zhao, W., Xie, S. W., Xie, J. J., Zhang, Z. H., Tian, L. X., ... & Niu, J. (2019). Effects of dietary hydrolyzed yeast (*Rhodotorula mucilaginosa*) on growth performance, immune response, antioxidant capacity and histomorphology of juvenile Nile tilapia (*Oreochromis niloticus*). *Fish & Shellfish Immunology*, 90, 30-39.

Janaszewska, A., & Bartosz, G. (2002). Assay of total antioxidant capacity: comparison of four methods as applied to human blood plasma. Scandinavian journal of clinical and laboratory investigation, 62(3), 231-236.

Oral V17T2D2

Toxic tide: The impact of environmental BPA on the iconic hilsa shad in the Ganga estuary

S. KUNDU, A. BISWAS, S. DAS GUPTA, S. DUTTA and B. K. DAS*

NMCG Laboratory, ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata 700 120, West Bengal, India.

E-mail: basantakumard@gmail.com

Key Words: *BPA Toxicity, Hilsa Shad, Environment, River Ganga, Health risk assessment*

INTRODUCTION

Hilsa (*Tenualosa ilisha*), designated as the "Queen of Fishes," is a species that embodies both gastronomic pleasure and cultural significance, representing the most profitable fishery in the Ganga-Hooghly delta estuary. Despite evidence indicating that environmental bisphenol A (eBPA) exposure is detrimental to aquatic species, no studies have investigated the impact of eBPA on the commercially significant Hilsa shad in the estuarine zone of the River Ganga. This study is the first investigation to quantify BPA contents in Hilsa shad and to establish a correlation with the physicochemical properties of water samples collected from the Ganga River. This study aimed to ascertain the average concentration of the plasticizer BPA in Hilsa shad collected from the lower stretches and estuarine areas of the Ganga River in India, as well as to assess the potential health risks linked to the consumption of BPA-contaminated Hilsa.

MATERIALS AND METHODS

This study involved the annual collection of Hilsa shad during commercial fishing for human consumption from the lower freshwater segment of the River Ganga, extending from Farakka to Fraserganj, and included male, female, and juvenile specimens. River water samples were obtained from all locations and preserved at 4°C for subsequent analysis. Water samples are generally processed using

solid-phase extraction for BPA extraction, while fish tissue samples were extracted for BPA following the methodology employed in our laboratory (Kundu *et al*., 2024). BPA was identified with a sandwich-ELISA kit (Cat. No. MBS2602664) obtained from My Biosource Inc. (San Diego, CA). The Estimated Daily Intake (EDI) and Target Hazard Quotient (THQ) are assessed utilizing the methodology outlined by Barboza *et al*. (2020). Statistical analysis was conducted using SPSS, and values are presented as the mean ± SEM (n=345).

RESULTS AND DISCUSSION

Figure 1A demonstrated that eBPA was present in all liver samples, with concentrations ranging from 219 to 288 ng/g-dw in males, 172 to 222 ng/g-dw in females, and 20.8 to 27.5 ng/g-dw in juveniles. The eBPA concentration in muscle was highest in May (male: 178 ng/g-dw; female: 196 ng/g-dw) and lowest in February (male: 98 ng/g-dw; female: 122 ng/g-dw). In juveniles, eBPA levels varied from 12.4 to 19.15 ng/g-dw during the sample period (Fig. 1B). The eBPA concentration in the kidneys was highest in male shad (111 ng/g-dw), followed by females (94 ng/g-dw) and juveniles (10.6 ng/g-dw). The minimum levels in males (65 ng/g-dw) were seen in February, in females (72 ng/g-dw) in March, and in juveniles (6.2 ng/g-dw) in April (Fig. 1C). eBPA levels in male gonads reached a maximum in May (41 ng/g-dw) and thereafter declined to a minimum (18 ng/g-dw, Fig. 1D). In females, it reached a high in May and declined in February (12 ng/g-dw, Fig. 1D). Barrackpore exhibited the highest eBPA concentration in males (149.57 ng/g-dw), but Farakka recorded the lowest (55.43 ng/g-dw); eBPA levels in females fluctuated between 121.63 and 47.84 ng/g-dw, while juvenile values ranged from 16.12 to 5.44 ng/g-dw. The male liver eBPA concentration considerably rose at Namkhana (272.09 ng/g-dw) and was lowest at Godakhali (229.11 ng/g-dw). Correspondingly, female liver samples (222-198 ng/g-dw) and juvenile liver samples (27.5-22.54 ng/g-dw) exhibited same results. Figure 1E clearly indicates that the eBPA concentration in the livers of fish captured in the estuary zone exceeds that of fish captured in the lower river segment. The eBPA concentration was markedly elevated ($p<0.05$) in muscle samples from the estuary zone compared to those from the lower stretch of the Ganga River (Fig. 1F). eBPA levels varied from 156.67 to 198.34 ng/g-dw in males, 176 to 196 ng/g-dw in females, and 14.1 to 19.15 ng/g-dw in juvenile samples, respectively. Figures 1G and H illustrate the eBPA contamination levels derived from kidney and gonad samples of Hilsa shad from both locations. The current investigation demonstrated that eBPA concentrations in Hilsa shad tissues were ranked as follows: Liver > Muscle > Kidney > Gonad. Table 1 shows EDI and THQ values for eBPA. The study revealed significant eBPA contamination in Hilsa shad tissues, with the liver consistently showing the highest concentrations, followed by muscle, kidney, and gonads. Seasonal and spatial variations were evident, with males generally exhibiting higher eBPA levels than females and juveniles, and estuarine zones displaying significantly elevated concentrations compared to lower river stretches. The EDI values exceeded the acceptable exposure limits set by EFSA (2023), indicating potential health risks. THQ for eBPA was alarmingly high across all demographic groups, especially in children, suggesting substantial exposure risks. This highlights an urgent need for monitoring and mitigating eBPA contamination in aquatic ecosystems.

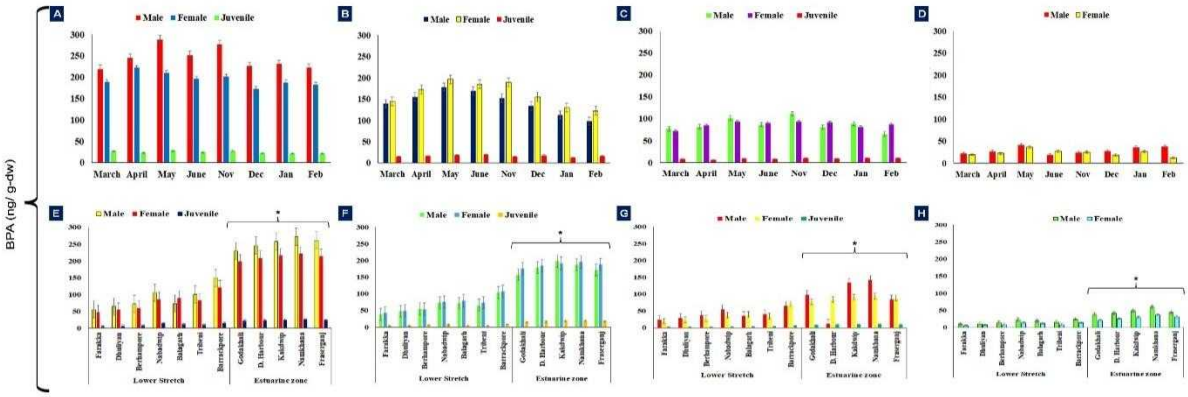

Fig. 1*. eBPA concentration over a year and stretches*.

Sampling Stations	Estimated Daily Intake of BPA (EDI) (ng/ g body weight/ day) *						Target hazard quotient (THQ)					
	Adult Men		Adult Women		Children (7-9 yrs)		Adult Men		Adult Women		Children (7-9 yrs)	
	Mean	95th Percentile	Mean	95th Percentile	Mean	95th Percentile	Mean	95th Percentile	Mean	95th Percentile	Mean	95th Percentile
GDK	50.125	19.744	6.136	21.539	131.773	47.198	2506.25	987.2	306.8	1076.95	6588.65	2359.9
DH	60.202	21.411	65.675	23.358	143.91	51.183	3010.1	1070.55	3283.75	1167.9	7195.5	2559.15
KWDP	64.91	22.821	70.811	24.895	155.164	54.552	3245.5	1141.05	3540.55	1244.75	7758.2	2727.6
NMKA	63.909	22.232	69.719	24.253	152.772	53.145	3195.45	1111.6	3485.95	1212.65	7638.6	2657.25
FG	59.977	21.01	65.43	22.92	143.373	50.223	2998.85	1050.5	3271.5	1146	7168.65	2511.15

* Unit recommended by EFSA (2023)

***Table 1**: EDI and THQ values (GDK-Godakhali, DH-Diamond Harbour, KWDP-Kakdwip, NMKA-Namkhana, FG-Frasergunj).*

CONCLUSIONS

The research also established an association between shad development and eBPA exposure, revealing elevated eBPA levels in adults. This study, for the first time, investigated into the effects of eBPA on aquatic ecosystems and fisheries, revealing that estuarine shad is contaminated with eBPA, which presents health risks to humans.

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REFERENCES

Barboza, L. G. A., Cunha, S. C., Monteiro, C., Fernandes, J. O., & Guilhermino, L. (2020). Bisphenol A and its analogs in muscle and liver of fish from the North East Atlantic Ocean in relation to microplastic contamination. Exposure and risk to human consumers. *Journal of hazardous materials*, 393, 122419.

EFSA Panel on Food Contact Materials, Enzymes and Processing Aids (CEP), Lambré, C., Barat Baviera, J. M., Bolognesi, C., Chesson, A., Cocconcelli, P. S., ... & Van Loveren, H. (2023). Re-evaluation of the risks to public health related to the presence of bisphenol A (BPA) in foodstuffs. *EFSA Journal*, 21(4), e06857.

Kundu, S., Biswas, A., Ray, A., Roy, S., Gupta, S. D., Ramteke, M. H., ... & Das, B. K. (2024). Bisphenol A contamination in Hilsa shad and assessment of potential health hazard: A pioneering investigation in the national river Ganga, India. *Journal of hazardous materials*, 461, 132532.

Oral V18T2D2

Empowering women through small-scale aquaculture: A pathway to sustainable livelihoods in the Indian Sundarbans

D.C. YATEESH,,* B. K. DAS, LITON PAUL, ANURAG SINGH, GITASHREE THENGAL, MONISHA MOLLA

ICAR-Central Inland Fisheries Research Institute, Kolkata - 700 120, India

E-mail: yateeshdc100@gmail.com

***Key Words:** Gender Roles, Small Scale Fisheries, Sundarbans*

INTRODUCTION

The Indian Sundarbans, a fragile mangrove ecosystem, faces escalating climate change impacts such as rising sea levels and salinity intrusion, threatening the livelihoods of its 4.5 million inhabitants (Danda, 2004; Raha et al., 2012). Small-scale fisheries (SSF) and aquaculture, vital for food security and income, are particularly affected. Women, constituting 39.6% of the global SSF workforce (FAO , 2008), play a crucial role in these sectors but remain marginalized due to limited access to resources, decision-making power, and economic opportunities (Kachroo et al., 2005). In the Sundarbans, women engage in diverse fisheries-related activities while facing extreme poverty, poor health, and social exclusion (Patal et al., 1994; Nasreen et al., 1996). Despite their contributions, gender dynamics in inland fisheries remain underexplored, and the impact of interventions like those by ICAR-CIFRI on women beneficiaries is poorly understood. This study addresses these gaps by examining women's involvement in income generation, decision-making participation, and perceived constraints, while evaluating the impact of ICAR-CIFRI interventions to inform gender-inclusive policies for sustainable aquaculture development. These efforts not only addressed gender disparities but also contributed to Sustainable Development Goals (SDGs) such as Gender Equality (SDG 5), Decent Work and Economic Growth (SDG 8), Responsible Consumption and Production (SDG 12) By strengthening economic resilience and implementing targeted improvements in small-scale aquaculture).

MATERIALS AND METHODS

The study was conducted in the Basanti Block of South 24 Parganas district and Hingalganj Block of North 24 Parganas district in the Indian Sundarbans, West Bengal. These regions were selected due to their high dependence on small-scale fisheries and aquaculture, as well as the significant involvement of women in these activities. Primary data were collected through structured interviews and focus group discussions (FGDs) with women engaged in fisheries and aquaculture activities. A purposive sampling method was used to select 120 women beneficiaries of ICAR-CIFRI interventions and Before After method was used to analyse the Impact of the Intervention. The questionnaire covered aspects such as income-generating activities, decision-making participation, and perceived constraints.

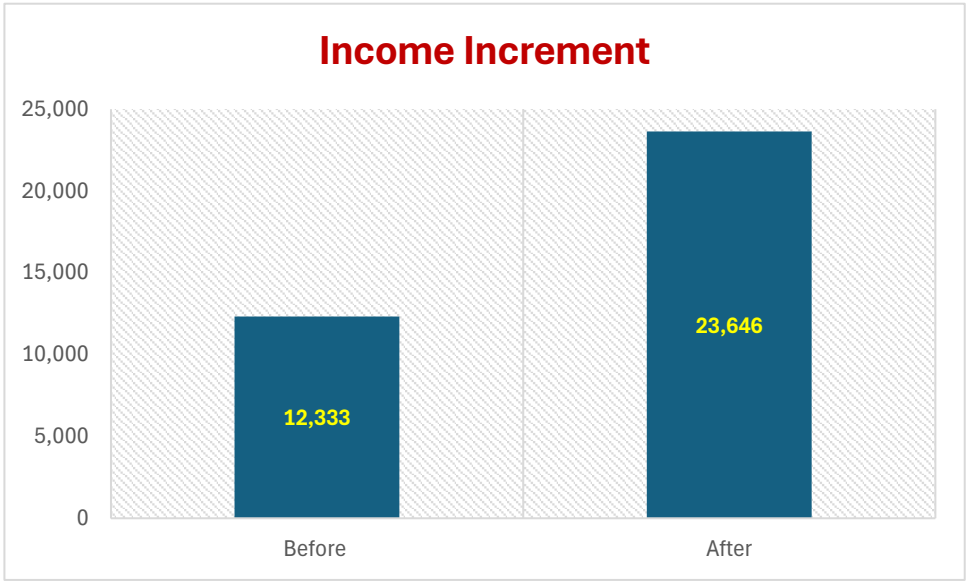
Secondary data were obtained from ICAR-CIFRI reports, government records, and relevant literature to contextualize the findings

RESULTS AND DISCUSSION

The study highlights the multifaceted involvement of rural women in the Sunderbans in various income-generating activities. Women are engaged in fishery-related activities such as spawn collection, fishing, fish drying, and fish vending, which are seasonal in nature. Due to the seasonal variability, women also participate in other activities, including crop planting (56% fully involved), animal rearing (42% fully involved), livestock selling, crop processing, casual labor, selling cooked food, and knitting. Additionally, 58% of the women are involved in gathering and selling non-timber products, while 28% work as hired labor during the crop harvesting season. The constraints faced by women in their daily livelihoods were identified and ranked using Garrett's Ranking Technique. Lack of credit/loan facilities emerged as the most severe constraint, ranked 1st. Other significant constraints included development programs not being tailored to women's specific needs (ranked 2nd) and Lack of coordination among line departments (ranked 3rd). Additional challenges included irregular contact with extension functionaries, domination by specific individuals or groups and lack of timely technological advice.

Women's involvement in aquaculture activities, such as pond stocking, fish feeding, pond management, fertilization, liming, and fish harvesting, was also documented. A few women participated in ornamental fish breeding under ICAR-CIFRI's intervention. The survey revealed a significant increase in average income from fish production, from Rs. 12,322/year before CIFRI's intervention to Rs. 23,646/year after, marking a 91.8% increase. This underscores the positive impact of ICAR-CIFRI's initiatives on women's livelihoods.

Fig 1: *Average Income from Fish Production Before and After ICAR-CIFRI Intervention*



The findings emphasize the critical role of women in sustaining rural economies and the need for targeted interventions to address their constraints. The success of ICAR-CIFRI's programs in doubling women's income highlights the potential of such initiatives to empower women and enhance their economic contributions. However, addressing constraints like access to credit, tailored development programs, and improved extension services is essential for further progress.

CONCLUSION

The study underscores the pivotal role of women in sustaining small-scale fisheries and aquaculture in the Indian Sundarbans, highlighting their significant economic contributions despite facing severe constraints such as limited access to credit, inadequate development programs, and lack of coordination among line departments. ICAR-CIFRI's interventions have demonstrated a transformative impact, doubling women's average income from fish production. To further empower women, targeted policies addressing credit access, gender-specific programs, and improved extension services are essential. These efforts align with SDGs 5, 8, and 12, promoting gender equality, economic growth, and sustainable development in the region.

REFERENCES

Ashaletha, S., Ramachandra, C., Sheela, I., Diwan, A.D., and Sathiadas, R. (2002). Changing roles of fisherwomen in India: issues and prospective, pp. 21-43. In: M.P. Kohli Singh and T. Ratna (eds.), *Women in Fisheries*. Indian Society of Fisheries Professionals, Mumbai, India.

Bhaumik, U., Sen, M., and Chatterjee, J.G. (1996). Participation of Rural women in decision making. *Indian Journal of Extension Education*. 32(3-4), 45-52.

Kachroo, A.B., and Kachroo, A. (2005). Role of women in decision-making process in agriculture in Jammu district. *Economic Affairs*, 50(1), 18-24.

Nasreen, R., Qazi, A.R., and Ijaz, K. (1996). Role of Rural women in decision making in various family affairs. *Journal of Rural Development and Administration*. 28(3), 85-90.

Technical session 3: Technological advancement in livestock and poultry management

Inv-01T3D2

Harnessing artificial intelligence for sustainable livestock farming and food security

SANTANU BANIK
Eastern Regional Station, ICAR-National Dairy Research Institute, Kalyani, West Bengal 741235
E-mail: sbanik2000@gmail.com

Abstract

The integration of Artificial Intelligence (AI) into livestock farming is transforming the industry by shifting from conventional practices to data-driven, precision-based approaches. AI technologies, including machine learning, smart sensors, and the Internet of Things (IoT), offer innovative solutions for real-time monitoring and efficient farm management. These advancements enhance productivity, improve sustainability, and promote better animal welfare. One of the key applications of AI in livestock farming is biometric-based animal identification, which enables accurate and non-invasive tracking of individual animals. Image-based breed classification further aids genetic conservation efforts and optimizes resource utilization. Additionally, AI-driven computer vision systems allow for precise live weight estimation, enabling farmers to implement effective feeding strategies and improve overall production efficiency. Behavioural and health monitoring systems powered by AI play a crucial role in early disease detection and stress management. By analysing real-time data, these systems can identify signs of discomfort, illness, or abnormal behaviour, facilitating timely interventions that reduce veterinary costs and prevent potential outbreaks. Predictive models also enhance production efficiency by optimizing breeding decisions and forecasting seasonal productivity trends based on historical data and environmental factors. Despite its transformative potential, AI implementation in livestock farming faces challenges such as ensuring seamless real-time data collection, adapting AI tools to diverse farm conditions, and addressing ethical concerns related to data privacy and animal welfare. Overcoming these barriers requires continuous research, technological innovation, and policy support. The transformative impact of AI on livestock farming, emphasizing its role in increasing efficiency, ensuring sustainability, and improving animal well-being are most important in present day livestock farming practices. By use of AI-driven solutions, farmers, researchers, and policymakers can collaboratively shape the future of livestock farming, making it more productive, resilient, and environmentally responsible.

Inv-02T3D2

Coastal livestock production: Challenges, innovations, and opportunities

AJOY MANDAL*, SYLVIA LALHMINGMAWII, AKILAN, M., LALMALSAWMI COLNEY, LOUREMBAM NEWTON SINGH and SANTANU BANIK
Division of Animal Genetics and Breeding, ICAR-NDRI, Eastern Regional Station, Kalyani-741235, West Bengal, India
E-mail: ajoymandal@gmail.com

Key Words: *Animal Husbandry, Dairy Production, Artificial Intelligence, Coastal Regions*

INTRODUCTION

India's extensive coastline of 8,118 km supports a large agricultural and livestock economy. However, coastal regions face significant challenges such as climate change, heat stress, salinity intrusion, and extreme weather events that threaten livestock productivity and sustainability. The integration of Artificial Intelligence (AI) is emerging as a transformative approach to monitor, predict, and mitigate these challenges. AI-driven solutions such as machine learning (ML), deep learning (DL), and artificial neural networks (ANNs) offer real-time health monitoring, disease prediction, behaviour assessment, and resource optimization, ensuring resilience and sustainability in coastal livestock farming.

CHALLENGES IN COASTAL LIVESTOCK PRODUCTION

Coastal areas are more vulnerable to multiple challenges impacting livestock farming in several ways. Problems such as quality and quantity of feed, increase salinity of water, natural disasters and thermal stress are some of the major challenges faced by the coastal areas. The production of traditional fodder crops in coastal areas faces significant challenges due to the unique geography and unpredictable weather patterns. Quality of feed crops and forage are also affected by increased temperatures and dry

conditions due to variations in concentrations of water-soluble carbohydrates and nitrogen. Increase influx of saltwater into coastal fresh waters results in chemical and biological contaminants and moreover, thermal stress reduces the livestock production.

INNOVATIONS IN ANIMAL PRODUCTION SYSTEM

AI-powered weather prediction models (e.g., Random Forest Regression, ANN) provide early warnings for heat waves, floods, and cyclones (Sarkar et al 2021; Alone et al., 2025). Precision feeding have been introduced recently with the help of Internet of Things (IoT) technology where data collection, transmission, analysis, and user interfaces are optimized, facilitating a system that empowers farmers to make informed feeding decisions based on data (Su et al., 2024). Overall, AI-integrated systems, such as machine learning (ML), deep learning (DL), artificial neural networks (ANNs), and predictive analytics, are the recent innovations transforming the livestock industry through real-time health monitoring, behaviour evaluation, disease identification, and enhanced resource management.

OPPORTUNITIES

The high population and rich genetic diversity of coastal livestock may serve as a valuable resource for coastal agriculture if well managed through appropriate breeding strategies that incorporate advanced AI technologies. Further, an integrated farming system can be optimized and during the lean period, unconventional feeding techniques. Scientifically designed housing, systematic livestock feeding, daily herd management to boost productivity, grassland management optimisation, and climate-resilient smart villages with shelters for humans and animals in cyclone- and flood-prone coastal regions will help these areas tackle their challenges (Behera et a., 2023)

CONCLUSION

The increasing environmental vulnerabilities of India's coastal regions necessitate innovative, technology-driven solutions for sustainable livestock and dairy production. Artificial intelligence has shown its capability in alleviating climate-related difficulties through predictive and adaptive management solutions. However, the extensive implementation of AI in livestock agriculture requires addressing difficulties including cost, accessibility, and farmer awareness. Investment in research, infrastructure, and governmental support is essential for the seamless integration of AI into livestock management systems

REFERENCES

Alone, A., Shukla, A. K., Nandan, G., and Pattanaik, D. R. (2025). Predicting temperature variability in major Indian cities using Random Forest Regression (RFR) Model. *Journal of Earth System Science* 134(1), 38.

Behera, R., Naik, P., Padhi, M., Kumar, D., Swain, B., Mishra, S., and Beura, C. (2023). Challenges and Future Prospects of Livestock and Poultry Farming in Indian Coastal Ecosystem-An Overview. *Journal of the Indian Society of Coastal Agricultural Research* 41(1), 53-63.

Sarkar, I., Chaudhuri, S., and Pal, J. (2021). Artificial intelligence in forecasting central pressure drop and maximum sustained wind speed of cyclonic systems over Arabian Sea: skill comparison with conventional models. *Meteorology and Atmospheric Physics* 133(3), 803-822.

Su, J., Jiang, Z., Wu, D., Nyachoti, C. M., Kim, S. W., Yin, Y., and Wang, J. (2024). Accelerating precision feeding with the internet of things for livestock: From concept to implementation. Science Bulletin 69(14), 2156-2160.

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Semen preservation and artificial insemination in Black Bengal goat- opportunities & challenges

RUTHI LALRAMCHANSANGI, SHUBHAM SINGHA, DEBAJYOTI SARKAR, MENDA RAJENDAR, MOHAN MONDAL, AJOY MONDAL, CHAMPAK BHAKAT, AND MUTHUPALANI KARUNAKARAN*

ICAR National Dairy Research Institute,
Eastern Regional Station, Kalyani, West Bengal- 741235
E-mail: drmkarunakaran@gmail.com

***Key Words**: Artificial Insemination, Goat, Semen Preservation*

INTRODUCTION

Goats are raised mainly for meat and milk purpose by the landless, small and marginal labourers providing financial reassurance. Black Bengal goat (*Capra hircus bengalensis*) is known for its prolificacy, docile nature, fertility, and excellent quality of meat and skin. The breed is native to and found all over West Bengal and in the conjoining states. There has been a reduction in the availability

of breeding bucks due to the early castration and slaughtering of male kids for economic and social reasons resulting in a 1:88 buck doe ratio in conjunction to the recommended 1:20. It poses a threat of inbreeding depression and dilution of elite germplasm because of frequent and indiscriminate breeding practices. These issues can be countered through the widespread use of artificial insemination. Hence the aim of this study was to investigate the effects of dilution, cooling and freezing on in vitro sperm characters during cryopreservation of buck semen.

MATERIALS AND METHODS

Semen ejaculates were collected by Artificial Vagina method from five mature Black Bengal bucks of 2-2.5 years of age. The basic extender was prepared before semen collection by mixing 300mM Tris, 28mM glucose, 95mM citric acid, egg yolk 20% (v/v), glycerol 5% (v/v)- single step addition and 500µg/ml gentamicin in distilled water and kept in water bath at 37°C until final dilution. A total of 100 ejaculates (20 ejaculates from each buck) were collected and those that passed the initial quality evaluation were pooled and the extended semen samples were kept for 3 hours at refrigeration temperature for equilibration. Filling of straws (0.25 ml) was done manually and placed on a plastic rack in a foam box containing static liquid nitrogen vapor, 5cm above the liquid nitrogen level (Karunakaran et al. 2019). After vapour freezing for 10 min, the straws were immediately plunged into a liquid nitrogen container (-196°C) and stored for a minimum 48 h period. Thawing of the straws was done and evaluated the in vitro sperm characters viz. individual motility, viability, functional membrane integrity and acrosomal integrity, along with lipid peroxidation status.

RESULTS AND DISCUSSION

In cryopreserved samples, the sperm motility was 25.97 ± 2.35% (Table 1) which is in concordance with the findings on buck semen cryopreservation by Altyeb et al. (2022) but lower than Rezaei et al. (2023). Percentages of live sperm and functionally intact membrane were 33.83 ± 2.23% and 32.20 ± 2.33% respectively which are at par with Tudu et al. (2023), but lower than Rezaei et al. (2023). Post-thaw acrosome integrity was 44.81 ± 2.26% in the current study which is in higher than the findings of Saratsi et al (2023) who had recorded 36.08%. MDA level in the frozen-thawed sample was 2.52 ± 0.16 µmol/ml which was similar to the values reported by Tudu et al. (2023), ranged between 2 and 2.5µmol/ml after cryopreservation. Variations in the in vitro sperm characters at different stages of preservation such as initial dilution with semen extender, after completion of equilibration, freeze - thaw might be due to breeds of bucks, composition of the cryopreservation media, cryo-protective agents, semen dilution, cooling and thawing rates etc. In the current study, a significant reduction of different sperm traits was observed after cryopreservation. Further works need to be carried out to enhance the cryo-survivability of Black Bengal buck semen and this study may be a baseline for future research.

Table 1. *In vitro sperm characters (mean ± SEM) of Black Bengal buck semen after dilution with Tris extender, equilibration and cryopreservation*

Parameters	After dilution	After equilibration	After cryopreservation
Individual motility (%)	92.50 ± 0.57^{A}	60.83 ± 1.53^{B}	25.97 ± 2.35^{C}
Sperm viability (%)	95.77 ± 3.69^{a}	58.50 ± 7.01^{b}	33.83 ± 2.23^{c}
Functional membrane integrity (%)	82.38 ± 3.30^{a}	42.72 ± 4.53^{b}	32.20 ± 2.33^{b}
Acrosomal integrity (%)	90.33 ± 1.55^{a}	53.55 ± 4.20^{b}	44.81 ± 2.26^{c}
MDA level (µmol/ml)	1.50 ± 0.04^{c}	1.94 ± 0.08^{b}	2.52 ± 0.16^{a}

Rows with superscripts a, b, c / A, B, C differ significantly @ $p < 0.05$ and $p < 0.01$, respectively (n=20)

REFERENCES

Altyeb, Y.H., Absy, G., Medan, M.S., Hassan, S.T. and Elsayed. D.H. (2022). The effects of cysteine and L-carnitine on the DNA integrity of post-thaw sperm of frozen buck semen. *Iran. J. Vet. Res*. 23(3): 196-203

Karunakaran, M., Konyak, P., Mandal, A., Mondal, M., Bhakat, C., Rai, S., Ghosh, M.K. and Behera, R. (2019). Effect of trehalose-an impermeant cryoprotectant on cryopreservation of Black Bengal buck semen. *Indian J. Anim. Res*. 53(1): 37-40

Rezaei, A., Bahmani, H.R., Mafakheri, S., Farshad, A., Nazari, P. and Masoudi, R. (2023). Protective effects of different doses of MitoQ separately and combined with trehalose on oxidative stress and sperm function of cryopreserved Markhoz goat semen. *Cryobiology*. 110: 36-43

Saratsi, A., Samartzi, F., Panagiotidis, I., Basioura, A., Tsiokos, D., Ligda, C., Rekkas, C.A. (2023). Post-Thaw Parameters of Buck Semen Quality after Soy Lecithin Extender Supplementation with Fumaric Acid. *Vet Sci.* 10 (9): 569

Tudu, K.C., Mandal, A., Mondal, M., Das, S.K., Ghosh, M.K., Rai, S., Bhakat, C. and Karunakaran, M. (2023a). Effect of butylated hydroxytoluene and tocopherol supplementation on in vitro sperm characters during cryopreservation of black bengal buck semen. *Indian J. Anim. Res*. 57(5): 547-551

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Towards enhancing reproductive efficiencies of coastal cattle: Roles of novel peptides and their analogues

MOHAN MONDAL and M KARUNAKARAN
ICAR-National Dairy Research Institute, Eastern Regional Station, Kalyani, West Bengal-741235
E-mail**:** drmmondal@gmail.com

INTRODUCTION

Gonadotropin-releasing hormone (GnRH) is a hypothalamic decapeptide that plays a central role in regulating the reproductive axis in both humans and animals. It triggers the release of gonadotropins—luteinizing hormone (LH) and follicle-stimulating hormone (FSH)—from the anterior pituitary, which in turn stimulate gonadal function, gametogenesis, and steroidogenesis. GnRH secretion is tightly regulated by feedback mechanisms from gonadal hormones, which maintain reproductive homeostasis. Given its critical role in reproduction, much attention has been focused on developing pharmacological agents that modulate GnRH release.

GnRH secretagogues, a class of compounds that stimulate the secretion of GnRH or mimic its activity, have become important tools in the management of reproductive function in domestic animals. These secretagogues are used to synchronize estrus, optimize fertility, and manage various reproductive disorders, including anestrus, subfertility, and ovarian cysts. The application of GnRH secretagogues in veterinary reproductive management represents a significant advancement over traditional methods, providing more controlled, efficient, and economically viable strategies for breeding and reproduction.

MECHANISMS OF ACTION OF GNRH SECRETAGOGUES

GnRH secretagogues function by either promoting the release of endogenous GnRH or by directly mimicking the action of GnRH at the pituitary level. There are two primary mechanisms through which these compounds exert their effects:

- *Direct Action on the Pituitary*
- *Indirect Stimulation of GnRH Release*

TYPES OF GNRH SECRETAGOGUES

GnRH secretagogues can be classified into two broad categories based on their structure and origin: natural and synthetic secretagogues.

- *Natural Secretagogues*
- *Synthetic Secretagogues*
- *4. Role of Kisspeptin on Reproduction*
- *Role of Kisspeptin on onset of Puberty*
- *Role of Kisspeptin on pituitary hormones*
- *Role of Kisspeptin on ovulation*
- *Role of Kisspeptin on pregnancy*
- *Role of Kisspeptin on follicular dynamics in animals*

APPLICATIONS OF GNRH SECRETAGOGUES IN DOMESTIC ANIMALS

GnRH secretagogues have found diverse applications in the management of reproductive health in domestic animals. The following are key areas where these compounds are used:

- *Estrus Synchronization and Ovulation Control*
- *Reproductive Disorders Management*
- *Improved Fertility in Artificial Insemination (AI)*
- *Timing of Breeding and Pregnancy Management*

CHALLENGES AND LIMITATIONS

Despite their potential, the use of GnRH secretagogues in domestic animals is not without challenges. Some of the key limitations include:

- *Species-Specific Differences*
- *Cost and Accessibility*
- *Long-Term Effects and Safety*

FUTURE DIRECTIONS

The future of GnRH secretagogues in veterinary medicine lies in the development of more targeted and efficient compounds, such as novel peptide-based or small-molecule agents. Advancements in biotechnology and pharmacology may lead to the creation of GnRH secretagogues that are more species-specific, have longer durations of action, and offer greater cost-efficiency. Additionally, the integration of GnRH secretagogues with other reproductive technologies, such as gene editing and precision breeding, holds promise for revolutionizing reproductive management in domestic animals.

CONCLUSIONS

GnRH secretagogues represent a significant advancement in the field of veterinary reproductive management. Their ability to modulate the hypothalamic-pituitary-gonadal axis provides valuable tools for controlling estrus, optimizing fertility, and managing reproductive disorders in domestic animals. While challenges remain, particularly concerning species-specific responses and long-term effects, the continued development and refinement of GnRH secretagogues are expected to play a central role in improving reproductive outcomes and efficiency in livestock production. Future research will likely expand the range of applications and enhance the effectiveness of these compounds, contributing to more sustainable and productive animal husbandry practices.

Oral V1T3D2

Feeding kitchen herbs and probiotics to the preweaned calves improves health and growth performances

SAROJ RAI*, S. K. DAS, D. K. MANDAL, ANUPAM CHATTERJEE and T.K. DUTTA
Indian Council of Agricultural Research – National Dairy Research Institute, Eastern, Regional Station, Kalyani – 741235, WB, India
E-mail: drsaroj.rai@gmail.com

Key Words: *Calf Diarrhea, Kitchen Herbs, Probiotics*

INTRODUCTION

Calf diarrhoea is a huge problem both in big and small farms. Some diarrheagenic *E coli* pathotypes reportedly are Enterotoxigenic *E coli* (ETEC) produces ST and LT enterotoxins causing rapid onset of secretory diarrhea and dehydration (Kolenda et al. 2015) in young animals. But, majority are systematically treated with antibiotics but the problem of resistance is of growing concern (WHO, 2014). Kitchen herbs are blessed with a diverse array of secondary metabolites such as phenols, turpenoids, flavonoids, tannins, lectins and polypeptides (Das, 2013). A meta-analysis report showed that probiotics have protective effects against opportunistic intestinal pathogens achieved by maintaining a favourable microbial balance reducing the occurrence of diarrhea in calves (Signorini *et al*., 2012). Not much research work is carried on the use of herbs and probiotics for treatment of diarrhea in calves. The experiment was carried out to determine the effect of feeding cinnamon, turmeric, carom seed powder and probiotics fortified whole milk on health and growth performance of Jersey crossbred calves.

MATERIALS AND METHODS

A complete randomized block design with 4 treatments of 10 calves in each experimental unit was applied. All experimental group except the control group was fed herbs (*Trachyspermum ammi, Curcuma Longa* and Cinnamon), probiotics (*Lactobacillus fermentum* NCDC605 and *Lactobacillus rhamnosus* NCDC610 of 10^9 cfu/ml) and a mixture of both, respectively for 3 months.

RESULT AND DISCUSSION

E coli isolates from calf diarrhea against 12 antimicrobials by disc diffusion method found multidrug resistance (MDR) as high as 80.70%. Highest resistance was seen with β lactamase inhibitor (Amoxicillin/Clavalinic acid) followed by β lactams (Ampicillin, Cefuroxime and Cefepime). Nearly forty-two isolates (36.84%) were the Diarrheagenic *E coli* with ETEC (22.80%) and STEC (15.78%). Only 4.38% STEC had the intimin gene *(eaeA).* The most predominant virulent gene was ST (18.42%) followed by stx1 (9.64%), respectively. Calves fed herb-probiotic mixture had significantly higher dry matter intake from concentrates ($p<0.05$), dry matter intake per 100 kg body weight ($p<0.05$) and better fecal scores ($p<0.05$). It maybe the presence of secondary metabolites in herbs that have the ability to improve digestibility and feed utilization by modulating the rumen microbial fermentation process (Patra *et al.*, 2011, Nayemeh *et al*., 2022). Also, there was increase in *Lactobacillus* count ($p<0.05$) with markedly reduced *E. coli* counts ($p<0.01$). There was reduced illness and higher serum total protein levels ($p<0.05$). It can be concluded that by feeding the herb-probiotic mixtures reduces calf diarrhea and improves dry matter intake in calves. While, the flavonoids present in certain herbs possess anti-

diarrhoeal activity, inhibiting intestinal motility and hydro electrolytic secretion known to change in diarrhoea conditions (Venkatesan *et al*., 2005); probiotics produce organic acids, hydrogen peroxide and bacteriocins that prevent colonization of pathogenic bacteria, form natural biofilm, increase γ-interferon, increase activity of lymphocytes and macrophages (Smulski *et al*., 2020).

CONCLUSION

Supplementation of probiotics (*Lactibacillus fermentum NCDC605* and *Lactobacillus rhamnosus NCDC610* @10^9 cfu/ml), kitchen herbs (cinnamon, carom seed and turmeric) or their combination dissolved in whole milk improved the fecal scores, reduces days of illness, serum total protein and dry matter intake of dairy calves during the preweaning period.

ACKNOWLEDGEMENT

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REFERENCES

Das S., 2013. Optimization of ultrasound-assisted extraction of total flavonoids and antioxidant properties from Trigonella foenum-graecum seeds with response surface methodology. *International Journal of Pharmaceutical Sciences and Research* 4(11): 4308.

Kolenda R., Burdukiewicz M. and Schierack P., 2015. A systematic review and meta-analysis of the epidemiology of pathogenic *Escherichia coli* of calves and the role of calves as reservoirs for human pathogenic *E. coli. Front. Cell. Infect. Microbiol*.

Nayemeh, S; Samane, A; Sevda, B; Elham, T; Mahdieh Farhoudi Sefidan, J; Parisa, E; Kamilia, A and Firouz, A (2022). Antibacterial and antibiofilm activity of Lactobacillus strains secretome and extraction against Escherichia coli isolated from urinary tract infection. Biotechnol. Rep., 36

Patra, AK (2012). Effects of essential oils on rumen fermentation, microbial ecology and ruminant production. Asian J. Anim. Vet. Adv., 6(5): 416-428

Signorini, ML; Soto, LP; Zbrun, MV; Sequeira, GJ; Rosmini, MR and Frizzo, LS (2012). Impact of probiotic administration on the health and fecal microbiota of young calves: A meta-analysis of randomized controlled trials of lactic acid bacteria. Res. Vet. Sci., 93 (1): 250-258, doi.org/10.1016/j.rvsc.2011.05.001

Smulski, S; Turlewicz-Podbielska, H; Wylandowska, A and Włodarek, J (2020). Non-antibiotic Possibilities in Prevention and Treatment of Calf Diarrhoea. J. Vet. Res., 20, 64(1): 119-126. doi: 10.2478/jvetres-2020-0002. PMID: 32258808; PMCID

Venkatesan, N; Vadivu, T; Sathiya, N; Arokya, A; Sundararajan, R; Sengodan, G; Vijaya, K; Thandavarayan, R and James, BP (2005). Anti-diarrhoeal potential of *Asparagus racemosus* wild root extracts in laboratory animals. Int. J. Pharm. Pharm. Sci. 8: 39-45

WHO (2014) Ministry of health and family welfare: Antimicrobial resistance and its containment in India. World Health Organization.

Oral V2T3D2

Morphometric study of Aseel chicken reared along the coastal-adjacent villages of Hingalganj block, North 24 Parganas

DEBOJYOTI BORKOTOKY, KAUSHIK PAL[1], V.OM SUBHAM RAJU, SYAM KR, ARAVIND T. RINKU BHARALI, D BERNICE EKHE and TANMAY SAMAJDAR

KVK North 24 Parganas (Addl.), ICAR-CRIJAF, Barrackpore, Kolkata 700121, India

[1]KVK North 24 Parganas, WBUAFS, Ashokenagar, West Bengal 743222, India

E-mail: debojyoti.borkotoky@gmail.com

Key Words: *Aseel, Morphometry, Coastal-Villages*

INTRODUCTION

India is home to a rich diversity of poultry breeds. Research suggests that body morphometric measurements, such as body length, shank length, and chest girth, can be good indicators of growth in poultry. To increase the productivity of backyard and rural farming, improved or exotic varieties are being introduced in rural areas or in their breeding traits leading to a dilution of genetic purity of the breeds or a complete replacement of the native germplasm; hence, these breeds are under threat of extinction (Singh, 2009). The studies on indigenous breeds are scanty barring a very few reports (Kumar *et al*., 2013; Kumar *et al,* 2016; Rajkumar *et al.,* 2017). Therefore, the present study was carried out with the aim to record the qualitative characters and biometric measurements of a native Aseel breed of chicken reared along the coastal-adjacent village of Hingalganj block of North 24 Parganas district.

MATERIALS AND METHODS

The relevant data for the present investigation was collected from Aseel population reared under backyard system and, maintained at 5 villages viz Sandelbil, Rupamari, Bishpur, Bailani, Bankra of Hingalganj block, a part of the Sundarban region. The body weight of 50 adult aseel male (≥72 weeks) and female (≥72 weeks) measured using electronic bird weighing machine with the accuracy of 10 gm. The beak length, comb length, comb height, wattle length, head length, Shank length, tarsus length, thigh length, and spur length was measured using vernier calliper with the accuracy of 0.1 cm. Breast girth (measured at the point of keel bone), shark girth and keel bone length (from the point to the tip), back length were measured using measuring tape with the accuracy of 0.5 cm. Body length from the tip of the beak to the tip of tail was measured after restraining the bird on table and extending the neck straight while, wing span by extending the wing when the bird was in standing posture was measured using measuring tape with the accuracy of 0.5 cm. Breast angle was also measured at the point of keel bone. Height of the bird was measured up to the tip of the comb when bird was in normal standing posture. The data so collected was entered in Microsoft excel worksheet and the mean and standard error were calculated

RESULTS AND DISCUSSION

The results of morphometric measurements of adult Aseel male (n=50) and female(n=50) males in this study are presented in table 1. Churchil et al. (2019) conducted a similar study on native male Aseel chickens in Tamil Nadu, reporting mean values for various body measurements. The recorded averages were 1.87 kg for body weight, 2.92 cm for beak length, 0.96 cm for comb height, 7.84 cm for tarsus length, 2.10 cm for spur length, 31.60 cm for body girth, 75.00 cm for wing span, 12.52 cm for keel bone length, 30.80 degrees for breast angle, 44.70 cm for bird height, and 53.80 cm for body length. These findings indicate that the male Aseel population in their study had a lower body weight and height, a longer beak, and shorter comb height, tarsus length, and body length compared to the Aseel being examined in the current study. He also noted 80% of the birds had pea comb and remaining 20% had rose comb. In the present study, the Pea comb type was noted in 40% of the birds, rose type in 34%, walnut type in 14%, while the remaining 12% had single type comb. The beak colour was either brownish yellow (70%) or blackish yellow (30%). In another study by Rajkumar et al. (2017) recorded body weight of cock and hen as 3,793.7 ± 20.8 g and 2,333.7 ± 26.10 respectively at 72 weeks in experimental farm condition. In the present study, lower adult body weight may be due to free range rearing of the birds.

CONCLUSION

This study was an attempt to characterize elaborately the morphological features of native Aseel chicken in coastal-adjacent villages of Hingalganj block, North 24 Parganas. The present study gives the basic information on Aseel chicken which could be useful for taking any on-ward attempt to prevent from genetic dilution of this valuable genetic resource through conservation and utilization.

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REFERENCES

Churchil, R.R., Jamima, J., Machindra,Y.S. Kanagaraju, P. and Srinivasan, G. (2019). Qualitative and Morphometric Characters of Aseel Male Chicken. *Internationa Journal of Current Microbiology and Applied Sciences*. 8(01): 1285-1289.

Kumar P.G., Churchil, R.R., Jalaludeen, A., Narayanankutty, K., Joseph, L., Kannan A. and Anitha. P. (2013). A survey on village chicken production in Kerala state of India. *World's Poultry Science Journal*. 69: 917-929.

Kumar, P.G., Churchil, R.R., Jalaludeen, A., Narayanankutty, K., Peethambaran, P.A., Praveena, P.E., Chacko B.and Ajithbabu, B. (2016). Egg production and certain behavioural characteristics and mortality pattern of indigenous chicken of India. *Animal Genetic Resources.* 59: 27-36.

Rajkumar, U., Haunshi, S., Paswan, C., Raju, M.V.L.N., Rama Rao, S.V. and Chatterjee, R.N. (2017). Characterization of indigenous Aseel chicken breed for morphological, growth, production, and meat composition traits from India. *Poultry Science.* 96: 2120-2126.

Singh D. P. (2009). Overview of existing breeds and issues of conserving indigenous breeds. In. Proc. Natl. Workshop on synthesizing experiences in the promotion of backyard Poultry. Govt. of Andhra Pradesh, Hyderabad, India. pp. 54-55.

Table. 1: *The biometrical value of Aseel male and female chicken*

Sl. No	Parameters	Male (Mean± SE)	Female (Mean± SE)
1.	Body weight (g)	3123.5±41.24	2215.36±14.23
2.	Height (cm)	47.20 ± 1.62	45.20 ± 1.44
3.	Body length (cm)	63.35±0.56	55.52±0.27
4.	Tarsus length (cm)	9.66±0.12	7.55±0.08
5.	Thigh length (cm)	16.09±0.26	12.45±0.13
6.	Comb length (cm)	4.10±0.11	1.35±0.14
7.	Comb height (cm)	1.75±0.08	0.72±0.06
8.	Wattle length (cm)	1.1±0.05	2.20±0.1
9.	Beak length (cm)	1.96±0.08	1.76±0.03
10.	Spur length (cm)	2.24 ± 0.19	2.18 ± 0.10
11.	Back length (cm)	17.09±0.22	15.02±0.08
12.	Head length(cm)	4.30±0.10	3.82±0.06
13.	Neck length(cm)	17.76±0.18	15.85±0.12
14.	Keelbone length (cm)	13.55 ± 0.24	12.88 ± 0.31
15.	Wing length (cm)	37.86±0.22	35.36±0.14
16.	Wing span (cm)	22.99±0.17	19.79±0.11
17.	Breast girth (cm)	31.66±0.27	26.54±0.12
18.	Shank girth (cm)	5.07±0.47	4.08±0.29
19.	Breast angle (degree)	60.72±0.60 &	50.45±0.5

Fig.1: Adult Aseel Male

Fig.2: Adult Aseel Female

Oral V1T3D2

Effect of different growth factors on *In-Vitro* embryo production of Bovine embryos

MENDA RAJENDAR, S BERA, V SHAH and S K DAS

[1]ICAR-National Dairy Research Institute-Eastern Regional Station (NDRI-ERS), Kalyani, 741235, West Bengal, India

E-mail: rajendarmendaa@gmail.com

Key Words: *Cattle, Embryos, Growth Factors, In Vitro Studies*

INTRODUCTION

Assisted Reproductive Technologies (IVM, IVF and IVC) are the potential baseline for the production of cattle embryos and enhances the breeding, superior germplasm and sustainable food production. The *in vitro* production of embryos are still facing challenges compared to *in vivo* production (Mikkola et al. 2024). The *in vitro* culture media plays a critical role in production of embryos and supplementation of different growth factors are effects lot alone or combination (Choi et al. 2024). The purpose of this study is to enhancement of in vitro production of cattle embryos by supplementing with different types of growth promoting factor treatments in the IVM, IVF and IVC media.

MATERIALS AND METHODS

Cattle ovaries were collected from the Kolkata abattoir in normal saline facilitated with antibiotics of penicillin (400 IU mL^{-1}), streptomycin (50 mG^{-1}) and transported to the laboratory under maintenance of 35 to 37°C within 2-3 h of slaughter of animal. Immature oocytes were aspirated from the ovaries after proper wash continued with cumulus oocyte complexes were washed 5-6 times with washing media and incubated in Bioscience matureration media (BO-IVM) for 24 h in a 5% CO_2 incubator at 38.5°C with maximum humidity. After matured oocytes were allowed to fertilization with capacitated sperm in Bioscience BO-SEMENPREP media at 38.5°C CO2 incubator. 15-18 h after the sperm-oocyte co-incubation the cumulus layers surrounded by the oocytes were washed off with gentile pipetting by 2-3 times and the presumptive zygotes were cultured in 50 µl drop of the Invitrogen IVC media for 48 hr. after 48 h cleavage was observed and cultured in the same in vitro environmental conditions up to 7-9 das with replacement of IVC media every 48 h. In the present study total 400 oocytes were employed in 5 replicates with each treatment (T2- Leukemia inhibitory factor (LIF) 15 ng/ mL^{-1}; T3- Platelet-derived growth factor (PDGF) 5 ng/ mL^{-1}; T4- Insulin-like growth factor (IGF)

50 ng/ mL^{-1}) and control group is without supplementation any growth factor. The obtained data were analyzed by using one-way ANOVA.

RESULTS AND DISCUSSION

The supplementation of three growth factors in the *in-vitro* Maturation (IVM), *in-vitro* Fertilization (IVF) and *in-vitro* Culture (IVC) media resulted production of early embryonic stages of cattle. The present results demonstrated that there is a significant difference in 2-Cell Stage formation rate between treatment groups and control group. T1 and T2 is significantly differ with the control group ($p<0.001$) as well as not with T3. In the case of 4-cell stage formation rate is significant in all three groups compared to control group ($p<0.001$). In 8-cell stage formation rate, only T2 group is significant compared to control and no variation in control and T3 group. There are no significant differences among groups in 16-cell stage. The formation of morula rate significantly differed among treatment groups and control group. T2 is significantly increased ($P>0.05$) the Blastocyst rate (2.60±0.748) compared to T3 (0.40±0.245), T4 (0.40±0.245) and control. The cumulative effect of all four groups (T1, T2, T3 and control) were not equal. T2 group (LIF 15 ng/ mL−1) have showed the highest formation of 2- cell, 4-cell, 8-cell, 16-cell, Morula and Blastocyst formation rate (Fig. 1). The supplementation of LIF in the culture media improves the oocyte maturation and developmental competence of early embryos (Zhao et al. 2022). The effect of LIF were more in current study correlated with the Pramanik et al. (2022).

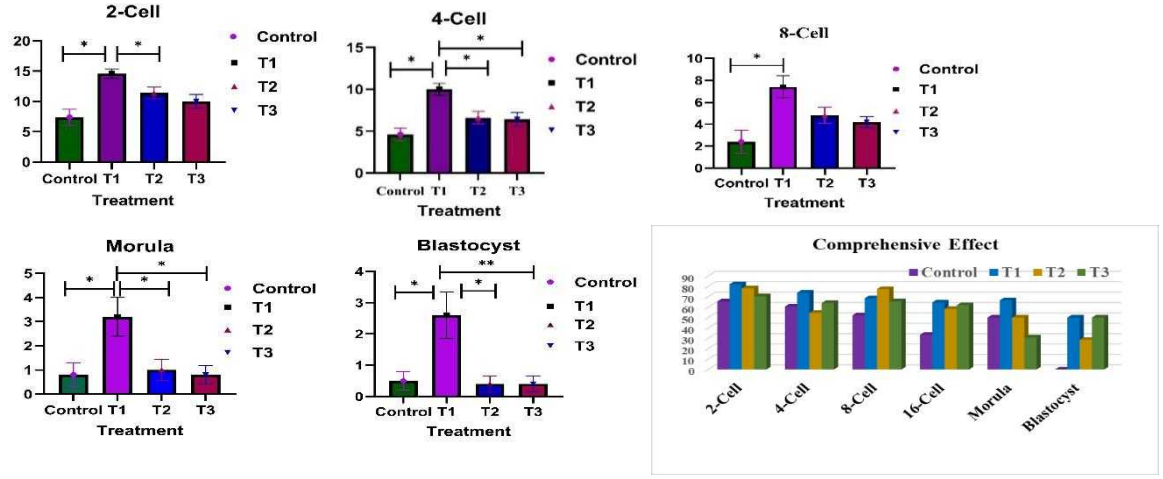

Fig.1. *Different cell stages of early embryos of cattle and comprehensive effect of growth factors*

CONCLUSION

In the current study LIF supplementation in IVM, IVF and IVC media resulted significantly higher blastocyst formation as compared to PDGF, IGF and control groups, so the LIF could be recommended for better *in vitro* embryo production.

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REFERENCE

Choi J.W, Kim S.W, Kim H.S, Kang M.J, Kim S.A, Han J.Y, Kim H, Ku S.Y. (2024). Effects of Melatonin, GM-CSF, IGF-1, and LIF in Culture Media on Embryonic Development: Potential Benefits of Individualization. *International Journal of Molecular Science* 25(2): 751.

Mikkola M, Desmet K.L.J, Kommisrud E, Riegler M.A. (2024). Recent advancements to increase success in assisted reproductive technologies in cattle. *Animal Reproduction* 21(3): e20240031.

Pramanik A, Bera S, Menda R, Mondal M, Karunakaran M, Santra A and Das S.K. (2023). Enhancement of Developmental Competence of Immature Cattle Oocytes with Leukemia inhibitory Factor as a Culture Media Supplement. Indian Journal of Animal Research.B-5015.

Zhao T, Pan Y, Li Q, Ding T, Niayale R, Zhang T, Wang J, Wang Y, Zhao L, Han X, Baloch A.R, Cui Y, Yu S. (2022). Leukemia inhibitory factor enhances the development and subsequent blastocysts quality of yak oocytes in vitro. *Frontiers in Veterinary Science* 9: 997709.

Technical session 4: Natural resource management, forestry and bio-diversity in coastal and marine ecosystem

Lead Lect-1T4D1

Salinity management for growing dry season crops in the salt-affected coastal zone of the Ganges delta

MOHAMMED MAINUDDIN
Principal Research Scientist and Team Leader
CSIRO Environment, Canberra, Australia
E-mail: mohammed.mainuddin@csiro.au

The salt-affected coastal zone of the Ganges Delta in Bangladesh and West Bengal, India is home to 20 million people who depend on agriculture for their livelihoods. There is a high incidence of poverty and poor food security in the region. Traditionally, farms produce low-yielding local rice under rainfed conditions in the wet season. In the dry season, most agricultural land remains fallow due to a late rice harvest, prolonged waterlogging, salinity in the soils, and the perceived lack of fresh water for irrigation.

CSIRO along with partner organizations from Australia, Bangladesh and India has been working since 2015 to sustainably increase cropping intensity and productivity in that region particularly in the dry season through integrated soil, water and crop management.

The trans-disciplinary project focused on analysing climate patterns to assess agroclimatic potential and developed models to understand salt and water dynamics. Field experiments and crop production modelling were conducted to study soil, plant, waterlogging, and salinity interactions. The project identified salt-tolerant crop varieties, optimal sowing times, and best agronomic and water management practices along with their socio-economic impacts.

To cultivate crops during the dry season several strategies such as drip irrigation, conjunctive use of saline and non-saline water, and pitcher and bottle irrigation for high-value vegetables were evaluated. We also used straw mulch to conserve moisture, sow crops early to take advantage of post-monsoon residual soil moisture, practice zero-tillage cultivation, and organize communities to store fresh water in canals and ponds for dry season irrigation.

The project has identified suitable and profitable cropping patterns that enhance cropping intensification. Crops like sunflower, maize, zero-tillage potato, garlic, onion, pumpkin, watermelon, and spinach have proven well-suited for dry season cultivation which are increasingly being taken up by the farmers. There is evidence of increasing crop productivity and intensity, enabling farmers to boost their incomes and livelihoods.

Lead Lect-2T4D1

Modeling and management option for groundwater in coastal regions: a case study from Sundarbans

Dr RENJI REMESAN, PhD, FHEA
Associate Professor, School of Water Resources, IIT Kharagpur
E-mail: renji.remesan@swr.iitkgp.ac.in

The coastal region of South and North 24 Parganas districts of West Bengal, India is known as Indian Sundarbans. This study has identified Gosaba Island in the Sundarbans region to perform a 2-D vertical cross-sectional modeling of surface water-groundwater interactions using MODFLOW in Gosaba Island of Sundarbans delta. The results were validated using head data from five piezometers along the cross-section and obtained highly promising results. A comprehensive parameter sensitivity analysis was also done in comparison with piezometric head and salt concentration considering major parameters. It is found that river stage, recharge, river conductance, horizontal hydraulic conductivity and specific yield of layer 1, are highly sensitive parameters influencing surface water-groundwater interactions. Further, scenario analyses (i.e. non-drain, single drain, three drains) was undertaken to evaluate the effectiveness of drainage infrastructure to reduce saline water logging conditions. The evaluation indicated that installation of three drains can remove water at a rate up to -123.3 m^3day-1 and lower the water table up to 0.4m. The single drain management scenario could divert water at the rate of -77.9 m^3day-1 during post monsoon season lowering the shallow saline groundwater table up to 0.1m. This preliminary modeling study shows encouraging results to consider drainage management as to solve the increasing challenge of water logging and salinity management in the deltaic region.

Lead Lect-5T4D1

Management of surface water resources in coastal region using geoinformatics

SUSANTA KUMAR JENA
Principal Scientist & Project Coordinator (Consortia Research Platform on Water)
ICAR- Indian Institute of Water Management, Chandrasekharpur, Bhubaneswar – 751023
Email: skjena.icar@gmail.com,

In climate change scenario we experience more extreme events of cyclone, flood, drought, long dry spells etc. in coastal region. The intensity, amount and distribution of rainfall are also not as per the crop requirement. Secondly land and water present in the coastal region are the two most vital natural resources and these resources must be conserved and maintained carefully for environmental protection and ecological balance. Prime soil resources of the coastal region are finite, non-renewable over the human time frame, and prone to degradation through misuse and mismanagement. Total global land degradation is estimated at 1964.4 M ha, of which 38% is classified as light, 46% as moderate, 15% as strong and the remaining 0.5% as extremely degraded, whereas present arable land is only 1463 M ha which is less than the land under degradation (Koohafkan, 2000). The annual rate of loss of productive land in the whole world is 5 to 7 M ha, which is alarming. In India, out of 328 M ha of geographical area, 182.03 M ha is affected by various degradation problems out of which 68 M ha are critically degraded and 114.03 M ha are severely eroded whereas total arable land is only 156.15 M ha (Velayutham 2000). It was reported that in India 0.97% of total geographical area is under very severe erosion (> 80 t ha^{-1} yr^{-1}), 2.53% area under severe erosion (40-80 t ha^{-1} yr^{-1}), 4.86% area under very high erosion (20-40 t ha^{-1} yr^{-1}), 24.42% area under high erosion (10-20 t ha^{-1} yr^{-1}), 42.64% area under moderate erosion (5-10 t ha^{-1} yr^{-1}) and rest 24.58% area under slight erosion (0-5 t ha^{-1} yr^{-1}) (Singh et al. 1992). Therefore, the problem of land degradation due to soil erosion is very serious and with increasing population pressure, exploitation of natural resources, faulty land and water management practices, it will further aggravate. Land degradation also reduces the world's fresh water reserves. It has a direct impact on river flow rates and the level of groundwater tables. The reduction of river flow rates and the lowering of groundwater levels lead to the silting up of estuaries, the encroachment of salt water into groundwater, the pollution of water by suspended particles and salinization, which in turn reduces the biodiversity in fresh and brackish water and consequently fish catches. Lower river flows also interfere with the operation of reservoirs and irrigation channels, increasing coastal erosion and adversely affecting human and animal health.

The coastal regions are exposed to frequent cyclone, flood, drought, long dry spells etc. in the same year or in different years at the same place. There is a need for surface water assessment, water harvesting, conservation and its efficient utilization as a climate change adaptation strategy in coastal regions. Water harvesting with a watershed concept is a major approach for water harvesting, conservation, and its efficient utilization. A watershed is an area from which runoff, resulting from precipitation, flows past a single point into a large stream, a river, lake or an ocean. Watershed management or protection implies the proper use of all land and water resource of a watershed for optimum production with minimum hazard to natural resources. Rainwater harvesting and its judicious use is the key for enhancing irrigated area, cropping intensity, land productivity and farm profitability in rainfed areas. Water conservation and harvesting measures which could be adopted are: In-situ water conservation by afforestation/ plantation/ vegetation; contour trenching on barren hill slopes; Bench terracing of steep slopes; Contour or graded bunding if agricultural lands; water harvesting though temporary and permanent gully control structures; and construction of water harvesting structures and ponds etc.

Assessment, planning and management of surface water resources in coastal region using geoinformatics is need of the present time. Geospatial database on water harvesting potential in different agro-ecological regions of the country was developed during 2015-20 at coarser scale which would be useful for design of water harvesting structures. With the set of satellite data used, identification of water bodies less than 2 ha area was not possible in the previous studies. However, presently the satellite data are available in finer resolution and it would be used for developing suitable design of rainwater

harvesting structures at basin scale. All the surface waterbodies, their spread can be easily assessed even up to 0.1 ha area. The command area of those water bodies also would be ascertained. Rain water harvesting (RWH) has been the major focus of research and development in the past 70 years and has proved to have the potential to improve rainfed crop yields significantly, apart from many environmental benefits such as reduced soil erosion, increased water conservation and overall improvement in the natural resources. Watershed development projects have demonstrated that with RWH interventions, the groundwater availability improved not only in the watershed, but also in the downstream areas.
Earlier studies on water resources assessment (CWC, 2019) used coarse resolution geo-spatial database in which small water bodies are not detected, and limited concept of rainwater harvesting in watersheds. There is a need of bottom-up water resources planning approach (Dsouza et al. 2017). Watersheds as the prime focus to meet local needs which would lead to evolution of a realistic and scientific water plan.

WATERBODY ASSESSMENT

The timely and accurate monitoring of surface water is crucial to hydrological processes and the management of water resources. An important distinction from the traditional field survey methods used in the past is the ability to collect water information for regional and global scales rapidly and precisely thanks to the advent of remote sensing technologies. Some of the methods used to extract water bodies from optical imagery are the single-band threshold method (Sekertekin et al. 2019), water index method (Wang et al. 2018), mixed pixel decomposition method (Bijeesh and Narasimhamurthy 2020), remote sensing image classification method (Isikdogan et al. 2017), and multisource data combination method (Huang et al. 2016). The most accurate and practical approaches for extracting water are the remote sensing image classification method and the water index method. The precision required and the process complexity are taken into account by these methods (Jiang et al. 2021, Acharya et al. 2018, Li et al. 2021, Li et al. 2022, Mehmood 2022). Das et al. (2020) mapped the water bodies in the Indian Brahmaputra River basin using satellite imagery. The study found that water bodies in China's Three Gorges Reservoir may be precisely mapped and their dynamics evaluated using high-resolution Sentinel-2 satellite images. According to Bie 2020, Sentinel-2 images can give precise and comprehensive information about the dynamics of water bodies.

Using optical images, supervised image classification using machine learning algorithms, such as SVM (Sun et al., 2015), random forest (Ko et al., 2015), and deep learning (Isikdogan et al., 2017; Wang et al., 2020), is an efficient and straightforward method of extracting surface water (Pickens et al., 2020; Wu et al., 2021). These supervised classification methods, which depend on the quantity and quality of the training samples, can yield acceptable results for water extraction if there are sufficient training samples. The two main types of pixel-based pattern recognition analysis utilized in machine learning techniques are supervised and unsupervised classification techniques. Because of its excellent accuracy, the approach has been frequently employed in remote sensing water extraction. At the moment, support vector machines, neural networks, and random forest approaches are the three main machine learning algorithms utilized to extract water bodies. Previous research has identified the most effective classifying approach by examining multiple classification algorithms. A comparison research of various object- and pixel-based classification methods employing multi-source high spatial resolution satellite data for Land Use and Land Cover (LULC) mapping was carried out by Balha in 2021. The project sought to improve the effectiveness and precision of mapping land use and land cover (LULC), with a special emphasis on regions such as India, by employing machine learning algorithms and high-resolution satellite data. In 2020, Sharifzadeh emphasized the importance of surface water mapping for comprehending global environmental changes for the St. Croix watershed area, with a particular focus on a Support Vector Machine-based water detection study. The study emphasized how crucial it is to precisely locate and map water bodies.

SURFACE WATER PLANNING AT LOWER MAHANADI BASIN USING GEOINFORMATICS

The Nayagarh district, which spans a geographical area of 3890 km^2 in lower Mahanadi basin is situated in south-eastern Odisha between latitudes 19° 54' - 20° 32' N and longitudes 84° 29' - 85° 27' E. The height above mean sea level (MSL) varies from 47 to 932 meters. The district is divided into eight Tehsils and eight Blocks, which are Daspalla, Gania, Khandapada, Nayagarh, Nuagaon, Odagaon, and Ranpur. Its northeastern region has created a small, well-cultivated, fertile valley that is crossed by small streams. This region experiences three distinct seasons: a hot and dry summer, a hot and humid rainy season, and a mild winter. In Nayagarh, there is 1356 mm of annual rainfall on average, with 80% of that falling between June and September during the monsoon season. The tropical climate of the area results in scorching summers and cold winters. In summer, the temperature reaches a maximum of 45.1 °C, while in winter, it drops to 9 °C. Winter typically lasts from October to February, and summers

typically run from March to May. Rain often occurs from June to September, which is the southwest monsoon. According to the National Bureau of Soil Survey and Land Use Planning (NBSS&LUP) (ICAR) and Planning Commission, Government of India classifications, the study area is located in Agro-Eco Sub-Region 12.2 (AESR 12.2) and Agro-Climatic Zone 7 (ACZ 7) of India, respectively. The majority of the research area is made up of rocks, including sandstones, granulites, quartz, garnetiferous granite gneiss, acid charnockite, khondalite, and pegmatite veins. The division's soils are mostly quite deep, have good drainage, a fine loamy texture, and react acidic.

Seasonal variations in atmospheric conditions and changes in viewing geometry led to considerable variations in the spectral properties of water bodies in the Nayagarh region. The research examined the effects of two machine learning algorithms (SVM and decision tree), three thresholding techniques (NDWI, MNDWI, and MNDWI2), and the SAR method used for water body extraction on Sentinel-1 and Sentinel-2A (level-1A) remote sensing images. It also assessed the transfer performance of models applied to remote sensing images at different times and compared the variations between these models. The proposed approach showed that, the performance of various water retrieval methods (NDWI, MNDWI, and SAR approaches) was limited by the complicated distribution of ground objects and varied factors impacting remote sensing image classification. When these methods were directly applied to remote sensing images in different seasons, the overall accuracy, kappa coefficient, and total area of water pixels showed a significant decline in the wet season. Misclassification of non-water pixels as water pixels was more for the water indices method during post-monsoon than pre-monsoon season.

The accuracy evaluation performance of each machine learning algorithm (SVM and Decision Tree) on the test set cannot represent the local area performance. Pixel-based Decision Trees showed poor performance among machine learning algorithms with overall accuracy (71% and 62%) and kappa coefficient (0.42 and 0.24) during pre-monsoon and post-monsoon seasons.

The MNDWI2 water extraction method using Sentinel-2A (Level-1A) MSI remote sensing images in the study area extracted more water pixels during the post-monsoon compared to the pre-monsoon season. This index had the highest water extraction accuracy seasonally compared to other methods. It possesses the best water enhancement effect that could suppress background information, especially for water-related land use types and pollution.

SURFACE WATER PLANNING AT BHARGABI-DAYA DOAB USING GEOINFORMATICS

The Bhargabi-Daya doab was selected in the Mahanadi delta for surface water planning. The study area is the doab portion of the river Daya on the west and river Bhargabi on the east side. Both rivers Daya and Bhargabi are distributary rivers of river Kathajodi which is also distributary of river Mahanadi. Field visits were made and information was collected about the study area, and problems related to waterlogging and drainage congestions. The major problem for drainage in the area is the very flat topography and meagre average slope of around 0.02% in the upper reaches reducing to about 0.01% in the coastal proximal areas. The pre and post monsoon water table in the area is very shallow and the seasonal fluctuation is of very minor magnitude. The extensive waterlogging condition in both pre and post monsoon season is mainly due to drainage congestion. This in turn results in poor agricultural yield. People, near coastal areas, resort to prawn cultivation which causes further degradation of water quality.

Indian remote sensing satellite digital images were procured from Odisha remote sensing application centre, Bhubaneswar and were processed and analysed for preparation of land use land cover map and surface water resources. Different land uses/and land covers which were demarcated are agriculture plantation; aquaculture; built up – compact (continuous); built up – rural; built up - sparse (discontinuous); canal/ drain; crop land- *kharif* crop; crop land- *rabi* crop; crop land- zaid crop; cropped in two seasons; deciduous (dry/moist/thorn) - dense/closed; deciduous (dry/moist/thorn) – open; fallow land; forest plantation; industrial area; inland - manmade (waterlogged, saltpans etc.); inland - natural (ox-bow lake, waterlogged etc.); lagoon, creeks, mudflats etc; lakes/ ponds – permanent; river - non perennial; river – perennial; sandy area-coastal; sandy area-riverine; scrub forest; scrub land - dense/closed; scrub land – open; tree clad area - dense/closed/open; and vegetated/ open area. Then they were regrouped as per the analytical need. The digital elevation data of ASTER (Advanced space borne Thermal Emission and Reflection radiometer) Global DEM (digital elevation model) was obtained from United State Geological Survey (USGS) Earth Explorer data base. The preparation of contour map with 10 m interval and 2 m interval was done separately for the study area.

The surface water potential as well as other land use land cover was estimated from digital satellite images using geoinformatics. The total geographical area of the study area is 1266.31 sq. km (126631.88 ha). The area under major land use and land covers found is as follows. The area under only *kharif* crop is 9441.96 ha (7.46%), only *rabi* crop is 32182.95 ha (25.41%), but area cropped for two seasons are 22871.05ha (18.06%) and area under zaid (summer) crop is only 271.40 ha (0.21%). The

area under agriculture current fallow is around 15778.34 ha (12.46%). The total wetland is 12422.21 ha (9.81%). Area under permanent lakes and ponds is 117.48 ha and area in which aquaculture is being taken is found to be 4205.88 ha (3.32%). This includes area adjacent to Chilika lake in which aquaculture is being taken or can be taken up. The Chilika lake was not included in the study area for drainage planning, however all the streams are finally discharging flow into Chilika lake only. The agricultural plantation such as coconut and other plantation crops etc. covers an area of 4361 ha (3.44%). As a compact continuous built up area, the Puri town falls in the study area covering an area of 984.05 ha and rural built up area including villages, hamlets etc. cover an area of 11762 ha (9.29%). Rivers which are perennial and non-perennial in nature covers an area of 2812.28 ha (2.22%). The river bed which remain dry during post-monsoon season but flows full during monsoon season has been demarcated as river (non-perennial). The area under canal and drain are 249.34 ha. There are also areas under deciduous and scrub forest (2644.33 ha) and waste land 1900.23 ha) etc. The interesting findings of the crop area analysis showed that area under crop during *rabi* season is considerable. This is due to the fact that because of severe waterlogging and drainage congestions which results standing water more than 1m in the field, it is not possible to take up *kharif* crop in those area. However, after the monsoon is over, there is a decrease in standing water and people go for transplanting of paddy in those areas to have a crop during *rabi*. Areas in which two crops are taken are either associated with availability of canal water or the farmers take pira-crop utilizing the residual moisture available around the harvesting of paddy. There are also some area in which paddy is taken both during *kharif* and *rabi*. Farmers grow vegetable and other cash crop adjacent to the bank of river and canal or area adjacent to the perennial stream of the river. The vegetable is also grown in the areas where good quality water is available in nearby channel, nala or other surface and groundwater sources. Ground truthing of above information has been done along Bhargabi river course till Gabakund barrage where river Nuanai has been originated from river Bhargabi and fall into Bay of Bengal. Also observations in area between Satyabadi and Uttara has also been done. Observation in hand held GPS (Global positioning system) was made regarding the latitude, longitude and elevation data. The name of the village and other land mark were noted. Observations were taken in prominent geographical locations such as river bridge, culverts, originating points of canals and drains from river, on the top of the barrage so that it can be easily verified on satellite images. The land use land cover of the adjacent areas close to the point of observation were noted and compared with the classified land use land cover map for verification and accuracy.

Drainage parameters of the Bhargabi-Daya doab were estimated. Analysis of drainage parameters of the Bhargabi-Daya doab using geoinformatics showed that the total geographical area of the study area is 1266.31 km^2, and the total stream length of the watershed is 297.24 km. The contour map shows majority of the agricultural field are within 10 m elevation from mean sea level. The area adjacent to river or stream course are flat and having contour value within 5 to 10 m above mean sea level. This indicates that during rainy season that water would not be easily drained to river.

To assess the extent and temporal variation of waterlogging, satellite images were analysed. LANDSAT images were obtained from United States Geographical Survey records for the year 2015. After browsing the available satellite images one cloud free image was chosen for 30thSeptember 2015 and another image with partial cloud was chosen for 16th October 2015. False color composite maps of the images were extracted showing the area under waterlogging. The images were classified and it was observed that waterlogged area on 30.09.2015 was 355.1 km^2 and reduced to 259.3 km^2 by 16.10.2015. The mapping of surface waterlogging was done for both the dates.

A comprehensive drainage plan was developed for Daya-Bhargabi doab considering all above information using geoinformatics. The existing drainage density is low. It needs to be enhanced. Enhancing drainage density is possible by two ways. Either new drainage/ streams are to be excavated in the study area. The second option is to desilt the stream which are unable to carry sufficient water due to siltation. Therefore, considering the topographic situations, presence of depressions and silted streams, a layout plan and location of streams which needs to be desilted were found out using geoinformatics.

TAKE HOME POINTS

During climate change scenario, it is essential to go for surface water planning for adopting water harvesting, conservation, and its efficient utilizations though in-situ (where it falls: field) and ex-situ (where it flows: stream) water conservation techniques and its efficient utilization. Assessment of accurate surface water resources available and planning is required along with geomorphologic parameters of the watersheds or study areas using geoinformatics. Accurate assessment of water bodies and other land use land cover are possible using geoinformatics. Use of geoinformatics for surface water planning is easy and time efficient. The dynamic nature of the water spreading, water logging can be

easily assessed using geoinformatics. The drainage planning of coastal area can be easily carried out using geoinformatics.

REFERENCES

Jena SK (2002) Development and evaluation of hydrological models for agricultural watersheds using remote sensing and GIS. Unpublished PhD Thesis. Indian Institute of Technology, Kharagpur, India

Koohafkan AP (2000) Land resources potential and sustainable land management-An overview. Lead paper of the international conference on Land resource management for food, employment and environmental security during November 9-13, 2000, New Delhi, India. pp: 1-22.

Singh G, Babu R, Narain P, Bhushan LS, and Abrol IP (1992) Soil erosion rates in India. *J. of Soil and Water Conservation.* 47(1): 97-99.

Tam PWM (1998) Application of inflatable dam technology-problems and countermeasures. *Canadian Journal of Civil Engineering.* 25: 383-388.

Tam PWM, and Zhang X (2002) Management of rubber dams in Hong Kong, *Canadian Journal of civil Engineering*. 29: 409-420.

Velayutham M (2000) Status of land resources in India. Lead paper of the international conference on Land Resource Management for Food, Employment and Environmental Security during November 9-13, 2000, New Delhi, India.pp: 67-83.

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Coastal saline soils of Gujarat: current status, reclamation measures and improved management strategies to restore productivity

ANIL R. CHINCHMALATPURE
ICAR Central Soil Salinity Research Institute, Regional Research Station, Bharuch 392012 Gujarat

Abstract

Coastal ecosystems are areas where land and water join to create an environment with a distinct structure, diversity and flow of energy. Coastal ecosystem support 1/3rd of world population. As we all know that the earth has two types of ecosystems namely land ecosystem and also a water ecosystem. The beach ecosystem is a type of land ecosystem. Although it is adjacent to a marine ecosystem, the coastal ecosystem is a land ecosystem. Coastal areas of the country pose serious problems from agricultural productivity point of view due to various constraints in soil, climate and other natural resources. Salinity of soil and water is an environmental constraint affecting million hectare of land. The problem of seawater-induced soil salinization in coastal areas can worsen by increasing sea levels and the unsustainable use of freshwater supplies from coastal aquifers (Karmakar *et al.,* 2016 and Dasgupta *et al.*, 2015). Coastal ecosystem is defined as an ecosystem which is a unit of both biotic and abiotic components that are around the coast, interact with each other. Among these soils and water are important in relation to agricultural point of view.

Coast has a significant role in agriculture food production, since the agricultural productivity in this ecosystem is generally lower than the country's average, although overall about 50-70 % of the global population live within 100 km of the coastline covering only about 4% of earth's land and within 200 km of coastal area shares less than 15% of the earth surface area. Agriculture in this ecosystem is constrained by a number of technological, anthropological and climatic factors limiting the productivity. Coastal saline soils are having dominant salts of sodium chloride and sodium sulphate with abundance of soluble cations with dominance of Na^+ followed by Mg^+, Ca^+ and K^+ and chloride as the predominant anion followed by sulphate.

As per the compilation (Velayutham *et al.,*1999) made on the soil resources and their potentials for different Agro-ecological Sub Region (AESR) in coastal tract of India show total 10.78 Mha area under this ecosystem (including the islands) which was the first scientific approach for delineation of the coastal ecosystem. The total geographical area of Gujarat is 196024 sq km which is 7th largest state in terms of area in India and the state has 1600 km longest coastline, which is nearly 1/3rd of the entire coastline of India. To the west and southwest Gujarat is surrounded by the vast Arabian Sea, by Pakistan to the northwest, Rajasthan to the North, Maharashtra to the South and Madhya Pradesh to the east. The coastal belt of 1125 km stretches from Bhavnagar to Lakhpat borders Saurashtra and Kutch districts of Gujarat (Rao et al., 2013). Due to see water ingress coastal area affected was estimated to 1.06 Mha in the year 1984, whereas In the year 2007-08, 15% increase in saline water ingress and area was 1.15 Mha and in the year 1996 about 1.31 million ha coastal salt affected soils (Mandal *et al.,* 2018). Every year on an average 0.5 to 1.0 km distance from the coastline is affected by salinity ingress. On an average 0.5–1.0 km distance from the coastline is affected by seawater ingress every year. A total of 16 coastal districts, covering ~ 68% area of the state and comprising ~58% of its dynamic groundwater resource, are adversely affected. These include the coastal districts, namely, Kutch, Morbi, Jamnagar, Devbhoomi Dwarka, Porbandar, Junagadh, Gir Somnath, Amreli, Bhavnagar, Anand, Ahmedabad, Vadodara, Bharuch, Surat, Navsari, and Valsad, besides the union territory of Daman (Daman and Diu). Thus, about 5- to 7.5-km-wide strip of the inland area has been rendered saline till now, and water quality has deteriorated to more than 2000 ppm of TDS (total dissolved salts) in an area of 100 km^2 (Gururaja Rao *et al.* 2013).

It has been estimated that India has 12.94 lakh ha of saline soil within arable lands in all the coastal districts, and Gujarat (5.28 lakh ha), West Bengal (5.08 lakh ha), and Andhra Pradesh (1.06 lakh ha) were identified as the top three-salinity affected coastal states in the country (Mandal *et al.,* 2023). As per the latest estimate (Mandal *et al.*, 2023), the extent of coastal saline soils in Gujarat state is 527,952 ha (around 40% area of the total coastal saline soils of India). They reported that the highest coastal saline soils of Gujarat are confined in Jamnagar district (18.9%), followed by Morbi (13.9%), Junagarh (10.9%), Rajkot (8.2%), Surat (7.6%), Bhavnagar (5.8%) and Devbhumi Dwarka (5.6%). These seven districts occupy 70.8% of the coastal saline soils in the state. As compared to earlier estimate (Mandal *et al.*, 2009) there was 27.6% increase in area of coastal saline soils.

Due to injudicious use of canal irrigation water on saline *Vertisols* of Baratract of coastal Gujarat, initiation of pedogenic process *i.e* sodification has been noticed as evident from increased ESP in the

lower horizon from 7.8 to 17.2 (Chinchmalatpure *et al.*, 2018). These changes may be due to the low to moderate saline soils and expected to be potentially more sodic if irrigation water of low salt concentration (<3 me/L) like canal water is applied owing to their susceptibility of clay dispersion and resultant reduction in hydraulic conductivity (Oster and Schoer, 1979; Shainberg *et al*., 1981) and because of the difference in osmotic potential between the bulk soil solution and the interior of soil aggregates. Besides, canal water (with low electrolyte concentration, EC = 0.5 dS/m and SAR = 0.31) is more likely to flow into the spaces (micropores) between clay platelets.

Salinisation and sodification in arid, semiarid and coastal regions of the country due to different causes minimized the land suitable for arable farming. Technological knowledge generated till date has helped in taming the problem in large tracts of land in different countries to restore their full productive potential. However, new challenges are set to be faced either due to changing climate or land use anomalies, leading to exponential increase in the area under salinity. With new challenges cropping up, soil salinity related stresses area can be more pronounced and more damaging to crop production.

The Gujarat State Land Development Corporation Ltd. has taken up salinity control measures in costal Gujarat covering Ahmedabad, Anand, Vadodara, Bharuch, Navsari, Valsad, Surat, Jamnagar, Rajkot, Bhavnagar, Amreli, Junagadh Porbandar and Kutch districts covering about 79,000 ha area. The major activities comprise construction of reclamation bunds, water recharge structures and soil management practices. The productivity of these soils can be restored by management and reclamation using different technologies available with the ICAR-Central Soil Salinity Research Institute. The processes of accumulation of salts and build-up of ESP have to be reversed. To achieve this, provision of adequate drainage, replacement of Na^+ ions from the exchange complexes, leaching out of soluble salts below root zone, cultivation of salt tolerant varieties/ halophytic plants, bio-saline agriculture, plantation of bio-shield including mangroves in coastal area, etc. have to be ensured for enhancing the productivity of these soils.

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Flue gas desulphurization gypsum (FGDG)- promoting Circular economy through usage as an alternate amendment for sodic soils reclamation

A.K. RAI[1*], P. SUNDHA[1], N. BASAK[1,2], P. CHANDRA[1], R. MUKHOPADHYAY[1], and R. K. YADAV[1]

[1]ICAR–Central Soil Salinity Research Institute, Karnal, Haryana 132001

[2]ICAR–National Bureau of Soil Survey and Land Use Planning, RRS, Kolkata, West Bengal 700091

E-mail: ak.rai@icar.gov.in; raiarvindkumar@gmail.com

Key Words: *Sodicity, Alkalinity, Amendments, Exchangeable Sodium Percent, Gypsum, Coal Fire Plant, Geoaccumulation Index*

INTRODUCTION

Gypsum has been used in agriculture for centuries to provide plant nutrients, improve soil physical and chemical properties, and increase crop productivity (CSSRI Vision 2030). India produced an estimated 4.3 million metric tons of gypsum in 2022 (Statista, 2023). Taking the recommendation of 50 % of 12 -15 t ha^{-1} for reclamation country may need a total supply of more than 32-45 million tons of gypsum with 70% purity. The sodic land reclamation in the country is primarily based on the application of gypsum amendment. In current scenario of limited availability of mined gypsum the success of bringing about 3.77 mha sodic lands under cultivation heavily depends upon the success of alternate reclamation strategies. Recognizing the role of flue gas desulfurized gypsum (FGDG) in reclamation of sodic soil as an alternative to mine gypsum, CSSRI and NTPC has jointly completed a collaborative project to study the efficiency and efficacy of FGDG and monitoring of the heavy metal(s) uptake, crop growth and quality of soil and water in FGDG amended soils. The flue gas desulfurization gypsum (FGDG) is a by–product gypsum synthesized by scrubbing sulphur in lime from combustion gases in coal–fired power generation plants

MATERIALS AND METHODS

The FGD gypsum as by-product of the FGD system was received from the wet FGD system of the coal power plant of NTPC, Vindhyachal, Singrauli, Madhya Pradesh, India. The FGD gypsum samples were collected at different time intervals. The pH and EC of FGD gypsum were measured in a 1:2 material-water suspension using a glass electrode and conductivity meter, respectively. The $CaCO_3$ percentage was calculated following the manometric method using Collin's calcimeter method of Allison and Moodie. For moisture content estimation, the FGD gypsum samples were weighed and dried

in a hot air oven at 105 °C for 48 h, and volumetric gypsum moisture content was expressed as percent weight loss on a volume basis. The leaching test of the HMs present in FGD gypsum samples was done following the US EPA SPLP standard to extract the acid-soluble fraction (USEPA, Method 1312, 1994) and European Standard leaching test EN 12457-2 (2002) for water-soluble fraction.

RESULTS AND DISCUSSION

This synthetic gypsum of >90% purity was found to be an excellent source of Ca (272.7 g kg–1) for sodic soil reclamation (Table 1). Its water solubility is 40% greater than the mineral gypsum. The heavy metals present such as Mn, Fe, Zn Al, Co, Ni showed a low level of risk assessment code (RAC), contamination factors, and geoaccumulation index, values were in the range 1.2 –7.47, 0-0.16 and <1.0, respectively. The risk assessment code (RAC) analysis of all the heavy metals present showed a low level of eco–toxicity of Mn, Fe, Zn with the RAC values ranging from 1.2 –7.47 for different metals (Fig. 1). The contamination factor calculated based on the FGDG application for sodic soil reclamation was in the range of 0.0-0.16 indicating no risk of the FGDG application. The geo–accumulation values (Igeo<1) after the application of FGDG for soil reclamation did not add any toxic metal to the soil (Table 2).Sodic soil reclamation was carried out in high pH soil in different soil ecologies by applying flue gas desulphurization gypsum (FGD gypsum) on an equivalent basis of 50% GR (replacing 50 percent of Na^+ from soil exchange phases by Ca^{2+}). Standard operating parameters were identified and tailored into a protocol for FGD gypsum based sodic soil reclamation. FGD gypsum was tested and validated in rice, wheat, and berseem crops in different agro-ecologies of Haryana (two), and UP (two) and Punjab (one location). Sodic soil reclamation was carried out in high pH soil in different soil ecologies by applying FGD gypsum on an equivalent basis of 50% GR (replacing 50 percent of Na^+ from soil exchange phases by Ca^{2+}). The reclamation study was carried out in controlled conditions and participatory field trials at farmers' fields in three states viz., Haryana (Sitamai and Pundrak, Karnal), Uttar Pradesh (Chirkihit, Azamgarh and Markshnagar, Unnao) and Punjab (Patti Jhungian, Patiala) during 2021–2023. Over the year yield of the rice, wheat, and berseem increased by 250, 179 and 43% because of the FGDG compared to the control, respectively. Depending upon the severity of sodicity, FGD gypsum applied equivalent to the fifty percent gypsum requirement caused a 2.0-2.9 times increase in crop yield (rice, wheat and berseem) compared to un–reclaimed soils.

Table 1. *Characteristics of the FGD gypsum l*

Property	Unit	Value provide range
$pH_{1:2}$		8.77
$EC_{1:2}$	dS m^{-1}	4.95
$CaCO_3$	%	1.5–5.0
Moisture content		15-17.0
Purity		> 90%
Ca	g kg^{-1}	272.7
Mg		8.8
Al	mg kg^{-1}	1726.7
Co		1.53
Fe		2540.0
Mn		71.9
Ni		7.1
Zn		24.3

As, B, Ba, Cd, Cu, Cr, Hg, Li, Mo, Pb, Sb, and V were below the detectable limit

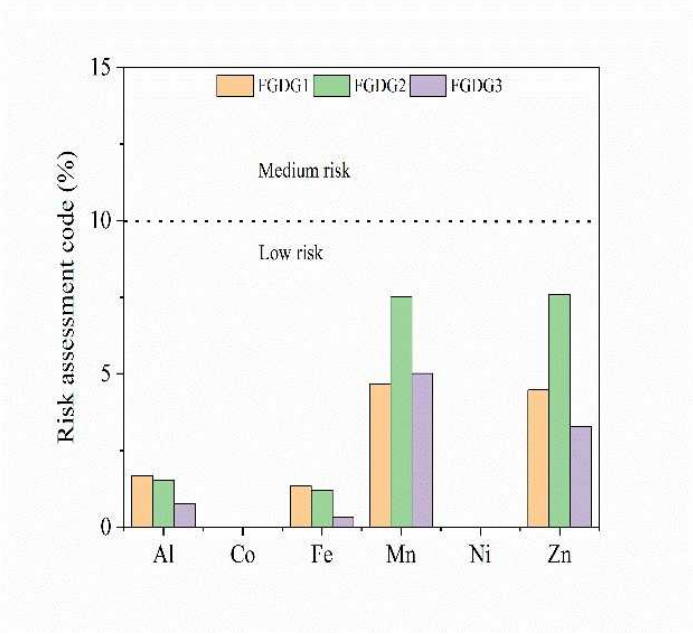

Fig. 1. *Risk assessment code of heavy metals in the heavy metals FGD gypsums*

Table 2. *Contamination factor (C_f) and geoaccumulation index (I_{geo}) values of elements in the FGDG samples*

Elements	Contamination factor (C_f)	Geoaccumulation index (I_{geo})
Al	0.0001	–14.1 to –13.8
Fe	0.0003	–12.2 to –12.1
Mn	0.0005-0.0006	–11.5 to –11.4
Ni	0.002	–9.9 to –9.9
Zn	0.33-0.35	–10.0 to –9.9
Co	0.14–0.17	–11.2 to –11.0

*C_f < 1.0: low contamination; $I_{geo} \leq 1.0$: uncontaminated

CONCLUSIONS

The success of the sodic land reclamation program to bring about 3.77 mha sodic lands under cultivation will heavily depend upon the success of the alternate reclamation strategy. This requirement is expected to increase further due to the development of sodicity in new areas under poor-quality water irrigation. The FGD gypsum can be utilized safely as an alternative to Gypsum to ensure the circular economy.

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REFERENCES

Allison, L. E. & Moodie, C. D. Carbonate. In Methods of Soil Analysis. Part 2. Chemical and Microbiological Properties (ed. Black, C. A.) 1379–1396 (American Society of Agronomy, 1965)

Schoonover, W. R. Examination of Soils for Alkali. (1952).

Page, A. L., Miller, R. H. & Keeney, D. R. Methods of Soil Analysis (Soil Science Society of America, 1982).

USSL. Diagnosis and Improvement of Saline and Alkali Soils. (USDA Handbook, 1954).

Jackson, M. L. Soil Chemical Analysis (Prentice Hall India, 1973).

Chesnin, L. & Yien, C. H. Turbidimetric determination of available sulphates. *Soil Sci. Soc. Am. Proc.* 15, 149–151 (1951).

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Cut-soiler: A sustainable solution for salinity management and yield improvement in arid ecosystem

GAJENDER YADAV[1*], RAJENDER KUMAR YADAV[1], ARVIND KUMAR RAI[1], NEHA[1,2], MANISH KUMAR[1], GOVIND PRASAD[1] and JUNYA ONISHI[2]
[1]ICAR-Central Soil Salinity Research Institute, Karnal, India
[2]Japan International Research Center for Agricultural Sciences, Japan
E-mail: gajender.icar@gmail.com

Key Words: *Cut-Soiler, Drainage, Mustard, Pearl Millet*

INTRODUCTION

Soil salinity and waterlogging are major factors driving land degradation in irrigated agriculture, particularly in saline-arid areas, where they adversely affect the crop yields. Out of all the salt-affected areas worldwide, ~397 million hectares (M ha) is saline, constituting 20% of total cultivated land and 50 % of the irrigated areas of Earth. To cope up with the problem of salinity, the cut-soiler constructed preferential shallow sub-surface drainage (PSSD) is a potential technique is being tested under ICAR-CSSRI and JIRCAS collaborative project. The Cut-soiler PSSD simulated in lysimeters by manual construction at 60 cm depth using rice residue as filling material to evaluate its effect on salinity and subsequent crop yields. Purpose of this study is to evaluate the effect of cut-soiler based salinity management.

MATERIALS AND METHODS

The experiment was conducted in split-split plot design with two replications, where size of each plot was 2m × 2m × 2m. The study comprised of 24 treatment combinations, cut-soiler based preferential drainage were applied in 12 plots as main plot treatments along with another 12 plots as control (without cut-soiler). The two soil types in sub plots i.e. saline soil and heavy textured; collected from selected representative sites i.e. 6 plots of each type of soil in both cut-soiler and control. The residue filled V shape drains were prepared to mimic the effect of cut-soiler preferential drainage operation in the field; three saline water irrigation treatments viz., 4, 8 and 12 dSm^{-1} were applied in sub-sub plots and scheduled as per crop water requirement. The productivity of mustard (var. CS 58) and pearl millet (var. HHB 197) were evaluated under the imposed treatments for two years.

RESULTS AND DISCUSSION

Under cut-soiler operated plots, the soil salinity (ECe) after pearl millet harvest at 0-15, 15-30, 30-60 and 60-90 cm depths were 37.8, 40.1, 39.2 and 37.2% lower than without cut-soiler plots. Similarly, the reduction in ECe after mustard harvest at 0-15, 15-30, 30-60 and 60-90 cm depths were 37.7, 42.9, 46.2 and 57.1% lower in cut-soiler plots than control. The lower soil salinity observed in residue-filled simulated cut-soiler PSSD plots throughout the experimental period showed the positive effect of preferential outflow of water and salts through cut-soiler PSSD. Under cut-soiler treatment, the average soil salinity reduction was upto 60% after 2 years of cut-soiler PSSD construction (Neha et al., 2022). Cut-soiler PSSD helps drain excess water and remove salts from the field, improving soil conditions.

Table 1. *Effect of cut-soiler on ECe (dS m^{-1}) after harvesting of pearlmillet-mustard*

Treatment	Pearlmillet				Mustard			
	0-15	15-30	30-60	60-90	0-15	15-30	30-60	60-90
Cut-soiler	1.63^{B}	1.87^{B}	2.17^{B}	2.46^{B}	3.25^{B}	2.80^{B}	2.47^{B}	1.76^{B}
Without cut-soiler	2.62^{A}	3.12^{A}	3.57^{A}	3.92^{A}	5.22^{A}	4.90^{A}	4.59^{A}	4.10^{A}
CD (P=0.05)	0.08	0.32	0.24	0.40	0.56	0.51	0.33	0.20

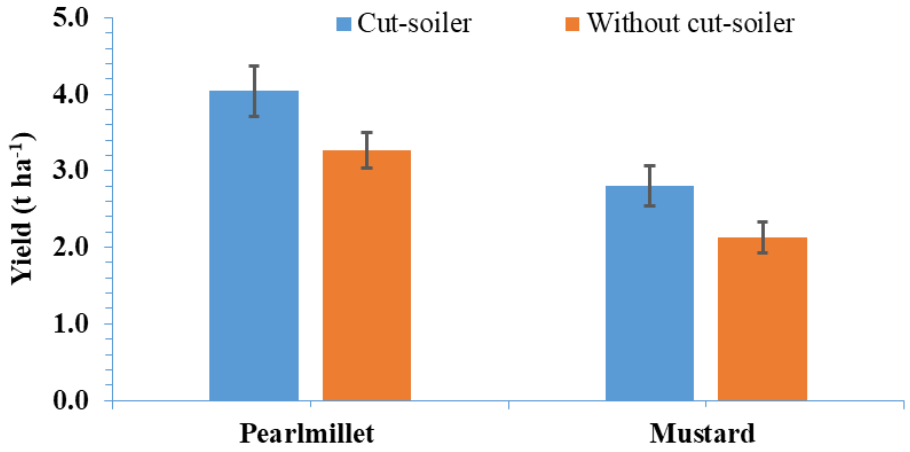

Fig. 1: *Effect of cut-soiler on yield (t ha-1) of pearlmillet-mustard*

The cut-soiler operation treatment significantly increased (~23.54 %; *p=0.0073*) pearl millet grain yield (4.04 t ha^{-1}) in comparison to without cut-soiler (3.27 t ha^{-1}) plots. The cut-soiler treatment significantly increased mustard seed yield (2.80 t ha^{-1}) in comparison to without cut-soiler (2.13 t ha^{-1}) plots. There was 31.5 % higher mustard yield under cut-soiler treatments over control. The pearl millet and mustard yield increased 27.4% and 31%, respectively under saline water (Neha et al., 2024). Improved drainage conditions of cut-soiler plots that led to lower soil salinity resultant in increased crop yields.

CONCLUSION

Cut-soiler PSSD proved effective in reducing salt soil salinity and significantly increased the yield of crops. Hence, the present study showed the potential of cut-soiler PSSD in the management of root zone salinity in salt-affected areas.

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REFERENCES

Neha, Yadav G., R. K., Yadav, A. K., Rai, M., Sehwag, J., Onishi, K., Omori and Sharma P.C. (2022). Desalinization effect of simulated Cut-soiler based residue filled preferential shallow sub surface drainage improves physiology and yield of rainfed pearl millet in saline semiarid regions. *Land Degradation Development* 33(10): 1758-1770.

Neha, Yadav G., R. K., Yadav, A. K., Rai, G., Prasad, S., Kumar, B., Narjary, J., Onishi, K., Omori and Chaudhari, S. K. (2024). Cut-soiler-constructed residue-filled preferential shallow sub-surface drainage improves the performance of mustard-pearl millet cropping system in saline soils of semi-arid regions. *Frontiers in Agronomy* 6: 1492505.

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Integration of organic and inorganic sources of nutrients on growth, yield and quality of groundnut

U. BAGAVATHI AMMAL[1], R. GANDHIMATHI, R [1], R. SANKAR[1], K. COUMARAVEL[1], PRADIP DEY[1] and SANJAY SRIVASATAVA[2]

[1]Department of Soil Science and Agricultural Chemistry, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal-609603.

[2]Project Coordinator, Indian Institute of Soil Science, Bhopal-462 038

E-mail: pancham112@gmail.com

Key Words: *Groundnut, Growth, Yield and Quality*

INTRODUCTION

The oilseed production grew to 365.65 lakh tonnes in 2020-21 from 108.3 lakh tonnes in 1985-86. India is the 4th largest oilseeds producer in the world. It has 20.8% of the total area under cultivation globally, accounting for 10 per cent of global production. Groundnut is a multipurpose crop providing edible oil (44-50 per cent), vegetable protein (26 per cent), carbohydrates (20 per cent) and fibre (5 per cent). The average yield of groundnut in India is extremely low compared to other countries like the USA, China, and Myanmar. The low yield may be due to cultivation of groundnut mainly under rainfed conditions, lack of awareness about modern production technologies, low input use and loss of commodity at various stages of crop production by biotic and abiotic stresses and many socioeconomic factors. Imbalanced and inadequate use of nutrients is one of the major constraints for lower yield of groundnut. Proper fertilizer management of groundnut crop with right kind of nutrients at correct time adapting right method of application improve the production and soil fertility status.

MATERIALS AND METHOD

To develop the fertilizer prescription equation for groundnut crop, the gradient crop (Maize - DMH - 8255) and the test crop (Groundnut-var G7) experiments were conducted at farmer's field in Earipakkam village, U.T of Puducherry. The soil of the experimental field belongs to Mannadipet series, taxonomically *Typic Ustropept;* sandy clay loam in texture, pH- 7.60, EC- 0.143dSm^{-1}, CEC-20.2 cmol (p^{+}) kg^{-1}, $KMnO_4$-N-182.0 kg ha^{-1}, Olsen-P-50.3 kg ha^{-1} and NH_4OAc-K- 198.8 kg ha^{-1}.

The study was based on the inductive methodology developed by Ramamoorthy *el al*. (1967) as followed in All India Coordinated Research Project on Soil Test Crop Response correlation (AICRP - STCR). The experiment was conducted in two phases. In the first phase, fertility gradient experiment was conducted by raising Maize hybrid as an exhaust crop. For this, the field was divided into three equal which were fertilized with $N_0P_0K_0$ (strip-I), $N_1P_1K_1$ (strip-II) and $N_2P_2K_2$ (strip-1II) levels to create fertility gradient. Subsequently, in the second phase, after the harvest of the exhaust crop, groundnut variety G7 was raised as test crop. Each of the fertility strips was subdivided into 24 sub-plots resulting in 72 plots. There were 24 treatments consists of four levels of N (0, 10, 20 and 30 kg ha^{-1}), P_2O_5 (0, 25,50 and 75 kg ha^{-1}), K_2O (0, 30, 60 and 90 kg ha^{-1}) and FYM (0,12.5 and 25 t ha^{-1}). The moisture and N, P_2O_5 and K_2O contents of FYM were 28, 0.56, 0.32 and 0.51%, respectively.

RESULTS AND DISCUSSION

The mean value of plant height (cm), leaf area index (LAI) number of branches per plant, No. of pegs/ plant and No. of nodules/ plant were 21.5 cm, 1.40, 11, 23 and 51, respectively in absolute control plots and 33.2,2.15,15,43 and 82, respectively in NPK + FYM @ 12.5 t ha^{-1}.The range of kernel yield (q ha^{-1}), haulm yield (q ha^{-1}) and number of pods per plant, were 12.49 to 12.93, 28.01 to 28.98 and 9.20 to 10.80, respectively in absolute control plots and the kernel yield ranged from 15.07 to 31.86, 16.62 to 33.22 and 17.91 to 34.42 q ha^{-1} in NPK alone, NPK + FYM @ 6.25 t ha^{-1} and NPK + FYM @ 12.5 t ha^{-1}, respectively. The mean value of 100 kernel weight (g) and shelling percentage 27.26 and 42, respectively in absolute control plots and 39.11 and 60.99, respectively in NPK + FYM @ 12.5 t ha^{-1}.

The minimum and maximum oil content (per cent) and protein content (per cent) were 24.31 to 29.9 and 16.21 to 20.43, respectively in absolute control plots. The oil content ranged from 25.31 to 42.71, 33.37 to 48.32 and 34.53 to 50.02 per cent in NPK alone, NPK + FYM @ 6.25 t ha^{-1} and NPK + FYM @ 12.5 t ha^{-1}, respectively. The protein content per cent was 17.83 to 31.06, 23.29 to 32.01 and 23.28 to 33.12 in NPK alone, NPK + FYM @ 6.25 t ha^{-1} and NPK + FYM @ 12.5 t ha^{-1}, respectively. The greater nitrogen assimilation in seed increased the amino acid and it is the integral part of protein and phosphorus is the essential constituent of a majority of enzymes, which played a major role in energy transportation required for cell division, activation of coenzymes for protein synthesis.

In absolute control plots, the groundnut pod yield ranged from 22.15 to 24.85 q ha^{-1} with a mean value of 23.51 q ha^{-1}. In plots where NPK alone were applied, the yield ranged from 24.6 to 41.8 q ha^{-1} with the mean value of 33.9 q ha^{-1} recording an increase of 44.4 per cent over absolute control. With respect to NPK + FYM @ 12.5 t ha^{-1} applied plots, the yield ranged from 27.55 to 47.15 q ha^{-1} with the mean value of 36.17 q ha^{-1} recording an increase of 53.8 and 39.6 per cent over absolute control and and FYM alone @ 12.5 t ha^{-1}, respectively. The increase of yield in IPNS may be due to enhanced photosynthesis, production of photosynthates and their partitioning between the vegetative and reproductive structure which might have improved the yield attributes and have finally increased the pod and haulm yield of groundnut. This result are in accordance with the findings of Mohapatra and Dixit (2010)) and Singh *et al*. (2014) .

CONCLUSION

To conclude, the present study had clearly indicated the superiority of IPNS in recording higher growth, yield attributes, seed quality and pod yield.

REFERENCES

Mohapatra, A.K.B. and Dixit, L. 2010. Integrated nutrient management in rainy season groundnut (*Arachishypogaea* L.). *Indian Journal of Agronomy,* 55(2): 123-127.

Ramamoorthy, B., R.K. Narasimham and R.S. Dinesh. 1967. Fertilizer application for specific yield targets on Sonora 64 (wheat). *Indian Fmg*., 17: 43-45.

Singh, Y.V., S.K. Singh, P.K. Sharma and S. Priyanka. 2014. Soil test based Integrated fertilizer recommendation for wheat in an Inceptisol of Eastern Plain zone of Uttar Pradesh. *J. Indian Soc. Soil Sci*., 2(3**):** 255-258.

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Soil health-assess, monitor and manage for our posterity

SUNANDA BISWAS

Division of Soil Science and Agricultural Chemistry, ICAR-Indian Agricultural Research Institute, New Delhi-110012, India

E-Mail: Sunandabiswas13@Gmail.Com

Key Words: *Crop Productivity, DSS, Long-Term Experiment, Resilience, Soil Health*

INTRODUCTION

Soil health degradation is a major threat to agricultural sustainability in India and elsewhere in the world. To arrest such degradation and decline in productivity, a holistic approach is needed. Assessment of soil health is important for taking necessary rehabilitation measures. A comprehensive assessment of soil health is very difficult because soil health cannot be measured directly; it is inferred from management induced changes in soil properties. Soil organic carbon (SOC) is the key or the most important indicator in maintaining soil health. There is a strong relationship between quality and stability of SOC and soil health. Therefore, it is essential to manage SOC level in soil and identify key soil health indicators with their critical limits in major soil orders and cropping systems under different agro-ecological regions (AERs) of India. A system's stability determines its ability to continue functioning under changing climate conditions, as might occur through either natural processes or human-driven disturbances. Soil resistance and resilience are the fundamental properties which have impact on nature and extent of soil degradation. Effective soil health management ensures long-term agricultural productivity, food security, and ecosystem sustainability. Healthy soil forms a continuum in the soil–plant–animal–human relationship and this continuum is crucial to maintain overall quality of food and human health.

MATERIALS AND METHODS

Soil samples were collected after harvesting of crops from farmers' fields as well as long term experiments of four major soil orders viz. Inceptisol, Alfisol, Mollisol and Vertisol from different agro-ecological regions of India. Yield data of whole duration of experiments, management inputs and other necessary information were recorded. Soil samples collected from each of sites were analysed for 21 physical, chemical and biological properties of soil. The key indicators of soil health were identified and soil health indices were developed using different approaches. The lower and upper threshold limits of the identified key indicators were established as a function of relative yield of crops. Soil resistance and resilience was measured in terms of carbon mineralization. A decision support system (DSS) was developed for on line assessment of soil health under different agro-ecological regions of India.

SHI was determined using the soil management assessment framework, applying a weighted additive indexing method (Andrews et al., 2001).

$$SHI = \sum_{i=1}^{n} W_i \times S_i \quad \text{(Eq 1)}$$

W = Principal component weightage factor and S = indicator score

RESULTS AND DISCUSSION

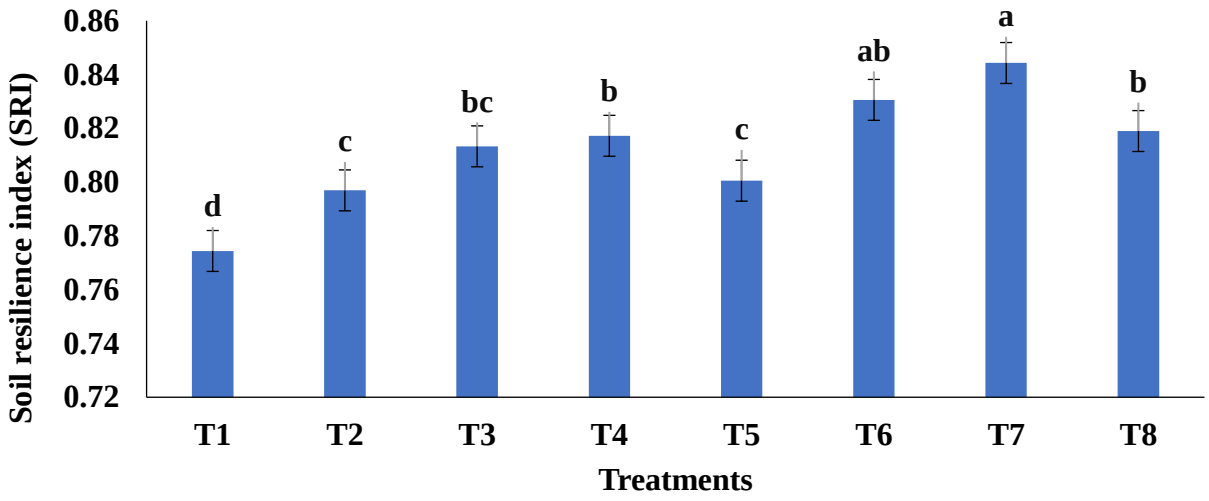
There were wide variations in soil parameters across different locations at various sites under different agro-ecological regions of India. Soil samples were analysed for 21 physical, chemical and biological properties of soil and key indicators were selected through PCA analysis. Among the identified key soil health indicators commonality were found: BD was selected under four sites, alkaline phosphatase activity and available N were selected in three sites, available Cu, available Mn, mean weight diameter and oxidisable organic C were selected in two sites. The SOC emerged as one of the powerful soil health indicators. Soil health index (SHI) was varied from 0.34 to 0.85 in Nadia site, 0.48 to 0.83 in Modipuram site, 0.47 to 0.78 in Birbhum site and 0.46 to 0.81 in Varanasi site, respectively. The lower and upper threshold limits of the identified key indicators were established as a function of relative yield of crops. The upper and lower critical limits of key soil health indicators and indices and their interpretative classes were established from this study act as guide to determine the health status of soil in terms of low, moderate or adequate. A decision support system (DSS) was developed for on line assessment of soil health under different agro-ecological regions of India.

Table 1. *Some indicators identified for different soil types and cropping systems*

Centre	Soil type	Cropping system	Indicators identified	Reference
AAU	Sandy Clay loam	Rice - rice	Bulk density, Available K, Zn, and acid phosphatase activity	Tripathy et al., 2023
BCKV	Clay loam	Rice-Mustered-Sesame	Mean weight diameter, total organic carbon, β-glucosidase activity, aavailable S, available N, urease and amidase	Ghorai et al., 2022
BHU	Sandy loam	Rice - lentil	Mean weight diameter, available N, Fe, Zn potentially mineralizable nitrogen, fluorescein diacetate activity, Clay	Biswas et al., 2023
IARI	Sandy loam	Rice-Wheat	β-glucosidase activity, Mineralizable C, Archaeal 16S rRNA, Bacteroides 16S rRNA, Bacterial 16S rRNA	Das et al., 2023

Fig. 3 Resilience index of soil in terms of carbon mineralization in an Alfisol

Values (mean) in each bar (between the treatments) for particular soil parameter followed by different



lower-case letters are significant according to Duncan's Multiple Range Test at P = 0.05

CONCLUSIONS

A uniform soil health assessment protocol is crucial for identifying sensitive indicators and ensuring consistency in evaluating soil health across varied climates, soil types, and management practices. The identified key indicators of soil health as well as soil health indices with their upper and lower threshold limits and interpretative classes (low, moderate and adequate) as a function of yield of

crops under different soil types and cropping systems under agro-ecological regions of India could be clubbed with routine soil testing laboratory, SAUs, State Governments, and KVKs operative all over India to judge the health of their soil whether it is aggrading or degrading over time. Sustainable soil health management enhances soil fertility, resilience, and ecosystem services while mitigating climate impacts. Prioritizing soil health is the key to long-term agricultural sustainability, biodiversity, and food security for future generations.

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REFERENCES

Andrews, S.S. and Carroll, C.R. 2001. Designing a soil quality assessment tool for sustainable agro-ecosystem management. Ecological Applications 11: 1573-1585.

Biswas, S., Singh, P., Rahaman, R., Patil, K. V., & De, N. (2023). Soil quality and crop productivity under 34 years old long-term rainfed rice based cropping system in an Inceptisol of sub-tropical India. *Frontiers in Soil Science*, 3, 1155712.

Das, S., Biswas, S., Ramakrishnan, B., Das, T. K., Purakayastha, T. J., Gawade, B. H., Sinha, K. (2023). Biological soil health with conventional and qPCR based indicators under conservation agriculture based rice-wheat cropping system in Indo-Gangetic Plain. *Applied Soil Ecology*, 193, 105128.

Ghorai, P. S., Biswas, S., Purakayastha, T. J., Ahmed, N., Das, T. K., Prasanna, R., ... & Das, S. (2023). Indicators of soil quality and crop productivity assessment at a long-term experiment site in the lower Indo-Gangetic plains. *Soil Use and Management*, 39(1), 503-520.

Tripathy, S., Biswas, S., Singh, P., Ghose, T. J., Purakayastha, T. J., Ahmed, N., ... & Ramakrishnan, B. (2023). Soil quality, resilience, and crop productivity under 32-year-old long-term rice-rice system in acidic alfisol of Assam. *Journal of Soil Science and Plant Nutrition*, 23(4), 5333-5344.

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Development of fragile Sundarban ecosystem through application of geo-textile and agro-textile

BIPLAB SAHA

Ex-Principal Scientist, ICAR-NINFET, Kolkata

E-mail: biplabsa@yahoo.com

Abstract

Frequent occurrence of floods and cyclones coupled with strong currents and sea level rise due to global warming cause severe erosion of river banks and agricultural lands making coastal ecosystem very much fragile. Livelihood of local people is affected very much due erosion of river banks and degradation of cultivable lands in the coastal zones of eastern India. To improve the rural economy of this zone, checking of river bank erosion, prevention of salinization of cultivable lands, protection of ponds from sea water intrusion is very much needed at present. Ecologically sustainable and bio-degradable jute geotextile (JGT) and agro-textiles, made out of 100 % natural fibers of jute, have been found to be more effective for soil conservation, stabilization of earthen slope, river bank protection including growth of seedling / sapling in forest nurseries, weed suppression, soil moisture conservation, enhancement of microbial activities in rhizosphere in horticultural production system and many more (Sanyal,2021; Saha, 2021). JGT emerged as technically sound, economically viable, socially acceptable and economically viable technology in mitigating soil related problems. It was also found to be effective in difficult soil management in and around Sunderban area where the materials have been used for construction of *Aila* affected flood embankment, road construction in Patharpratima and elsewhere, river bank protection in Kakdweep, growth of mangrove sapling at Kulpi, construction of rainwater harvesting tank at Sagar Island etc. Thus, jute geo-textile/agro-textile played key role towards protecting this coastal area against erosion (Chowdhuri, 2021). The ultimate tensile strength of jute woven and jute non-woven were respectively 194 and 1.45 Newton. The moisture content of the samples recorded at 0-15 cm and 15-30 cm depth respectively showed that the average moisture percentage under jute woven, jute non-woven and control were 16.6,13.4 and 9.4 % respectively. Consequently, overall vegetative growth was enhanced after soil stabilisation through jute geo-textiles (Saha, 2021; Nag,2004). Non-woven Jute Geo-textiles (NJGT) and woven Jute Geo-Textiles (JGT) were used to check river bank erosion in the coastal areas of the district of south 24-Parganas. After laying the fabrics across the trench

and along the slope suitable grass seeds were spread and a few saplings of suitable plants were also planted randomly on the bank for its better stabilization. Huge growth of grass and vegetation with short spell of rain the degraded soil of the bank was stabilized within six months. Non-woven geo-textile covered field showed its supremacy over the woven one (Chowdhuri, 2021). It was observed that use of agro-textiles of 250 gsm and 300gsm were able to reduce seepage loss through irrigation channels in the field substantially increasing irrigation efficiency 30-40% (Saha, 2021, Saha *et al*, 2006). Jute agro - textiles as surface cover also improved soil quality by improving soil physical, chemical and microbial parameters in horticulture production system (Manna *et al*, 2018,2023; Saha and Nag, 2013). Agro textile products like shade netting and thermal screens enabled farmers a saving of 40% on energy used for heating greenhouses and brought about improvement in the quality of fruit and vegetables, uniformity of color and prevent staining. The enhanced productivity along with improved quality of horticultural produces attracted better market price leading to livelihood improvement and enhanced rural economic growth (Saha, 2021). Jute geo-textiles and agro-textiles are recommended as essential components for development of Sundarban ecosystem on the basis of review of research and development works conducted by individual workers and different Government and Non-Government organizations.

REFERENCES

Chowdhury, P. (2021) Efficacy of jute geo-textiles in Mitigating soil related problems along with a few case studies . In Sarangi *et al* eds. Book of abstracts *International Symposium on Coastal Agriculture: Transforming Coastal Zone for Sustainable Food and Income Security Webinar* T3S3102

Manna,K., Kundu, M.C., Saha, B., Ghosh, G. (2018). Effect of nonwoven jute agrotextile mulch on soil health and productivity of broccoli (Brassica oleracea L.) in lateritic Soil. Environment Monitoring and Assessment 190(2): 1-10. https://doi.org/10.1007/s10661-017-6452-y

Manna,K., Kundu, M.C., Saha, B., Ghosh, G. (2023). Residual impact of non-woven jute agro-textile mulch on soil health and productivity of maize (Zea mays L) in laterite soil. Biomass conversion and bio-refinery. . https://doi.org/10.1007/s13399-023-04437-w

Nag, D. (2004). Final report of AP Cess Fund sponsored project on development of geo-textiles and its blends for agro-horticulture production, ICAR-NIRJAFT

Saha,B. 2021. Non-woven Jute Agro-Textiles for Improvement of Soil Quality and Horticultural Production: Example from Coastal Ecosystem. In Mondal *et al* eds. Souvenir *International Symposium on Coastal Agriculture: Transforming Coastal Zone for Sustainable Food and Income Security Webinar* pp.47-57

Saha, B., Nag, D. (2013). Effect of geo-textile mulch on Rhizosphere, Root Growth, Soil Physical Properties and yield of horticulture crops. In Book chapter of *Diversification of Jute and Allied Fibres: Some recent Development* edited by Satapathy K.K.and Ganguly P.K. pp:115-120.

Saha, B., Prasad, L.K., Harris, Abul, A., Sikka A.K. and Batta, R.A. (2006). Effect of geo-textile mulch on soil moisture, temperature and yield of vegetable crops grown in planes of Bihar. *International Journal of Tropical Agriculture* 24(1-2): 153-157.

Sanyal, T. (2021). Application Of Synthetic Geo-Textiles for Protection Against Coastal Erosion. In Sarangi *et al* eds. Book of abstracts *International Symposium on Coastal Agriculture: Transforming Coastal Zone for Sustainable Food and Income Security Webinar* T3S3101

Chowdhury, P. (2021) Efficacy of jute geo-textiles in Mitigating soil related problems along with a few case studies. In Sarangi *et al* eds. Book of abstracts *International Symposium on Coastal Agriculture: Transforming Coastal Zone for Sustainable Food and Income Security Webinar* T3S3102

Manna,K., Kundu, M.C., Saha, B., Ghosh, G. (2018). Effect of nonwoven jute agrotextile mulch on soil health and productivity of broccoli (Brassica oleracea L.) in lateritic Soil. Environment Monitoring and Assessment 190(2): 1-10. https://doi.org/10.1007/s10661-017-6452-y

Nag, D. (2004). Final report of AP Cess Fund sponsored project on development of geo-textiles and its blends for agro-horticulture production, ICAR-NIRJAFT

Saha,B. 2021. Non-woven Jute Agro-Textiles for Improvement of Soil Quality and Horticultural Production: Example from Coastal Ecosystem. In Mondal et al eds. Souvenir International Symposium on Coastal Agriculture: Transforming Coastal Zone for Sustainable Food and Income Security Webinar pp.47-57

Saha, B., Nag, D. (2013). Effect of geo-textile mulch on Rhizosphere, Root Growth, Soil Physical Properties and yield of horticulture crops. In Book chapter of Diversification of Jute and *Allied Fibres: Some recent Development* edited by Satapathy K.K.and Ganguly P.K. pp:115-120.

Saha, B., Prasad, L.K., Harris, Abul, A., Sikka A.K. and Batta, R.A. (2006). Effect of geo-textile mulch on soil moisture, temperature and yield of vegetable crops grown in planes of Bihar. *International Journal of Tropical Agriculture* 24(1-2): 153-157

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Conservation agriculture and sustainable land management for climate resilience: A special reference to coastal ecosystem

K. M. HATI[1], A.K. BISWAS[2], J. SOMASUNDARAM[2], S K REZA[1], S. CHATTARAJ[1], S. BANDYOPADHYAY[1], F.H. RAHMAN[1]

ICAR-National Bureau of Soil Survey and Land Use Planning, Regional Centre-Kolkata, Salt Lake, Kolkata -700091, West Bengal

[1]ICAR-National Bureau of Soil Survey and Land Use Planning, Regional Centre-Kolkata, West Bengal

[2]ICAR-Indian Institute of Soil Science, Nabibagh, Berasia Raod, Bhopal-462038, Madhya Pradesh

E-mail*:* kuntalmouli@gmail.com

Climate change is a significant threat to global food security and environmental sustainability. India, with its vast and diverse agro-ecological zones, is particularly vulnerable to the impacts of climate change effects, like, rising temperatures, erratic rainfall patterns, and increased frequency of extreme weather events. These changes pose a significant challenge to Indian agriculture, which is the backbone of the country's economy and livelihoods. The coastal regions of India support diverse agricultural activities that provide food, feed and fibre to millions of its inhabitants and provide sustenance to their livelihood. However, climate-induced challenges such as rising sea levels, increased saltwater intrusion, storm surges, and erratic rainfall patterns facing this region aggravate soil degradation and reduce agricultural productivity. Conservation agriculture (CA) and sustainable land management (SLM) could offer viable strategies to address these climate change challenges by improving soil health, water conservation, and biodiversity. This research summary explores the principles of CA and SLM, their role in mitigating climate risks in coastal India, and policy implications for their widespread adoption.

CHALLENGES OF CLIMATE CHANGE IN COASTAL AGRICULTURE

Owing to the impending climate change threats coastal agricultural landscapes in India face multiple challenges, such as:

Enhanced soil salinity and alkalinity**:** Saltwater intrusion due to rising sea levels reduces soil fertility.

Cyclones and extreme weather events**:** Frequent storms cause accelerated soil erosion and crop loss.

Erratic monsoon patterns**:** Unpredictable rainfall affects crop sowing and harvesting cycles, severely undermining crop productivity.

Decreasing freshwater availability: Over-extraction of groundwater to meet the rising demand for irrigation leads to saline water intrusion into the groundwater.

The cumulative effects of these challenges necessitate a systematic approach to climate resilience that can combine traditional knowledge with innovative agricultural techniques.

CONSERVATION AGRICULTURE: PRINCIPLES, BENEFITS AND ADOPTION IN COASTAL REGIONS

Conservation agriculture (CA) is a farming system that aims to improve soil health and reduce the environmental impact of agriculture. It's based on three core principles: minimal soil disturbance (no-till or reduced tillage), permanent soil cover (cover crops, mulching) and crop diversification (crop rotation and intercropping). Implementation of these practices enhances soil structure, reduces erosion, improves water infiltration, and increases soil organic matter content, leading to improved water retention, carbon sequestration, higher input use efficiency and sustainable crop intensification. Maintaining a permanent soil cover through crop residue retention or cover crops protects the soil from erosion, regulates soil hydro-thermal regime, and suppresses weeds. In coastal regions, CA helps mitigate soil salinization by maintaining soil moisture and reducing surface evaporation. It also supports climate change adaptation by improving the resilience of crops to extreme weather conditions. Diversifying crop rotations with different types of crops, including legumes, improves soil health,

reduces pest and disease pressure, and enhances nutrient cycling which, improves the resilience of the cropping practices. CA can lead to increased crop yields and profitability in the long term, as soil health and resilience improve. Besides this, CA provides a viable alternative against the burning of crop residues through recycling of the residues in field. Thus, CA permits the management of soils for sustainable agricultural production without excessively disturbing the soil while protecting it from the processes that contribute to soil degradation like erosion, compaction, aggregate breakdown, loss of organic carbon, leaching of nutrients etc. The organic material conserved through this practice is decomposed slowly, and much of it is incorporated into the surface layer, thus reducing the liberation rate of carbon into the atmosphere. In the total balance, carbon is sequestered in the soil and turns the soil into a net sink of carbon.

Over the past two decades, efforts have been made on research for developing, adapting and scaling conservation agriculture-based sustainable intensification under various programs, schemes and initiatives by ICAR and State Agriculture Universities (SAUs). There are some success stories around CA-based technologies. Under the aegis of the Consortium Research Platform on Conservation Agriculture under ICAR, efforts were made to refine, develop and popularize the conservation agriculture technologies under different agro-ecological regions of the country. Several studies highlight the success of CA in coastal India: The introduction of salt-tolerant rice varieties and no-till farming has improved productivity in the Sundarban region of West Bengal. A study conducted in the coastal zones of Andhra Pradesh and Tamil Nadu showed that the adoption of agroforestry and mulching techniques could reduce soil erosion and enhance organic matter. These examples illustrate the adaptability of CA to different coastal environments, reinforcing the need for localized interventions that consider socio-economic and environmental factors.

SUSTAINABLE LAND MANAGEMENT: A HOLISTIC APPROACH

Sustainable land management (SLM) is a broader approach that encompasses a range of practices aimed at maintaining and enhancing the productivity and ecosystem services of land resources. The SLM integrates ecological, economic, and social aspects of land use to ensure long-term productivity. Implementation of SLM strategies enhances soil fertility, conserves water, and minimizes vulnerability to climate change effects. Addressing saltwater intrusion in coastal regions requires an integrated water resource management approach. Rainwater harvesting, coupled with efficient irrigation and groundwater management, can help to maintain freshwater availability. Promoting salt-tolerant crop varieties and diversifying agricultural practices can enable communities to adapt to increasing salinity. In severely affected areas, transitioning to aquaculture or other non-agricultural income-generating activities may be necessary. SLM also emphasizes the importance of land use planning, ensuring that development activities are strategically located to minimize vulnerability to coastal hazards

Key SLM strategies that can augment climate resilience in coastal areas include:

Soil conservation techniques: Use of contour ploughing, contour bunding, ridge and furrow system, raised and sunken bed technique, terracing, and bio-engineering to reduce soil erosion and runoff on sloping lands, conserving water and topsoil.

Water management: Rainwater harvesting through check dams and farm ponds and its efficient recycling enhances water availability during the lean season, micro-irrigation, and saline water management to optimize water use.

Climate-resilient cropping systems: Cultivation of salt-tolerant and drought-resistant crop varieties.

Agroforestry: Integration of trees with crops to improve soil fertility and act as windbreaks.

Coastal erosion control: SLM practices like mangrove restoration and coastal afforestation can help stabilize shorelines and protect coastal communities from erosion.

BARRIERS TO ADOPTION AND FUTURE STRATEGIES:

Despite its proven benefits, the adoption of CA and SLM faces significant challenges due to lack of awareness and technical knowledge, availability of suitable implements, high initial investment and access to resources, limited research on location-specific adaptation strategies and weak policy enforcement and coordination. Some of the future strategies to enhance adoption include: Capacity building and farmer education programs, incentivization and financial support for climate-smart practices, strengthening research on coastal ecosystem-specific solutions and integrating Indigenous knowledge with modern agricultural practices

CONCLUSION

Conservation agriculture and sustainable land management are essential strategies for building climate resilience in Indian agriculture, especially in vulnerable coastal ecosystems. By minimizing soil disturbance, maintaining a permanent soil cover, diversifying crop rotations, and implementing various SLM practices, farmers can enhance soil health, improve water management, increase carbon

sequestration, and adapt to the impacts of climate change. Thus, CA and SLM practices offer promising solutions for mitigating climate risks in India's coastal regions. Implementing these practices at scale requires coordinated efforts between policymakers, researchers, and farming communities. Strengthening institutional frameworks, and promoting participatory approaches will be critical in achieving climate resilience and sustainable agricultural growth in coastal India.

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Marine gypsum: A waste from coastal regions effective in amelioration of degraded sodic soils

S.K. JHA
ICAR-Central Soil Salinity Research Institute, Regional Research Station, Lucknow -226002
E-mail: jhask_01@yahoo.com

Globally, the extent of salt-affected soils (SAS) is increasing because of mismanagement of the land use, faulty irrigation practices, and climatic change incidences. The global increase of atmospheric temperature is also causing aridity in the areas, resulting in salt appearance at the soil surface due to capillary rise. As per the Food and Agricultural Organization Report (FAO, 2024), the total area of salt-affected soils is 1381 million ha (Mha), which is 10.7 percent of the global land area. The largest areas are found in Australia (357 Mha), followed by Argentina where such soil is 153 Mha. The global sodic soil area has been estimated as 210 Mha (Levy and Shainberg, 2005). As far as Indian scenario is concerned, the total SAS is 6.73 Mha, out of which the saline and sodic soils are 2.96 Mha and 3.77 Mha, respectively. The Central Indo-gangetic plains of Uttar Pradesh, India alone accounts for 1.37 million ha of sodic soils, dominated by bicarbonate (HCO_3^-) and carbonate (CO_3^{2-}) salts of Na both in solution as well as at exchange site, resulting in the deterioration of soil structure and hampering crop productivity. Mineral or mined gypsum has been used widely so far for the sustainable management of sodic soils, being cheapest and easily available ameliorant but the urbanization and increase of industrial establishments, limited its use as a chemical amendment for the reclamation of sodic soils, as it is being used extensively in making gypsum boards, plaster of paris, cement industries besides its use as fertilizers. Moreover, its availability w.r.t. the desired purity of mineral gypsum in the reclamation of sodic soil as per bureau of Indian Standards (BIS, 1973) is also lacking, along with its diminishing status, being a natural resource.

Looking into the declining scenario of mineral gypsum availability for the reclamation, many waste/ by-products have been tried as amendment in the past which were phosphogypsum, fly ash, flue gas desulphurized gypsum but every amendments had their own limitations. As it had become imperative to search an ameliorant which does not have any limitations and must be obtained from the natural resource, the marine gypsum was found to be the best candidate as an amendment to sodic soil which could have acted as an alternative to mineral gypsum. The marine gypsum is a waste/by-product of edible salt (NaCl) manufacturing process obtained from natural source (sea water) where gypsum gets precipitated before the precipitation of Salt (NaCl) and has vast potential. In India, marine gypsum is recovered from salt pans during production of common edible salt in coastal region, particularly in Gujarat and Tamil Nadu. The primary constituent of marine gypsum is $CaSO_4.2H_2O$ which is chemically identical to mineral gypsum with purity percentage ranging from 89.72 to 92.62% instead of desired 70% in mineral gypsum. India is the third largest salt producing country in the world after China and USA with global annual production of about 230 million tones, in which contribution of India is 215.80 lakh tones (MoCI, 2018). For each ton of salt production, on an average 30-50 kg of marine gypsum is produced. So far only small amount of marine gypsum is being used in cement producing industries while the rest is being piled near sea shore. Thus, looking into the scarce availability of mineral gypsum and in absence of required purity, marine gypsum was used as a chemical amendment for the first time across the globe by Jha et al. (2022) in the reclamation of sodic soils and sustainable production of crops. The research data revealed a significant decrease in soil pH and exchangeable sodium percentage w.r.t. mineral gypsum when 50 GR marine gypsum equivalent was applied to the soil having initial pH 10.2. The presence of $MgCl_2$, NaCl, and KCl as impurities in marine gypsum assisted its dissolution by increasing ionic strength of solution and facilitated Ca^{2+} release for exchange reactions. Thus, study suggested that marine gypsum could effectively be used as an alternative ameliorant for the reclamation of degraded sodic soil without compromising crop yields, under scarce availability of mineral gypsum.

AVAILABILITY OF MARINE GYPSUM FOR FUTURE

During 2021-22, salt production in India was about 27 million tonnes (https://saltcomindia.gov.in/). But the demand is increasing due to its extensive use in industries like Chlor-alkali such as chlorine gas and sodium hydroxide, and hydrochloric acid manufacturing plants etc. At present level of salt manufacturing, the marine gypsum production is 1.35 million tonnes per year (taking 50 kg production of marine gypsum from 1 tonne of salt production).

BENEFIT COST RATIO

The cost of reclamation per hectare by marine gypsum is Rs. 55,500/- only for reclamation of sodic soil having pH > 10 while it is Rs. 76500/- using mineral gypsum. Thus, B/C ratio is 1.38.

RECOMMENDATIONS FOR USE OF MARINE GYPSUM

- Case -1: Non-availability of mineral gypsum
- Recommendation: 50 GR equivalent marine gypsum for reclamation of 0-15 cm of soil depth with pH > 10.
- Case 2: Poor availability of mineral gypsum
- Recommendation: 25 GR value of mineral gypsum + 25 GR equivalent value of marine gypsum for reclamation of 0-15 cm of soil depth with pH > 10.

REFERENCES

FAO. (2024). Global status of salt affected soils - Main report. Food and Agriculture Organization of the United Nations, Rome. https://doi.org/10.4060/cd3044en.

Levy, G.J. and Shainberg, I. (2005). Sodic soil. In: Encyclopedia of soils in the environment, Elsevier Ltd., pp. 504-513. doi.org/10.1016/B0-12-348530-4/00218-6.

BIS. 1973. Specification for Mineral Gypsum, Bureau of Indian Standard IS: 1290-1973. (2nd Revision). New Delhi.

MoCI. 2018. Annual report 2017-18, Salt Department, Ministry of Commerce and Industry, Department of Industrial Policy & Promotion, Government of India, New Delhi, pp. 102.

S.K. Jha, V.K. Mishra, T. Damodaran, Y.P. Singh, P.C. Sharma (2022). Utilization of marine gypsum as an alternative to mineral gypsum in the reclamation of degraded sodic soil and enhancing crop productivity. *Land Degradation and Development* 33:2276-2288. DOI: 10.1002/ldr.4282.

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Impact of salinity on nutrient dynamics and its response on yield and quality of sweet potato under coastal island ecosystem of Andaman

LAXMINARAYANA, K., SUBRAMANI, T., BURMAN, D., BYJU, G., and ARUTSELVAN, R.
Regional Station of ICAR-Central Tuber Crops Research Institute, Bhubaneswar-751019, Odisha
E-mail: laxmi.narayana@icar.gov.in

Abstract

Field experiments were conducted for two consecutive rabi seasons during 2013-15 in natural saline soils at farmers' fields in South Andaman district, Andaman & Nicobar Islands. The trials were laid out with 4 white fleshed varieties (Samrat, Kishan, Sree Bhadra and Pusa Safed) and 2 orange fleshed varieties (Bhu Sona and Bhu Ja) of sweet potato. The results revealed that the variety Samrat recorded significantly highest mean tuber yield in both the locations of Andaman (15.18 & 16.12 t ha-1, respectively) followed by Bhu Ja (13.45 & 14.43 t ha-1, respectively) and Sree Bhadra (12.80 & 13.38 t ha-1, respectively). Significantly highest mean vine yield was recorded by Samrat at both the locations (16.69 & 16.62 t ha-1, respectively) at par with Sree Bhadra (16.48 & 15.66 t ha-1, respectively). The harvest index was also found highest in Samrat at both the locations (47.6 and 49.2 %, respectively) followed by Bhu Ja (45.7 and 48.9%, respectively). Significantly highest mean dry matter (27.35 & 26.63%) was observed in Kishan at par with Samrat (26.5 & 25.6%). Significantly highest mean starch content (17.67 & 18.38 %) was recorded by Kishan in both the locations. Total sugars ranged from 2.86 - 3.53 %. Samrat has recorded significantly highest mean uptake of N & P (165 & 21 kg ha-1), whereas significantly highest uptake of K (191 kg ha-1) recorded by Bhu Ja followed by Samrat (189 kg ha-1) at both the locations, indicated that Bhu Ja and Samrat have the ability to absorb more K nutrition which helps the genotypes to tolerate salt stress against the deleterious effects of Na. The varieties Samrat and Bhu Ja were found tolerant to salinity stress under Island ecosystem of Andaman & Nicobar Islands. Studied the effect of phosphorus and potassium for two seasons during rabi, 2015-17 with saline tolerant sweet potato (cv Samrat) under Island ecosystem. The trial was laid out with 4 levels of phosphorus (0, 20, 40, 60 kg P2O5 ha-1) and 4 levels of potassium (0, 25, 50, 75 kg K2O ha-1). The results of the study revealed that significantly highest tuber yield of sweet potato (15.9 t ha-1) was recorded due to combined

application of 40 and 75 kg ha-1 of P2O5 and K2O, respectively. Positive response on tuber yields was observed due to application of 40 kg P2O5 ha-1 (14.3 t ha-1) and K up to 75 kg K2O ha-1 (14.4 t ha-1). Application of 40 & 75 kg ha-1 of P2O5 & K2O, respectively has recorded highest vine yield (17.9 t ha-1). Highest starch (17.28%) and sugars (3.66%) in sweet potato was observed due to application of 60 & 50 kg ha-1 of P2O5 & K2O, respectively, whereas highest dry matter (27.70%) was recorded due to application of 40 & 75 kg ha-1 of P2O5 & K2O, respectively. Application of 50-40-75 kg N, P2O5 and K2O ha-1 has recorded significantly highest mean (2015-16 and 2016-17) tuber & vine yields (14.53 and 17.23 t ha-1), starch (16.61%) and dry matter (26.91%). Highest total uptake of N (151 kg ha-1) and K (189 kg ha-1) was recorded due to addition of 50-40-75 kg N, P2O5 and K2O ha-1. Highest total P uptake (23.1 kg ha-1) was observed due to combined application of 50-60-75 kg N, P2O5 and K2O ha-1. Among the three major nutrients, N has shown higher mean yield response (38%) followed by K (37%) and P (25%) over control. Combined application of NK has recorded higher yield response (76%) over control rather than NP (65%) and PK (63%). Total uptake of N, P and K (151, 25 and 168 kg ha-1) was recorded highest due to combined application of 50, 25 and 50 kg ha-1 of N, P2O5 and K2O. The study emphasized that application of 50-40-75 kg N, P2O5 and K2O, respectively was found optimum to realize higher tuber yields with good amount of bio-chemical constituents in the natural saline soils under island ecosystem of Andaman.

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Biodiversity of halophytes and halophilic microbes for bio-remediation of coastal and inland salt affected soils

SANJAY ARORA
ICAR-Central Soil Salinity Research Institute, Regional Research Station, Lucknow
E-mail: aroraicar@gmail.com

Abstract

Salt stress has been identified as one of the most serious environmental factors limiting the productivity of crop plants, with a huge impact on agricultural productivity. Future agricultural production will rely increasingly on our ability to grow food and fibre plants in salt-affected land.

The physical and chemical methods for saline/sodic soil reclamation are not cost- effective. The phytoremediation and 'plant-microbe interaction' approach to overcome salt stress has recently received a considerable attention from many workers throughout the world.

On salt affected soil, phytoremediation is often effective and economical method of removing or reducing salt stress. A number of halophytic grasses have been proven to be effective in re-vegetating of coastal and inland salt affected soils. Halophytes are remarkable plants that tolerate salt concentrations and has ability 'to complete the life cycle in a salt concentration of at least 200 mm NaCl under conditions similar to those that might be encountered in the natural environment'. Although saline habitats do differ in many regards (e.g. soil water content) and differences do exist amongst species in the balance of Na^+ and K^+ in shoot tissues. Since last three decades, it has been widely examined halophytes for their eco-physiology, photosynthesis, response to oxidative stress and flooding tolerance as well as the physiology of sea grasses. The potential of halophytes as donors of tolerance for cereals and as crops in their own right has also been ascertained, as have the effects of salinity on plants in general. Majority of the halophytes are deep-rooting perennials that achieve their optimum growth and yield potential at thresholds between 6-25 dS m^{-1} (EC), levels at which virtually all of our modern crops would perish. Some of the more prolific ones thrive in the coastal saline soils and arid inland saline areas with concentrations of 45 dS m^{-1} (seawater) and above eg., *Salvadora persica.* Halophytes are highly specialized plants that naturally grow in highly saline soils which have developed different strategies to survive even at sea water salinity. Salt tolerant plants such as *Salvadora perisca, Salicornia, Calophyllum inophyllum, Pandanus* spp., *Suaeda, Anethum graveolens* etc. can be great industrial value. Many other species like *Aeluropus*, *Eragrostis, Leptochloa, Atriplex* have high forage value and thus can form integral part of forage production systems. With their vigorous growth and root development, these plants are often able to take advantage of less saline moisture within the soil profile and adapt to seasonal variability in salinity by altering germination, growth, and reproduction cycles to best suit their survival needs.

Scenario in Coastal Gujarat:

The total salt affected soil in India was reported approx. about 6.74 M ha out of which 3.2 M ha is coastal soil and 2.8 mha is sodic land rest is inland saline soil. Gujarat with 2.2 Mha contributes to 20 percent of the total salt affected soil in country. Gujarat comes second after West Bengal in the total extent of coastal salt affected soil with estimated area of about 7.2 lakh hectare. This 7.2 lakh hectare is distributed

in district of Kutch, Saurastra region and districts of South Gujarat. The wide variety of halophytes and of their characters permits to envision a profitable use of vast barren extensions of saline lands by selecting the appropriate species best fitting local conditions.

All the possible actions listed in the table can be easily undertaken after an appropriate plant selection but a preliminary analysis assessing their environmental, economic and social feasibility is in all cases required.

Bioremediation through halophilic microbes:

Plant-microbe interaction is beneficial association between plants and microorganisms and also a more efficient method used for the reclamation of salt affected soils. Bacteria are the most commonly used microbes in this technique. Rhizosphere bacteria improve the uptake of nutrients by plants and /or produce plant growth promoting compounds and regenerate the quality of soil. This plant growth promoting bacteria can directly or indirectly affect plant growth. Indirect plant growth promotion includes the prevention of the deleterious effects of phytopathogenic organisms by inducing cell wall structural modifications, biochemical and physiological changes leading to the synthesis of proteins and chemicals involved in plant defence mechanisms. Halophilic bacteria provide a high potential for biotechnological applications for at least two reasons: (1) their activities in natural environments with regard to their participation in biogeochemical processes of C, N, S, and P, the formation and dissolution of carbonates, the immobilization of phosphate, and the production of growth factors and nutrients; and (2) their nutritional requirements are simple. The majority can use a large range of compounds as their sole carbon and energy source. Most of them can grow at high salt concentrations, minimizing the risk of contamination. Moreover, several genetic tools developed for the non-halophilic bacteria can be applied to the halophiles, and hence their genetic manipulation seems feasible.

For bio-remediation of salt affected soils and to enhance productivity and improvement of soil health, we have isolated halophilic plant growth promoting bacteria especially having N-fixation and P solubilization efficiency. The strains were isolated from salt affected soils of Indo-Gangetic plains and saline coastal region of Gujarat and screened for salt tolerance. The elite plant growth promoting bacteria strains were screened, characterized and tested for their efficacy and were prepared as liquid bio-formulations *viz* Halo-Azo and Halo-PSB. It was noted that plant growth and yield as well as soil bio-chemical properties and nutrient status of saline and sodic soils was significantly improved. The study confirms that plant growth promoting bacteria, not only helps in crop production but also maintains soil health.

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Proximal sensors for soil salinity mapping: Insights from inland and coastal regions of India

BHASKAR NARJARY*, SATYENDRA KUMAR, JITENDRA KUMAR and SAGAR VIBHUTE

ICAR-Central Soil Salinity Research Institute, Karnal-132001, Haryana, India

E-mail: bhaskar.narjary@icar.gov.in

Key Words: *Soil Salinity, Proximal Sensors, Electromagnetic Induction Techniques, Coastal Salinity*

INTRODUCTION

Soil salinity is a serious environmental problem that needs continuous monitoring for effective management. Proximal sensors are increasingly used for mapping of soil salinity, offering efficient, rapid and precise way to monitor soil conditions compared to traditional soil sampling methods (Narjary et al. 2024). These sensors are placed close to the soil surface (proximal), and they can measure a variety of soil properties in real-time, providing valuable data for agricultural and environmental management (Alam et al. 2025). However, Soil salinity characteristics varies in coastal and inland areas due to differences in parent materials, climatic, geo-hydrologic and environmental conditions. To provide a cost-effective, rapid, easy, and less labor-intensive assessment of salinity through proximal sensors we describe here geophysical electromagnetic induction technique (EMI) to map soil salinity in coastal and inland regions of India.

MATERIALS AND METHODS

For rapid measurement of soil salinity through proximal sensors, EMI (EM38MK-2) survey was conducted at various salt-affected places of Haryana state, representing inland soil salinity and coastal salt-affected regions of Gujrat state. We compared soil salinity characteristics and mapping accuracy between coastal and inland areas and developed a relationship between apparent conductivity (EC_a) measured by proximal sensors soil salinity measured through saturation paste extract (EC_e).

RESULTS AND DISCUSSION

At inland salt affected soil, salinity mostly characterized by the dominance of sodium and chloride ion. In inland salt-affected soil, a regression coefficient of 0.66 was observed between soil salinity (EC_e) and apparent electrical conductivity (EC_a) salinity mapping was done (Fig 1). While at coastal salt affected soil, salinity mostly characterized by the dominance of sodium, magnesium and chloride ion. Kahni, location site, regression coefficient of 0.79 observed between soil salinity (EC_e) and apparent electrical conductivity (EC_a) (Fig 2).

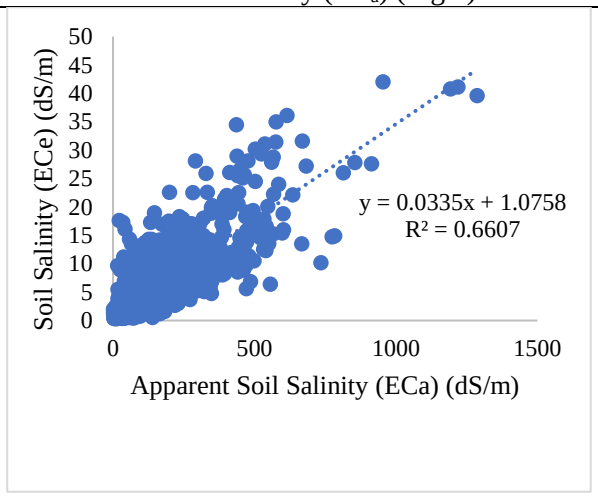

Fig1: *Relationship between Apparent Soil Salinity (ECa) with soil salinity (ECe) at inland salt affected soil*

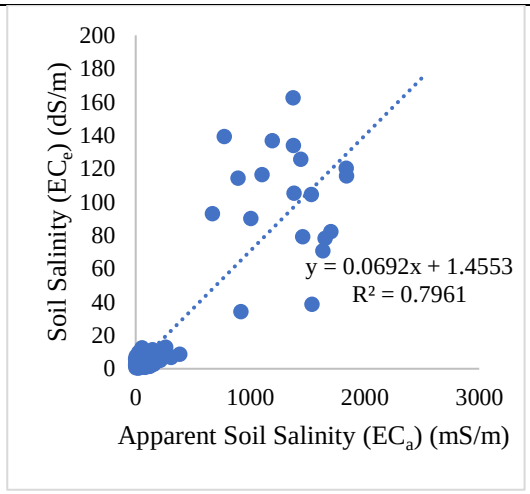

Fig2: *Relationship between Apparent Soil Salinity (ECa) with soil salinity (ECe) at coastal salt affected soil*

CONCLUSIONS

These salinity maps were categorized into different salinity zones for developing potential management option for sustainable crop production. This methodology is useful in rapid mapping of saline soils at farm/village level and district level.

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REFERENCES

Alam, S. S., Chakraborty, S., Jain, F. C., Deb, S., Singh, R., and Weindorf, D.C. (2025). Proximal sensor integration for land use classification and soil analysis in a coastal environment. *Case* Studies in Chemical and Environmental Engineering 11: 101079. https://doi.org/10.1016/j.cscee.2024.101079.

Narjary, B., Nand, V., Goswami, S., Prajapat, K., Bundela, D. S. and Kumar, S. (2024). Restoration of degraded waterlogged saline soil through subsurface drainage: Spatiotemporal soil salinity assessment using electromagnetic induction (EMI) and geographic information system (GIS) techniques. Land Degradation and Development 35: 3790-3801. https://doi.org/10.1002/ldr.5167.

Oral V1T4D1

An evaluation of the potassium (K) status on some low-land rice-growing soils from tropical climatic zone by quantity-intensity measurement.

SANJIB KAR
Department of Agricultural Chemistry & Soil Science, Institute of Agricultural Science, Institute of Agricultural Science, University of Calcutta, 35, B. C. Road, Kolkata-700019.India.
E-mail: sanjib_cu@yahoo.co.in

Key Words: *Quantity-Intensity Relationship, Labile K, Specific K, Free Energy Change, Equilibrium Activity Ratio, and Potential Buffering Capacity Of Soil.*

INTRODUCTION

Potassium (K^+) is considered a macronutrient for plants and much of this K^+ exists in unavailable forms in the soil. Sometimes, despite that the soil shows a significant amount of total potassium content, the availability of K^+ is insignificant to plants. For a greater understanding of the fertility status of agricultural soils, the quantity intensity (Q/I) relationship has been used to measure the availability of K in soils (Panda &Patra,2009). The aim of the present study was to evaluate the potassium dynamics of some selected low-land rice-growing soils, by applying the quantity-intensity concept. The specific purpose was to point out the potential capacity of these soils for K supply.

MATERIALS AND METHODS

Soil samples were analyzed for physico-chemical properties using standard methods (Sparks, 1996). X-ray diffraction (XRD) patterns of the clay fraction were obtained using CuKα radiation with a D8 ADVNCE diffractometer and graphite monochromator. For the determination of K potential, using the method developed by Beckett (1964a). The K quantity factor (Δ K) was found by computing the difference in K concentration between the initial and equilibrium solution. A plot of Δ K on the ordinate axis and AR_K on the abscissa axis was constructed for each soil sample, from which values for AR_K , Δ K_O, PBC_K, and K_X were determined. Each experiment was laid out in a randomized block design (RBD) with three replications. Data analysis was conducted using SPSS window version 16.0 (SPSS Inc., Chicago, USA). Duncan Multiple Range Test (DMRT) was performed for separation of treatment means at 5% level of significance ($P<0.05$).

RESULTS AND DISCUSSION

Soil characteristics*:*

The soils belong to Typic endoaquept, Aeric endoaquept, and Typic haplustept. Soil type varied from fine loamy to fine aeric, with main clay minerals being hydrated and dehydrated Kaolinite, Chlorite, Illite, and Palygosite.

Quantity-intensity parameters:

The relationship of potassium for Mohonpur, Moukhali, and Bhanderdihi soils illustrated in curves is very characteristic, since its upper part is linear, whereas the bottom part is curvilinear in regression. The linear portion is attributed to nonspecific sites for K related to planar surfaces. The curvilinear portion is caused by specific sites related to the edges of clay crystals.

Labile K (K_L):

K_L consists of $-\Delta K_0$ and K_X, and it is the quantity parameter of the Q/I relationship. Higher cation exchange capacity enhances the labile K pool. The K_L value indicates that exchangeable K is readily replaceable with other cations and made available to plants. A very highly significant and positive relationship was observed between K_L and K_X($r = 0.999$), $-\Delta G$ ($r=0.999$) ,K_{EX} ($r=0.999$),which suggests that the labile pool of K may be controlled by or is in equilibrium with the availability of labile K in soil and the free energy change of the reaction.

Specific K (K_O):

The quantity of K that is held on the specific site was obtained by extrapolating of quantity intensity (Q/I) curve to the ordinate. The curvilinear portion is caused by specific sites with high affinity for potassium, such as the edges of clay crystals or wedge sites.

Non-specific K (Kx):

The upper part of the Q/I curve is linear; that linear portion is considered to be a special case of the Gapon equation and is attributed to non-specific sites for K related to the planar surface. The quantity of K non-specific sites is obtained by extracting of the linear part of the Q/I curve from the ordinate. The non-specific K values range from 0.420 to 3.749 $Cmol_cKg^{-1}$. Greater values of K indicate a greater K release into solution, which results in a larger pool of labile K. The variability in the specific adsorption of K on the exchange sites of soil colloids was probably due to the variation in the composition of the K-bearing minerals and the specific surface area of the soil colloids.

Potassium activity ratio (Ar_e^K):

The intercept of the curve with the activity ratio axis ($\Delta k = 0$) gives the value of the activity ratio of potassium in soils (Fig. 1). The Ar_e^K value is a measure of the availability or intensity of immediately available labile K in soil for crops' growth.A lower Ar_e^K value indicates their high cation retention power. Greater values of AR_e^k indicate greater K ion strength in the solution, so the immediate availability of K will be greater. The AR_e^K values are the status of immediately available K . A significant and negative correlation between AR_e^k and $-\Delta G$ is apparent as free energy of exchange is derived from AR_e^k .

Free energy change (Δ G):

The heat required to break the K desorption barrier is greater than that of K adsorption. Soils differed in the amount of $-\Delta G$, which was -13.1, -13.07, and -8.38 $KJmol^{-1}$. Hence, lower $-\Delta G$ values show more K exchange than that of higher $-\Delta G$ values. Thus, K availability to plants can be characterized by the free energy of K-Ca exchange with regard to solid - solution reactions.

Potential buffering capacity (PBC_k):

The soils with high PBC_K values were associated with lower K^+ saturation and low soil pH, which is indicative of a higher potential to replenish K^+ concentration in soil solutions . PBC_K variation among these soils is due to changes in soil clay mineralogy. Consequently, this study concluded that external K fertilizer application is not essential in these low-land rice-growing soils.

CONCLUSIONS

The study thus highlights the potential of soil potassium, which is controlled by dynamic interactions among its different pools. Soil physico-chemical properties and the presence of some specific clay maintain K supply to crops. K fertilization is not required in paddy soil with higher organic matter and the presence of some specific clay.

REFERENCES

Panda, R., Patra, S.K., 2018. Quantity-intensity relations of potassium in representative coastal soils of eastern India. Geoderma. December 2018, Pages 198-206.

Sparks D.L.,1996. Editor, Methods of Soil Analysis: Chemical Methods and Processess. Am. Soc. Agron. Madison, WI

Beckett, P. H. T. 1964a. Studies on soil potassium II: The "immediate" Q/I relations of labile potassium in the soil. European Journal of Soil Science 15 (1): 9–23.

Oral V2T4D1

Evaluating potassium dynamics in coastal soils of eastern India under intensive cropping and fertilization regimes

S. SENGUPTA[1*], R PANDA[2] and S. K. PATRA[3]

[1]School of Agriculture, Swami Vivekananda University, Barrackpore 700121, West Bengal, India

[2] Uttar Banga Krishi Viswavidyalaya, Majhian, Dakshin Dinajpur 733133, West Bengal, India

[3] Bidhan Chandra Krishi Viswavidyalaya, Mohanpur 741252, Nadia, West Bengal, India

E-mail: sudips@svu.ac.in

Key Words: *Dynamics, Fertilization, Intensive Cropping*

INTRODUCTION

Potassium (K) is a very important macronutrient for plant growth and productivity, but the dynamics in the soil-plant system are far more complex compared to those of nitrogen and phosphorus. Soils of the eastern Indian coasts, predominantly used for intensive rice-based cropping systems, have inherently medium to high K contents (Rahman et al. 2020). However, a long history of cropping with high-yielding varieties with excessive application of N and P fertilizers along with minimal to no K fertilization resulted in significant decline in both the exchangeable as well as the non-exchangeable K reserves. Most of the existing studies overlook the variability of non-exchangeable K reserve, its mechanisms of release and the degree it contributes to the crop K nutrition under continuous cropping. This study aims to fill these gaps by applying the K exhaustion technique to evaluate the K supplying capacity of four coastal soils under continuous paddy-greengram-sunflower cropping and will hopefully provide vital insights into sustainable management and fertilization strategies with regard to the maintenance of soil fertility and crop productivity in these intensively cultivated systems.

MATERIALS AND METHODS

Four bulk surface soil samples (0–0.15 m) were collected from agricultural sites in the coastal saline zone of West Bengal, India. A fraction of the air-dried and sieved (2-mm) soil was used for laboratory analysis, while larger portions sieved to 10 mm were reserved for a greenhouse potassium

(K) exhaustion experiment in pots. Soil properties were analyzed using standard methods: particle size distribution by the hydrometer method, pH and electrical conductivity (EC) in a 1:2.5 soil-water suspension, organic carbon by Walkley and Black method, and cation exchange capacity (CEC) with neutral 1N NH4OAc. Water-soluble, exchangeable, available, and non-exchangeable forms of K were determined following standard method (Panda et al., 2022). The pot experiment involved 2 kg of soil, arranged in a randomized block design with four treatments (control, NP, K, and NPK) and four replications. Test crops included paddy, greengram, and sunflower in a two-year rotation. Fertilizer applications adhered to specific crop requirements, and deionized water was used for irrigation. Post-harvest, soils were analyzed for NH_4OAc extractable K, and plant biomass was processed for K concentration using flame photometry. Soil K depletion and crop K uptake were calculated using standard equations, and data were statistically analyzed using Fisher's LSD at $P < 0.05$.

RESULTS AND DISCUSSION

The studied soils displayed significant variation in physical and chemical properties. Classified as Endoaquent and Endoaquept, the soils exhibited textures ranging from silty clay loam to clay loam. Potassium fractions also varied widely across the soils (Table 1).

Table 1. *Different forms of potassium (mg kg^{-1}) of the experimental soils*

Soil location	Water soluble	Exchangeable	Available	Non-exchangeable	Total
Akshyanagar	10.4	59.8	75.0	547	11800
Kamalpur	34.5	143.2	181.6	884	19200
Bibipur	36.7	192.1	222.6	924	20100
Sarda	43.3	221.6	262.5	996	23000

The Sarda soil exhibited the highest labile and non-labile K contents, attributed to its mineralogical composition rich in K-bearing minerals like feldspar and illite. The sequential cropping experiment revealed significant variation in crop K uptake across soils and treatments. Generally, dry biomass yield, tissue K concentration, and K uptake were higher during the first crop cycle compared to the second (Patra et al., 2008). NPK treatment consistently achieved the highest K uptake, followed by K and NP treatments. Crop K uptake in Akshyanagar soil was lower than in Kamalpur, Bibipur, and Sarda soils due to its lower K reserves. Similar findings were reported by Yadav et al. (2011), indicating that applied K fertilizer mitigates the rapid depletion of soil K reserves by providing an easily accessible source of K. Continuous cropping led to a decline in available K across all soils, with the depletion more pronounced during the first cycle. Control and NP treatments exhibited higher depletion rates due to the absence of K supplementation, resulting in the mining of labile K pools (Fig. 1). Conversely, K and NPK treatments showed lower K depletion, as applied K compensated for crop removal. Notably, Akshyanagar soil experienced the least K depletion due to its inherently low K reserves and reduced biomass yield. Non-exchangeable K contributed significantly to crop K nutrition, particularly in control and NP treatments. Soils with higher reserves released less non-exchangeable K proportionately, likely due to the energy required to release K from illitic clay minerals, as noted by Bandyopadhyay et al. (2003). Non-exchangeable K reserves are crucial for crop nutrition in the absence of K fertilization but deplete rapidly under NP treatments. Continuous K supplementation sustains biomass yield and mitigates soil K depletion, ensuring long-term soil fertility. These findings align with previous studies (Yaduvanshi & Swarup, 2006), advocating balanced fertilization to prevent soil K exhaustion and support sustainable agriculture

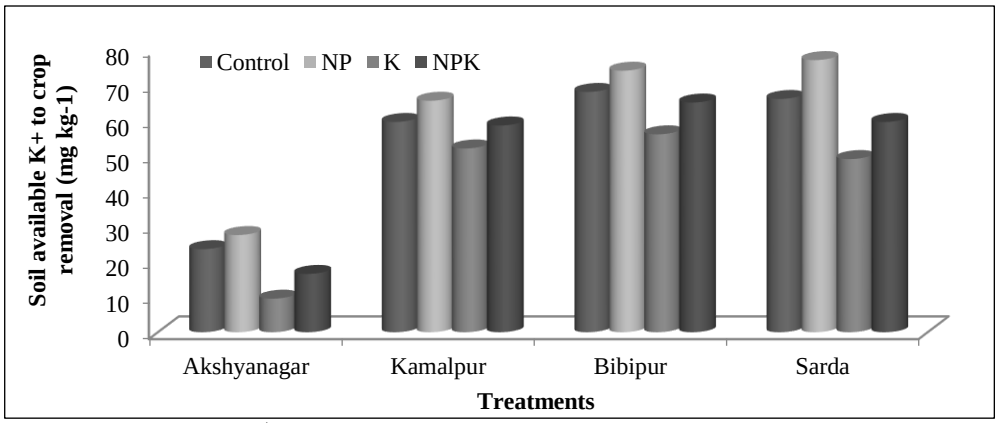

Fig. 1. *Depletion of available K^+ to crop removal in four coastal soils under various treatments*

CONCLUSIONS

In conclusion, the study highlights that the absence of K fertilization leads to rapid depletion of non-exchangeable K reserves, particularly in soils with lower K reserves like Akshyanagar. Conversely, K fertilization slows this depletion, ensuring sustainable crop K nutrition. Soils with higher K reserves, such as Kamalpur, Bibipur, and Sarda, can temporarily sustain cropping without K inputs. However, to maintain soil fertility and high crop yields in coastal regions under intensive cropping, regular soil testing and timely K fertilization are essential.

REFERENCES

Bandyopadhyay, B. K., B. Maji, H. S. Sen, and N. K. Tyagi. (2003). Coastal soils of West Bengal - their nature, distribution and characteristics. Central Soil Salinity Research Institute, RRS, Canning town, India, Bull. No. 1, 62.

Patra, S. K., R. Ray, and S. S. Das. (2008). Soil potassium parameters as indices of potassium supplying power of foothill acid Inceptisols of West Bengal. *Indian Agriculturist* 52:11-15.

Rahman, M. S., M. Khatun, M. A. A. Topu, A. B. M. S. Alam, A. Sarker, and M. A. Saleque. (2020). Potassium release and fixation in old Brahmaputra and Ganges tidal floodplain soils of Bangladesh. *International Journal of Natural and Social Sciences* 7 (1):40-54.

Yaduvanshi, N. P. S., and Swarup, A. (2006). Effect of long-term fertilization and manuring on potassium balance and non-exchangeable K release in a reclaimed sodic soil. *Journal of the Indian Society of Soil Science* 54:203-7.

Panda, R., Patra, S. K., & Sengupta, S. (2022). Assessment of the potassium supplying capacity of coastal Entisols and Inceptisols under intensive cropping and fertilization. *Communications in Soil Science and Plant Analysis*, *53*(21), 2878-2891.

Oral V3T4D1

Soil salinity mapping of different landforms of mining lease area in coastal Gujarat

NIRMALENDU BASAK[1,3*], BHASKAR NARJARY[1], ARVIND KUMAR RAI[1], ANIL R. CHINCHMALATPURE[2], FEROZE HASAN RAHMAN[3] and RAJENDER KUMAR YADAV[1]

[1]ICAR–Central Soil Salinity Research Institute, Karnal 132001, Haryana

[2]ICAR–Central Soil Salinity Research Institute, Regional Research Station, Bharuch, Gujarat

[3]ICAR–National Bureau of Soil Survey and Land Use Planning, Regional Station, DK Block, Salt Lake City, Kolkata 700091, West Bengal

E-mail: nirmalendu.basak@icar.gov.in; nirmalendubasak@rediffmail.com

Key Words: *Salinity, Sodium Adsorption Ratio, Calcium Carbonate, Landform*

INTRODUCTION

India has an extended coastline with extensive human habitation. The natural resources, demographic exploration, resourceful habitation, and industry–trade–harbor settlement are the drivers of the urbanization in the sea–coastlines. The common ecological constraints are the intrusion of brackish water, sea level rise, congestion of ingress saline and high sodium or magnesium–rich sea water, impedes drainage, waterlogging, and shortage of freshwater, and occurrence of acid sulphate soil is the serious threat to land degradation and buildup salinity in coastal soils. Further, temperature rises, drought, anthropogenic activities, and erratic rainfall behavior increase soil evaporation demand. The objective of the research work is to develop of mining lease area in coastal Gujarat.

MATERIALS AND METHODS

The biophysical data including information about landform and land use were collected and a proximal ground–based electromagnetic induction soil sensor (EM38MK2) survey was conducted for soil salinity monitoring from coastal Gujarat. The objective of the current study was to develop a soil salinity map of the landform of coastal–regulation zone (CRZ) and away from the coastal regulation zone *i.e*. cultivated village land. For this purpose, depth–wise fifty–two soil samples of 0–15, 15–30, 30–45, 45–60, 60–80, and 80–100 cm were collected from the different landforms and land uses of the mine lease areas for detailed chemical analysis.

RESULTS AND DISCUSSION

Irrespective of soil depth (0–15, 15–30, 30–45, 45–60, 60–80, and 80–100 cm), overall salinity of soils (electrical conductivity of soil water saturation paste extract, EC_e) was greater (43.09 ppt) under coastal–regulation zone (CRZ) than the soil collected from villages (1.51 ppt) (Table 1; Fig. 1). The brackish water intrusion in nearby areas of sea increased higher values salinity in CRZ than the village and similar result also reported (Deb et al. 2018; Mandal et al. 2019). Soil salinity was similar upto 60 cm soil depth and thereafter it increased 60 to 75 cm depth and remained similar upto 90 cm for soil collected from CRZ. However, the salinity of the soils was nearly identical in all the depths collected from villages. The studied soils were alkaline in reaction. Along depth, soil pH_s (pH of soil water saturation paste extract) increased and the mean values of pH_s were greater for soil of cultivated areas of villages than soil under coastal–regulation zone (CRZ). The *kankar* (lime nodules) content (w/w) was greater in soils of CRZ than in cultivated areas of the village. Along soil depth, *kankar* content increased. Whereas, amorphous calcium carbonate ($CaCO_3$) content (w/w) was greater in cultivated soils of villages than soils under CRZ. Likewise, amorphous $CaCO_3$ increased along depth. Sodium adsorption ratios (SAR_e) of soil water saturation paste extract indicate the sodicity hazard was many–fold higher for soils under CRZ than cultivated soils under villages. The presence of an appreciable amount of Na^+ in inundated brackish water resulted in greater values of SAR_e in soils of CRZ than soils of villages (Basak et al. 2023). The EM38MK2 data showed that 172.8, 175.4, 165.0 and 171.9 ha areas under CRZ had electrical conductivity (EC) >5 ppt at 0–15, 15–30, 30–60 and 60–100 cm depth, respectively.

Table 1. *Physiochemical properties of collected soils along depth (n indicated the number of soil samples mean ± standard error)*

Soil depth (cm)	Electrical conductivity (EC, ppt)		pH_s		*Kankar* (Calcium carbonate) (%)	
	CRZ (n= 3)	Cultivated village land (n=12)	CRZ (n= 3)	Cultivated village land (n=12)	CRZ (n= 3)	Cultivated village land (n=12)
0-15	39.17±16.53	1.44±0.36	7.46±0.08	7.68± 0.04	20.08±4.99	13.90±1.60
15-30	37.97±17.24	1.33±0.32	7.71±0.05	7.85± 0.04	23.60±5.66	14.84±1.39
30-45	34.98±16.55	1.16±0.33	7.79±0.07	7.84± 0.04	22.92±4.20	17.22±1.78
45-60	51.29±15.96	1.36±0.38	7.79±0.07	7.92± 0.04	27.72±4.88	17.69±1.75
60-80	47.97±24.94	2.19±1.14	7.82±0.05	8.01± 0.05	27.37±5.18	19.79±2.25
80-100	47.13±23.59	1.59±0.45	7.75±0.05	8.00± 0.05	26.96±5.88	18.23±1.75
Mean	43.09	1.51	7.72	7.88	24.78	16.95
Soil depth (cm)	SAR_e		Amorphous $CaCO_3$ (%)		Walkley Black organic C ($g\ kg^{-1}$)	

	CRZ (n= 3)	Cultivated village land (n=12)	CRZ (n= 3)	Cultivated village land (n=12)	CRZ (n= 3)	Cultivated village land (n=12)
0-15	71.07±15.8	13.87±2.5	18.80± 3.8	39.37±2.9	9.53±0.57	7.08±0.63
15-30	66.61±15.7	11.26±2.3	23.22± 4.0	45.82±4.3	10.62±3.64	5.56±0.65
30-45	72.32±23.8	10.14±2.3	28.55± 7.6	47.50±4.4	8.56±1.53	5.06±0.64
45-60	64.40±18.9	10.58±1.1	30.18± 9.9	43.67±6.3	13.02±2.01	4.42±0.69
60-80	31.28±6.2	18.54±6.9	44.88± 8.1	46.23±5.2	4.63±1.66	5.01±0.60
80-100	26.94±18.9	18.56±6.1	43.84± 7.0	48.26±5.1	4.83±2.18	5.33±0.70
Mean	55.44	13.83	31.58	45.14	8.53	5.41

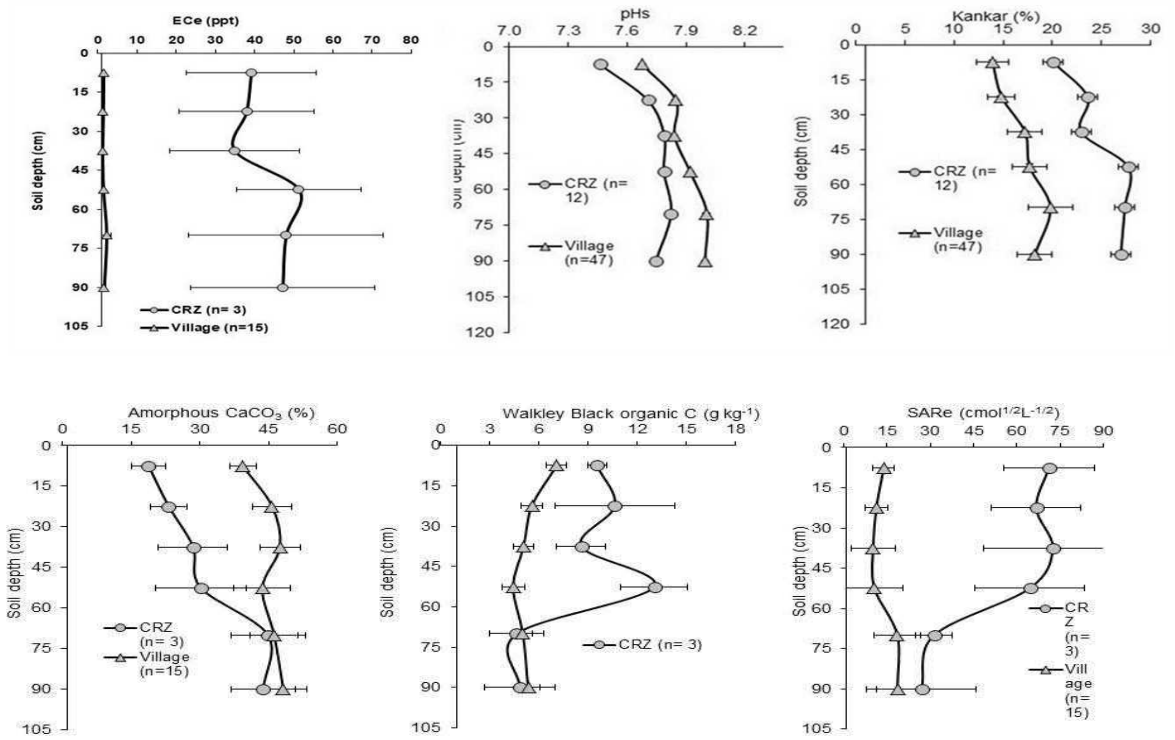

Fig. 1 a, b. *Physiochemical properties collected soils along depth (n indicated the number of soil samples mean ±standard error); CRZ: coastal regulation zone; village: cultivated village land Amorphous calcium carbonate ($CaCO_3$) content (w/w) was greater in cultivated soils of villages compared to the soils under CRZ. Mono cropping and a few places with two hundred percent cropping intensity with pearl millet–channa, cotton–pearl millet, cotton–wheat, cotton–fallow, fallow–chana, isolated orchards of coconut, barren fallow land were observed in three villages. The soils of these land uses have a salt content of <2.0 ppt irrespective of soil depth up to 100 cm*

CONCLUSIONS

The groundwater of these villages was mostly saline to strongly saline in categories, had high sodium adsorption ratio (SAR), Mg to Ca ratio >1.2, and high chloride to carbonate content in their groundwater (>2.0). These areas need good quality water irrigation through rainwater harvesting for reclamation and prevention of soil salinization. Amorphous and crystalline calcium carbonate (kankar) constitutes about 50–60% of total soil mass in an entire profile of 0–100 cm. Therefore, supply of organic amendments, compost, brown manure, and cultivation salt–tolerant crops, and salt–tolerant cultivars are recommended for successful cropping.

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REFERENCES

Basak N, Rai AK, Krishnamurthy SL, et al (2023) Nutrients availability in salt-affected soils varies with the ionic composition of solid and solution phases of inland and coastal agroecosystems of India. *Environ Earth Sci* .82:489. https://doi.org/10.1007/s12665-023-11167-9.

Deb S, Mandal B, Bhadoria PBS, et al (2018) Microbial Biomass and Activity in Relation to Accessibility of Organic Carbon in Saline Soils of Coastal Agro-Ecosystem. Proceedings of the National Academy of Sciences, India Section B: *Biological Sciences*. 88:633–643. https://doi.org/10.1007/s40011-016-0801-4.

Mandal UK, Burman D, Bhardwaj AK, et al (2019) Waterlogging and coastal salinity management through land shaping and cropping intensification in climatically vulnerable Indian Sundarbans. *Agric Water Manag.* 216:12–26. https://doi.org/10.1016/j.agwat.2019.01.012.

Oral V1T4D2

Study of ground water in a village of coastal West Bengal using geo-electrical method

SHISHIR RAUT, D. BURMAN and T.D. LAMA

Central Soil Salinity Research Institute, Regional Research Station, Canning Town-743329, West Bengal, India

E-mail: shi_cssri21@yahoo.com

Key Words: *Geo-Electrical, Ground Water, Kathalberia*

INTRODUCTION

Water is becoming a scarce commodity due to increase in population and expanding economy of the country. Kumar *et al*. (2005) reported that a well-planned long-term strategy is required for sustainable water resources assessment and management. In coastal areas of West Bengal and Bangladesh, groundwater is saline at shallow-to-intermediate depths (typically 0–150 m) across much of the area , making the deeper, fresh coastal groundwater an invaluable source of water to meet growing demand in this region as stated by Michael & Voss (2008). Mas-Pla *et al*. (2014) reported that the excessive withdrawal of ground water for irrigation leads to the development of salinity. The productivity of Coastal West Bengal is low. This is mainly due to high ground water salinity particularly in *rabi* season. In many areas ground water may occur in perched aquifer at greater depths (>40 m and up to 300 m) which is non saline and available for cultivation of crops. Geological information and bore hole statistics of an area help in assessing potential ground water of the area. Chandrasekharan (1988), Chandrasekharan and Singh (1995) coined that exploration of ground water sources by geo-electrical methods is one of the inexpensive and *in-situ* methods and has been used for long. The electrical resistivity method in combination with hydrogeological data and tube well bore hole lithologs have been proved to be very successful for the assessment of ground water, its potential and quality at different depths. Field-based studies have been conducted by various researchers like Goswami (1968) and Dhar *et al*. (2010). Hence, in this study, assessment of ground water potential and quality at various depths in the Kathalberia village of coastal West Bengal was done with the help of resistivity soundings and geochemical parameters.

MATERIALS AND METHODS

The study area is a coastal village namely, Kathalberia of West Bengal (approx. 8.0 ha). It is mostly under *kharif* rice. It is a plain area and is drained in the east-west direction through a small

channel. The elevation is 2-3 m above mean sea level. It is an extensive alluvial tract and the general slope is towards east and south-east.

Geo-electrical investigations:

Field investigations were carried out in different locations in Kathalberia village of coastal West Bengal. Twelve vertical electrical sounding (VES) were carried out throughout the village to understand the overall geo-hydrological situations. Out of these, VES 1, 2, 3 come in the western side and VES 4, 5, 6, 7, 8, 9, 10, 11, and 12 come in the eastern side of the study area. A road passing north-south direction divides the VES points. The field data were interpreted for true resistivity and corresponding thickness of different sub-surface horizons. To locate the potential aquifer, the Dar Zarrouk parameters (S ant T) were used. Ground water samples were collected from tube wells situated near different VES locations and analyzed for EC, pH, Na, K, Ca, Mg, CO_3, HCO_3, Cl etc.

RESULTS AND DISCUSSION

The interpreted (true) resistivity values along with the thickness of different formations for VES points indicate five geoelectric layers. The iso-resistivity contour map for different depth zones were drawn separately in Surfer 26. Resistivity data of VES 1 was compared with the borehole lithology of adjoining tube wells. The comparison of VES 1 with borehole lithology is given below. The true resistivity data of VES 1 show the presence of a layer of 400 ohm-m up to 5.7 m and another layer of 200 ohm-m at 13.9 m (Fig.1). As the apparent resistivity curve drawn on the basis of field data started with 1 m half electrode spacings, the curve was extrapolated backwards to show the resistivity data for depths below 1 m to represent the soil cover. The resistivity values of 120-300 ohm-m up to 1.2-5.7 m indicate presence of soil cover (clay) and mangrove roots. The 200 ohm-m resistivity up to 13.9 m represents fine sand plus clay. The 3rd layer with a resistivity of 300 ohm-m corresponds to sand. In the interpreted data, the interface between 3rd and 4th layers is at 28.5 below ground level (bgl) which agrees well with the borehole data. The resistivities of 3rd and 4th layer indicated water bearing zones. The resistivity of 150 ohm-m in the 5th layer indicates presence of clay and small amount of kankar.

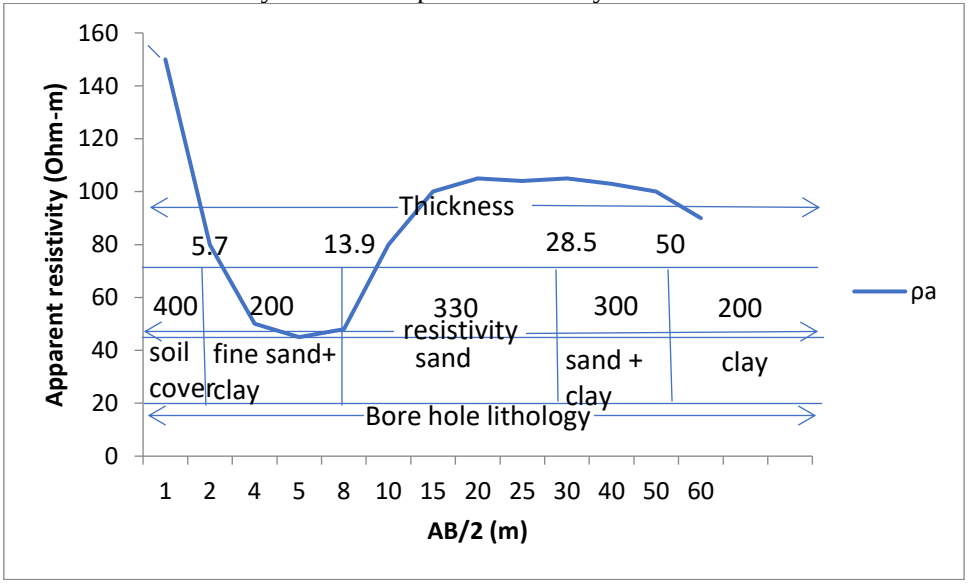

Fig. 1. *Comparison of VES 1 data with bore hole lithology*

Table 1*: Geochemical data of ground water, Kathalberia village*

Tube well location	EC (dS/ m)	pH	Cations and anions (me/l)							RSC (me/l)	SAR
			Na^+	K^+	Ca^{+2}	Mg^{+2}	CO_3^{-2}	HCO_3^{-1}	Cl^{-1}		
1	1.03	7.7	6.5	0.14	6	6	Tr	13	9	1	2.6
2	1.16	8.3	5.4	0.15	6	6	2	11	18	1	2.2
3	1.83	8.0	9.0	0.21	8	3	2	11.5	18	2.5	3.8
4	1.12	7.7	2.8	0.13	4	7	Tr	13	18	2	1.2
5	1.15	7.8	6.5	0.14	5	7	2	11	4.5	1	2.6
6	1.21	7.7	6.5	0.14	6	4	Tr	12.5	9	2.5	2.9
7	1.13	7.7	6.7	0.15	5	3	2	8	9	2	3.4
8	1.60	7.6	10.6	0.15	4	6	2	9	18	1	4.7

Tube well location: 1. Near VES 1, 2. Near VES 3, 3. Near VES 4, 4. Near VES 5, 5. Near VES 6. 6. Near VES 7 7. Near VES 9, 8. Near VES 10

Geochemical investigations of ground water:

The electrical conductivity (EC) of ground water ranged from 1.03 to 1.6 dS m^{-1}, representing medium (C_3) salinity group of USDA classification of irrigation water. The relatively high salinity (C_3) of irrigation water near some of the VES points was possibly due the presence of saline aquifer zone (Table 1). The pH of the water samples varies from 7.6-8.3 with majority of the samples having pH>7.0, which indicates that the ground water was neutral to alkiline. Carbonates in the ground water samples were in trace amount in most of the tube wells (0-2 me l^{-1}). Bi-carbonate ions ranged from 8.0-13.0 me l^{-1}. The bi-carbonate content of the tube well water 7 and 8 were less than the other tube wells. High bicarbonate caused slight alkalinity in the ground water. The residual sodium carbonate (RSC) of the samples varied from 1.0 to 2.5 me l^{-1}. According to RSC irrigation water classification, samples 1, 2, 5 and 8 could be safe, although RSC of other samples were slightly higher (samples 3, 4, 6 and 7), the harmful effects were not prominent because of low carbonate content. In clay loam to loam soil under Indian conditions, the samples 3 and 6 are also considered to be safe, although these are not suitable for use as per USDA classification. The sodium absorption ratio (SAR) of ground water samples varied from 1.2-4.7 me l^{-1}. On the basis of USDA classification, the samples may be classified under S_1 (low alkali hazards). The high chloride and sodium ion concentration in sample 8 (> 5 me l^{-1}) in the ground water samples were responsible for relatively high SAR values. On the whole, the ground water of the study area could be grouped under C_3S_1. The interrelationship between the longitudinal unit conductance (S) and the EC of ground water samples collected from the tube wells adjoining to VES points showed that EC values of ground water increase linearly with the S values.

CONCLUSIONS

The interpreted (true) resistivity values along with the thickness of different formations for VES points indicate presence of five geoelectric layers in the study area. The quality of ground water is more or less uniform. The approximate available water from the phreatic aquifer (area = 2.2 ha) of the investigated area (approx. 8.0 ha) were worked out as 2.5 ha-m. The ground water was low to medium saline (<2.0 dS m^{-1}) for agricultural use with respect to salinity and less sodic as observed with SAR values (<5.0).

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REFERENCES

Chandrasekharan, H. (1988). Geo-electrical investigations for ground water in Thar desert –some case studies. *Trans. ISDT part II* 155-168.

Chandrasekharan, H. and Singh, A. (1995). Ground water exploration in a micro watershed in the Aravalli region- a successful field experience. *Bhujal News* 10.

Dhar, S., Das, S. and Mazumdar, A. (2010). *Surface & Ground Water Exploration of the Piyali River in the Sundarbans*, Paper presented at 3rd International Conference on Hydrology and Watershed Management, pp. 119-129.

Goswami, AB. (1968). A Study of Salt Water Encroachment in the Coastal Aquifer at Digha, Midnapore District, West Bengal, India. In: *Bulletin of the International Association of Science Hydrology* 13, 77-87.

Kumar, Rakesh., Singh, RD and Sharma, KD (2005). Water resources of India. *Current Science* 89, 794- 811.

Mas-Pla, J., Ghiglieri, G. and GUras, G. (2014). Seawater intrusion and coastal groundwater resources management. Examples from two Mediterranean regions: Catalonia and Sardinia. *Contrib. Science* 10, 171-184.

Oral V2T4D2

Conjunctive use of poor-quality water for post-*kharif* mulched zero tillage potato in coastal salt affected soils of West Bengal

K. K. MAHANTA, S. K. SARANGI, D. BURMAN, U. K. MANDAL and T. D. LAMA
ICAR-CSSRI, RRS, Canning Town, South 24 Parganas, West Bengal, 743329
E-mail: mahantakk@rediffmail.com

Key Words: *Poor Quality Water, Zero Tillage, Conjunctive Use*

INTRODUCTION

At the end of kharif season, during paddy harvesting time, the excess water ponded in rice fields is drained out. It takes lot of time to dry the soil and prepare the field for next crop by conventional

practice. The zero-tillage potato cropping has emerged as a promising crop in the coastal low lands where residual moisture is utilized for crop establishment and later less quantity of water is required for the crop as paddy straw mulching check evaporation during the cropping period. Here, for further reducing the water requirement of the crop, experiment conducted with drip irrigated mulched zero tillage potato.

MATERIALS AND METHODS

An experiment was carried out at ICAR-CSSRI, RRS, Canning Town for zero tillage mulched potato under micro-irrigation and by conventional method. The test crop was potato (var. *Kufri Pukhraj*). Before experimentation, soil samples were collected and analyzed for EC and pH. After sowing of seeds, the plots were covered with straw mulch. The drip laterals are placed over the straw layer and water of desired quality applied from tank by a 0.5 hp electric pump. Water salinity such as 1~2 dS m^{-1} and 5~6 dS m^{-1}were used in the experiment. Irrigation scheduling was done based on IW/CPE ratios 0.5 and 0.7. There were eight treatments such as T1: ECw(1~2 dS m^{-1}), IW/CPE=0.5; T2: ECw (5~6 dS m^{-1}), IW/CPE=0.5; T3: ECw (1~2 dS m^{-1}), IW/CPE=0.7; T4: ECw (5~6 dS m^{-1}), IW/CPE=0.7 irrigated with drip system and TC1: ECw (1~2 dS m^{-1}) IW/CPE=0.5; TC2: ECw (5~6 dS m^{-1}), IW/CPE=0.5; TC3: ECw (1~2 dS m^{-1}), IW/CPE=0.7; TC4: ECw (5~6 dS m^{-1}), IW/CPE=0.7 irrigated as per farmers' practice (Control) by spraying water on the crop. Saline water irrigation was implemented after 1 month of sowing. Soil quality change and the crop parameters were recorded.

RESULTS AND DISCUSSION

The experimental plot was non-saline at the beginning of experiment during November. After imposition of saline water treatment, the performance of potato crop was little bit inferior to the crop which was irrigated with fresh quality water (highest NDVI value 0.83). However, there was no mortality of the crop. Salinity of the top soil (15 cm) was highest (4.72 dS m^{-1}) for saline water (5~6 dS m^{-1}) with IW/CPE=0.7 in control (TC4) at the time of harvest (Fig.1).

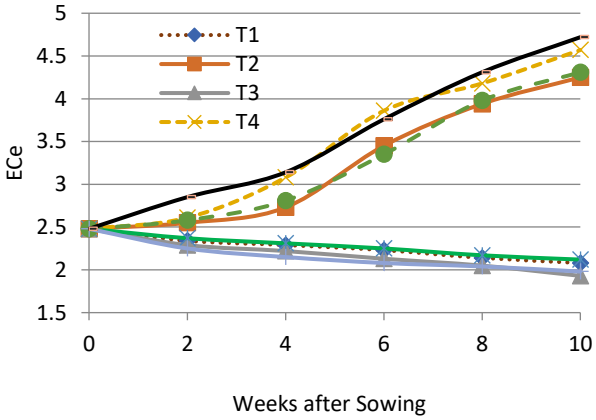

Fig. 1.*The ECe change in soil due to application of treatments*

The harvesting was done by just removing the straw and laterals and picking up the potatoes (Sarangi et al, 2019; 2021). The highest weight of single potato was 438 gm. Potato yield was 12.5 % higher for T1 where fresh water irrigation was applied through drip (Mahanta et al.,2019) than higher saline water irrigation applied as per farmers' practice (TC4). The highest yield of 21.8 t/ha was obtained for treatment, T1. There was 17 % water saving for treatment with IW/CPE ratio 0.5 than IW/CPE ratio 0.7.

CONCLUSION

Potato yield was 12.5 % higher for lower saline water (1~2 dS/m) with IW/CPE=0.5 (T1) than higher saline water (5~6 dS/m) with IW/CPE=0.7 (TC4). There was 17% water saving for treatment with IW/CPE ratio 0.5 than IW/CPE ratio 0.7. Salinity of the top soil (15 cm) was highest (4.72 dS/m) for TC4 where 5-6 dS/m saline water applied at IW/CPE ratio 0.7 at the time of harvest.

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REFERENCES

Mahanta, K. K., Burman,D., Sarangi, S.K., Mandal, U.K., Maji, B, Mandal. S., Digar, S., Mainuddin, M. (2019) Drip irrigation for reducing soil salinity and increasing cropping intensity: Case studies in Indian Sundarbans. *Journal of Indian Society of Coastal Agricultural Research*, 37(2): 64-71.

Sarangi, S.K., Maji, B., Digar, S., Burman, D., Mandal, U.K., Mahanta, K.K. and Mandal, S. (2019). *Package of practices for potato cultivation in coastal saline soils*. Technical Bulletin No. ICAR-

CSSRI/Canning Town/2019/11. ICAR-CSSRI, RRS, Canning Town - 743 329, South 24 Parganas, West Bengal, India. p.12

Sarangi,S.K., Maji, B.,Sharma,P.C., Digar,S., Mahanta,K.K., Burman,D., Mandal, U.K., Mandal, S., Mainuddin, M. (2021) Potato (*Solanum tuberosum* L.) Cultivation by Zero Tillage and Paddy Straw Mulching in the Saline Soils of the Ganges Delta. *Potato Research* 64, p 277–305.

Oral V3T4D2

Development of improved farm machinery for jute farming

R.K. NAIK, C.S. KAR, G. KAR, S. MITRA and S.K. JHA

ICAR-Central Research Institute for Jute and Allied Fibres, Barrackpore, Kolkata-700121, West Bengal, India

E-mail: ranjanagrieng@gmail.com

***Key Words**: Farming, Jute, Retting, Seeding, Weeding*

INTRODUCTION

Sustainable agriculture can be a labour-intensive activity but by selecting the appropriate tool, farmers can increase profits by increasing crop yields, improving crop quality and reducing expenses. The factors to consider for choosing appropriate agricultural equipment and tools include the location and growing conditions of the farm, the type of crops being grown and the production practices being used. Equipment for small-scale crop production tends to be simple and less specialized than equipment for larger-scale production. As a result, the equipment is often affordable and requires less capital for small and marginal farmers (Naik et al., 2017[b] and 2018[c]).

The jute farming is a matter of culture to the farmers of major jute growing states of the Indian sub-continent. Considering the agro-climatic requirements of jute crop, almost 85 % of its farming is mainly concentrated in the Ganga-Brahmaputra-Meghna Delta areas of India and Bangladesh (Kundu et al., 1959). Millions of small and marginal farmers are engaged in the farming of jute and playing an important role in the country's economy. Jute is considered as the golden fibre of India, but its area production is declining due to the involvement of higher production and processing costs, where a major portion of the cost is needed for weeding & thinning and fibre extraction. Also in the present scenario, the scarcity of fresh water has become a major problem in retting and fibre extraction. Hence, jute farming becomes a non-profit enterprise and traditional jute farmers slowly diverting to other profitable crops. In this situation mechanization in jute farming can play an important role in reducing production cost and drudgery while increasing jute fibre production. To address these issues, this study relates to the development of manual and power driven seeding and weeding machineries and power-operated ribboner machine aiming for reducing the production and processing cost.

DEVELOPMENT OF IMPROVED SOWING MACHINERY

The basic objective of sowing operation is to put the seed in rows at desired depth and spacing, cover the seeds with soil and provide proper compaction over the seed (Ghosal and Pradhan, 2013). The recommended row to row spacing, seed rate, seed to seed spacing and depth of seed placement vary from crop to crop and for different agricultural and climatic conditions to achieve optimum yields. Method of sowing is the most important farm operation in jute farming for getting healthy and dieses less crop for higher fibre production. The crop yield is affected by type and variety of seed, their emergence and plant density in the field (Ojha and Michel, 1987). In practice farmers use a higher seed rate (6-7 kg/ha) than recommended due to small size seeds. To maintain optimum plant population in the field, about 75-80% of the emergent seedlings are removed during weeding and thinning operation at 21-45 DAE. Further, due to uneven plant population or higher plant density, the overall fibre yield reduces about 10-15 per cent (Naik and Karmakar, 2016; Naik and Shamna, 2019). Whereas, the line sowing of small seeds using seed drill saves precious seed, ensures depth of placement, germination and reduced cost of sowing and weeding (Chandel et al., 2009). The seed drills available commercially for small seeds, use sophisticated pneumatic metering mechanism and are costly (Ghosal and Pradhan, 2013). Poor socio-economic conditions with minimum land holding do not permit them to have seed drills. They are therefore bound to follow the traditional practice of broadcast sowing and face difficulty in intercultural operations and overall management of their crop. As the yield rate is low, farmers derive marginal benefit out of their produce (Shambhu and Thakur, 2018).

To mechanize the sowing in jute farming several improved machines both manual and power operated have been developed.

CRIJAF Multi-ROW SEED DRILL

The use of manually operated CRIJAF multi-row (4-rows) seed drill machine of capacity 0.2 ha/h reduces seed rate by more than 50 per cent i.e. 3-4 kg/ha against broadcast sowing method of 7-8 kg/ha. There is a saving of 15-30 man-days for weeding and thinning activity and also, the sowing method facilitates other operations like irrigation, plant protection and harvesting. Due to evenly plant population, uniform distribution of soil moisture, plant nutrients and solar energy in line sown jute; the overall fibre yield increases about 10-15 per cent with overall reduction in cost of cultivation of about Rs. 6,500-11,000/- per ha (Kumar et al., 2015).

JUTE SEEDER

The manually operated jute seeder facilitate line sowing of jute and other small seeded up-land crops. The transparent seed box facilitates the visibility of seed during its operation. During the movement of implement the seed drops on the furrow through the seed dispensing orifices of the seed box inscribed at equal interval of 30.0 mm to achieve desired plant to plant distance of 30-50 mm in the field (Goswami, 2001; Mausam et al., 2001; Herbek and Murdock, 2009). The bigger size ground wheels with pegs facilitates easy movement of implement on tilled soil. The two sealed bearings provided on the drive shaft facilitates easy movement with less effort by operator. The height adjustable handle reduces drudgery in operation.

The machine reduces seed rate by more than 50 % than broadcast sowing i.e. 3.5-4.0 kg/ha. It ensures the depth of seed placement of 10 mm to 15 mm at the operational speed of 2.0-2.5 km/h. Its effective field capacity (EFC) is 0.25 to 0.28 ha/h with field efficiency of 90-95 per cent. The average draft and power requirement is 85.02 N and 41.93 W, respectively. Hence, it could be easily pulled by a man or women for 2-3 hours continuously.

TRACTOR OPERATED MULTI-CROP SEED DRILL FOR SMALL SEEDED CROPS

The "Tractor drawn multi-crop seed drill" is a machine for precision sowing of jute and other small seeded crops. The machine uses inclined plate metering mechanism for precision placement of seeds in rows. The machine is driven by tractor through 3-point linkage of tractor drawbar (35 hp and above). It is having separate box and metering mechanism for application of granular fertilizer in the field. The power transmission from ground wheel to metering mechanism is through chain & sprocket and bevel gear drive. The seed drill is having 7-rows and spacing in between rows is 25 cm. The row to row distance can be adjusted as per the requirement of different crops. In the seed box there is provision for controlled addition of seed to metering unit for accurate picking of seed by metering plate. The outlet in the bottom of the seed box is for complete removal of unused seeds from the box. A platform is provided at back of the machine for standing of operator to carry out regulation/ inspection of quantity of seeds in the seed box.

The performance of tractor drawn planter/seed drill is superior in terms of time and cost requirement. There is reduction in seed rate of about 50 % i.e. 3.0-3.5 kg/ha than broadcast sowing (7-8 kg/ha). It reduces drudgery in sowing of jute. Line sowing using followed by mechanical weeding operation reduces manual labour requirement up to 60 % and cost saving of Rs. 6500 -11,500/- per ha for weeding operation. The machine can also be used for sowing of Millets, mustard and sesame etc.

DEVELOPMENT OF IMPROVED WEEDING MACHINERY

Mechanical weed control is any physical activity that inhibits unwanted plant growth. The operation involves remove, injure, kill or make the growing condition un-favourable for weeds. During initial growth period of jute crop, it competes with profuse weed population in the field. Weeding before 30-40 days after sowing is most important operation in jute farming to eliminate yield loss. Manual weeding using traditional weeding tools like khunti, khurpi etc. requires 90-160 labourers/ha and about 30 per cent of total production cost (Naik et al., 2017[a]). Whereas, weeding through machines reduces time and labour requirement and stimulates plant growth by creating favourable microclimate. For delivering economic advantages out of line sowing, high speed mechanical weeding is essential. Considering the socio-economic factors of the jute farmers and nature of land holding, ICAR-CRIJAF has developed various low cost and light weight manual machines like wheel hoe, CRIJAF Nail weeder, CRIJAF Single wheel jute weeder etc. suitable to operate in line sown jute and other up-landed crops.

CRIJAF Nail weeder

CRIJAF Nail weeder developed at ICAR-CRIJAF, Barrackpore helps to weed out young composite weed flora including germinating ones from line sown crop since 3 - 4 days of crop sowing (F. It is used at 5 days interval (5-30 days of crop age) in between lines and controlled about 80 - 85 per cent weeds. It requires 7-10 labours/ha against 90-160 labourers/ha (2-3 weeding) in broadcast sowing and there is a saving of about Rs. 15000/ha in weeding and thinning operation in line sown jute crop.

Mechanical intercultural operations in line sown crop reduce labour and cost of weeding and thinning by more than 50 per cent.

CRIJAF Single wheel jute weeder

The CRIJAF Single wheel jute weeder is suitable for weeding out young composite weed flora from jute and other similar line sown upland field crops (mesta, cereals, pulses, vegetables etc.). It consists of body frame, wheel, tyne attachment frame (hoe type and scraper) and handle. The weeder operates on a small size tube-less rubber cycle wheel of diameter 40 cm for its smooth operation in the field with better stability and balance. The weeding operation involves push and pull type and removes weeds completely from its operational width. To avoid the accumulation of weeds ahead of tynes, the operator walks behind while using the tool. About 80 to 85 % weeds can be controlled using the tool and rest 15 to 20 % of the weed flora has to be removed manually. The actual field capacity of weeder is about 0.026-0.028 ha/h, which is about 20-25 % more than wheel hoe. The operational draft requirement was found to be 29.7 kg. Weeding with this tool reduces drudgery, saves 60% of weeding time and reduces labour requirement 50-60 man-days/ha. Saves Rs. 15,000-18,000/ha compared to manual weeding cost.

DEVELOPMENT OF FIBRE EXTRACTION MACHINERY

The fibre is obtained from the bark of the jute plant. The bark consists of cellulose cemented by non-cellulosic materials such as pectin, hemicelluloses, etc. Majority of Jute farmers uses the traditional method of whole plant retting in stagnant water. Now-a-days the trend of dryness of river and ponds/canals during short harvesting period due to the climate change, it is difficult for the farmers to ret jute.

JUTE RIBBONER

The power operated jute ribboner machine developed for extraction of jute ribbon from freshly harvested jute plants without breaking sticks. It is powered by single phase 3 hp electric motor and can be operated by 5 hp Diesel engine with slight modification. It consists of two sets of stick breaker-cum-ribbon pulling units placed one above the other. It has two input chutes so that two operators can work simultaneously at a time. Five to six jute plants can be fed in one set of breaker unit, there by 10-12 plants can be extracted at a time by two units. The principle involves feeding of jute plants by butt end in between the upper breaking rollers, which crushes the stick about 5 cm and then pulling of ribbon by the lower rollers at high speed and placing the ribbon on conveyor belt for delivery at front/ side of the machine. The sticks of the feeding plants ejected intact from the upper tray of the machine. The performance evaluation of the machine shows jute stem input capacity of 1 t h^{-1} (0.022 ha plants/h). The improved jute retting system involving ribbons reduces the retting duration by 10-12 days against traditional retting duration of 21-25 days. Due to reduction in biomass the water requirement reduces and also improves the fibre yield to about 7-8% on green biomass basis against 5-6 % in traditional retting system.

There is saving of water, labour, time and energy as the fibre is obtained through retting of extracted ribbons (60% of biomass) instead of the whole plants. The advantage of ribbon retting are i) requires much less water, ii) retting time reduced to almost half of traditional retting process, iii) root contents of fibre eliminated and iv) improves the fibre quality.

CONCLUSION

Several improved equipment and machines have been developed for mechanization in sowing, weeding and fibre extraction operations in jute farming. Line sowing of small seeds like jute is very much desirable to save seed, to reduce the cost cultivation by cutting the cost involvement in weeding and thinning. The seed sowing through machine distributed seeds uniformly along the rows which facilitates better growth and higher production. Development of multi crop seeder will help in intercropping of jute with other crops. Mechanical intercultural operations in line sown crop using mechanical weeding machine showed 60 % reduction in manual labour requirement and cost for weeding and thinning by more than 50 per cent. There is saving of inner wood and time for ribbon extraction and improved jute retting system reduces the retting duration. The developed manual and power operated seed drill machines for jute and other small seeded crops are most suitable for small and marginal farmers having small land holdings and limited capital investment capacity.

REFERENCES

Ghosal, M.K. and Pradhan, S.C. (2013). Performance study of a low cost manually operated cup feed metering seed drill for sowing green gram, Agril. Engg. Today, Vol. 37, No. 1, pp. 37-41.

Goswami, M.D. (2001). A laboratory set up for testing planters and seed drills, *J of Agril. Engg.*, Vol. 38, No. 4, pp. 69-72.

Herbek, J. and Murdock, L. (2009). Planting and drill calibration, A comprehensive Guide to Wheat Management in Kentucky, Vol. 4, pp. 20-24.

Kumar, S., Naik, R.K. and Shambhu, V.B. (2015). Profitable production of jute through mechanization. *Farmers' Digest*, Vol 48(03):38-39.

Kundu, B. C., Basak, K. C., and Sarkar, P. B. (1959). Jute in India- A monograph. Indian Central Jute Committee, Calcutta, 395p.

Mandal, T. C. (1991). Report of jute seeder development project. No. IJO/AGRI/06/08. International Jute Organization, Bangladesh, Dhaka.

Masum, S.M., Ali, M.H., Islam, M.S. and Sultana, S. (2001). Influence of plant spacing and post emergence herbicide on the yield of white jute (*Corchorus capsularis*), *Int. J. Sustain. Agric*. Vol.3, No. 3, pp. 82-87.

Naik, R.K. and Karmakar, P.G. (2016). Mechanization of jute cultivation. *Agril. Engg. Today*, 40(2): 62-69.

Naik, R.K., Jha, S.K. and Sarkar S. (2017)[a]. Performance evaluation of manual weeders for jute crop in West Bengal, India. *Research Journal of Agricultural Sciences*, 8(6): 1341-1343.

Naik, R.K. and Shamna, A. (2019). Mechanization of jute farming. Agrobios Newsletter, Vol. 18(07): 113-114.

Naik, R.K.,Jha, S.K., Sarkar, S. and Ghorai, A.K. (2017)[b]. Performance study of a low cost manually operated seed drill for sowing of jute. *International Journal of Agricultural Sciences*, 9(38):4577-4579.

Naik, R.K., Jha, S.K., Sarkar, S. and Ghorai, A.K. (2018)[c]. Performance evaluation of manual operated single wheel weeder for jute crop. *International Journal of Agricultural Engineering*, 11(1): 49-53.

Ojha, T.P. and Michel, A.M. (1987). Principles of Agricultural Engineering, Vol. 1, Jain Brothers, New Delhi.

Shambhu, V.B. and Thakur, A.K. (2018). Functional performance of a manually operated seed drill for jute. *Int.J. Curr. Microbiol. App. Sci*., Vol. 7, No. 6, pp.52-59.

Oral V4T4D2

Soil morphological properties of Varathuru watershed in Chittoor district, Andhra Pradesh

G P LEELAVATHY[1*] and M V S NAIDU[2],

[1]Soil Science, RARS, Tirupati, A.P, India;

[2] Professor & Head, Department of Soil Science and Agricultural Chemistry, S V Agricultural College, Tirupati, A.P, India

Acharya N. G. Ranga Agricultural University, Lam, Guntur

E-mail: gp.leelavathi@angrau.ac.in

Key Words: *Colour, Texture, Structure and Consistency*

INTRODUCTION

Soil morphological properties refer to the physical characteristics and structure of soil, which are crucial for understanding soil behaviour and its relationship with plant growth, water retention, drainage and other environmental factors. These properties include soil texture, colour, structure, depth, and porosity. The Varathuru watershed in Chittoor district of Andhra Pradesh is predominantly under rainfed farming with erratic rainfall distribution associated with low crop productivity. The morphological characteristics were the most imperative key features for classifying soil into defined categories. Soils with deeper, more stable structures can store more carbon. Soil fertility in relation to morphology under various stressors such as drought, flooding, or heat stress is still an emerging area. Soil morphological properties are crucial to many environmental and agricultural processes, but there are many gaps in research that need attention. These gaps present opportunities for scientists to delve deeper into understanding how soil morphological properties influences both natural and managed ecosystems, especially in the face of climate change, urbanization, and changing land-use patterns.

METERIAL AND METHODS

The present study involved the study of three typical pedons for morphological properties in the Varathuru watershed. Soil morphological features estimated in the field as per Soil Survey Staff, 1951. The depth of soil profile varied from shallow to very deep. Munsell's colour notation of Hue, Value and Chroma was observed for both air dried and moist profile soil samples. Soil texture was found based on grittiness, sticky and plasticity with the sense of feel from clay to loamy sand. Soil structure was

estimated based on the aggregate's size, grade and shape into very fine to coarse, structureless to strong and crumb to angular blocky, respectively. Consistency was found at dry, moist and wet conditions as soft to very hard, loose to extremely firm and nonsticky and nonplastic to very sticky and very plastic, respectively. Cutans on the surfaces of soil particles or the boundaries between soil horizons were identified based on the type, thickness and quantity as argillans, thick or thin, and patchy or continuous, respectively. Soil pores and root distribution in the profile were identified as fine to coarse in size and few to many in quantity, respectively.

RESULTS AND DISCUSSION

The soils were very shallow to deep in depth and depth varied from 0.18 m to more than 1.41 m and were ended with weathered-gneiss whereas the pedon 3 was ended with hard granite gneiss. The depth of the pedons was the manifestation of topography. These results were in accordance with the findings of leelavathy *et al.* (2010). The colour varied from dark reddish brown to light yellowish brown in colour. The colour appears to be the function of chemical and mineralogical composition of the soil (Lakshmi *et al.,* 2020). Soils exhibited single-grain, granular and sub-angular blocky structures. Weak structural development might be due to low clay and organic carbon content (Sitanggang *et al.,* 2006).

Texture of the horizons varied from gravelly sandy loam to sandy clay loam. These differences were caused by topographic position, nature of parent material, *in-situ* weathering and translocation of clay and age of soils. Soil consistency is measured for wet, moist and dry soil samples and also refers to the manifestation of the physical forces of cohesion and adhesion acting within the soil at various moisture levels. The consistence varied from loose to hard, friable to firm and non-sticky and non-plastic to slightly sticky and slightly plastic in dry, moist and wet conditions, respectively in different horizons of all the pedons. Roots were fine in size and few in quantity in surface horizons and absent in sub-surface horizons. Root distribution indicated that vegetation of the area comprises of annuals and grasses. Represented in Table1.

CONCLUSION

The soils in the study area were shallow to deep in depth, dark reddish brown to light yellowish brown in colour, The texture of these pedons ranged from gravelly sandy loam to sandy clay loam. Single grain, granular, and sub-angular blocky in structure, loose to extremely hard, friable to stiff, and non-sticky and non-plastic to slightly sticky and somewhat plastic in consistency. These soil morphological properties are crucial for understanding soil behaviour and its relationship with plant growth.

REFERENCES

Leelavathi, G.P., Naidu, M.V.S., Ramavatharam, N and Sagar, G.K. 2009. Studies on genesis, classification and evaluation of soils for sustainable land use planning in Yerpedu mandal of Chittoor district, Andhra Pradesh. *Journal of the Indian Society of Soil Science*. 57: 109-120.

Soil Survey Staff. 1951. *Soil Survey Manual.* US Department of Agricultural Hand book No. 18.

Sitanggang, M., Rao, Y.S., Ahmed, N and Mahapatra, S.K. 2006. Characterisation and classification of soils in watershed area of Shikohpur, Gurgaon district, Haryana. *Journal of the Indian Society of Soil Science.* 54: 106-110

Lakshmi, Ch.S.R., Sreelatha, T., Sireesha, A. and Lakshmi, M.B. 2020. Characterisation and classification of sugarcane growing soils of North coastal district of Andhra Predeash. *Journal of the Indian Society of Soil Science*. 68 (4): 357-366.

Table 1: *Summary of the morphological characters of the pedons*

Pedon No. & Horizon	Depth (m)	Matrix dry	Colour Moist	Texture	Structure			Consistence			Boundary		Roots	
					S	G	T	Dry	Moist	Wet	D	T	S	Q
Ap	0.00 – 0.20	7.5 YR 3/1	7.5 YR 2.5/1	cl	m	3	sbk	Sh	fi	sssp	c	s	f	f
Bw1	0.20 – 0.40	7.5 YR 3/2	7.5 YR 2.5/2	cl	m	3	abk	Sh	fi	sp	c	s	-	-
Bw2	0.40 –0.62	7.5 YR 3/2	7.5 YR 2.5/3	cl	m	3	abk	h	fi	sp	c	s	-	-
Cr	0.62	Weathered gneiss												
Pedon2														
Ap	0.00 – 0.23	10 YR 5/1	10 YR 3/2	sl	f	1	gr	Sh	fr	sssp	c	s	f	f
1Bt1	0.23 – 0.31	5 YR 6/1	5 YR 4/4	scl	m	2	sbk	Sh	fi	sssp	c	s	-	-
11BC	0.31 – 0.80	7.5 YR 6/8	7.5 YR 5/6	s	f	0	sg	L	l	sopo	c	s	-	-
111Bt2	0.80 – 1.41	7.5 YR 6/8	7.5 YR 4/4	sic	m	2	sbk	H	fi	s p	c	s	-	-
Cr	1.41	Weathered gneiss												

Pedon3														
A	0.00 – 0.18	7.5 YR 4/6	7.5 YR 3/4	gsl	f	1	gr	sh	fr	sopo	c	s	f	f
R	0.18	Hard granite-gneiss												

Oral V5T4D2

Precision irrigation scheduling for augmenting yield, resource-use efficiency, and water productivity in jute-based cropping systems

SOURAV GHOSH, G. KAR, S. MITRA, A.K. SINGH, T. SAMAJDAR, R.K. NAIK, D. BARMAN, S. SAHA, DEBARATI DATTA and SUVAM NANDA
ICAR-Central Research Institute for Jute and Allied Fibres-700121
E-mail: ravseven.agri@gmail.com

Key Words: *Jute, Sprinkler Irrigation, Water Productivity, Evapotranspiration, Irrigation Scheduling, Micro-Irrigation, Climate-Smart Agriculture.*

INTRODUCTION

India, the world's largest jute producer (6.3 lakh ha; 17 lakh tonnes, MOAFW 2021), faces water management challenges due to jute's high evapotranspiration demand (450–500 mm) and sensitivity to drought and waterlogging (Barman et al., 2012). Early-season moisture stress (March–May) often limits growth and yield. Traditional surface irrigation leads to high water losses, necessitating efficient micro-irrigation systems like sprinklers and drip.

Sprinkler irrigation ensures uniform water distribution, reduces water usage, improves water productivity, and enhances early crop growth. In jute-based cropping systems, sprinkler irrigation benefits both puddled transplanted rice and flax by increasing water use efficiency and optimizing irrigation scheduling. Research highlights significant yield and water savings using sprinkler irrigation in jute (Mitra et al., 2006), rice (Mandal et al., 2019), and global studies (Vories et al., 2013; Pinto et al., 2020). Climate-smart irrigation strategies, integrating soil moisture depletion and evapotranspiration-based scheduling, are crucial for maximizing water efficiency in jute-based cropping systems. To address these issues, a study was undertaken at ICAR-CRIJAF, Barrackpore, to evaluate the efficiency of sprinkler irrigation in a Jute-Rice-Flax cropping system, focusing on crop growth, fibre yield, irrigation water-use efficiency (IWUE), and soil microbial properties.

MATERIAL AND METHODS

A field experiment was conducted to evaluate the efficiency of sprinkler irrigation in a Jute-Rice-Flax cropping system, and included different irrigation treatments: sprinkler irrigation at 50% Depletion of Available Soil Moisture (DASM), sprinkler irrigation at 75% DASM, surface irrigation at 75% DASM, and a control with one post-sowing irrigation. The rate of water delivery ranged from 10 to 15 mm/hr, carefully controlled to prevent waterlogging and ensure even moisture distribution. Each sprinkler had a discharge rate between 0.6 and 1.5 m^3/hr, depending on crop water requirements and field conditions, with a wetting diameter of 10 to 12 meters for effective coverage and uniform water distribution.

RESULTS AND DISCUSSION

The study demonstrated the effectiveness of sprinkler irrigation in enhancing fibre yield, water productivity, energy efficiency, and soil microbial activity in a jute-rice-flax cropping system. In jute, sprinkler irrigation at 50% DASM (15 mm) increased fibre yield by 34% and water productivity by 12% over the control, performing comparably to surface irrigation at 75% DASM (40 mm). In rice, sprinkler irrigation in puddled transplanted rice (PTR) and SRI maintained grain yields (~5.6 t/ha) while improving water productivity by 35% and reducing water use by 32%. In flax, sprinkler irrigation at 50% DASM (15 mm) increased fibre yield by 24% and IWUE by 28% compared to surface irrigation.

Energy use analysis showed that SPK 50 DASM required 175% more irrigation energy than the control but remained more efficient than surface irrigation at 75% DASM. SPK 75 DASM reduced energy inputs by 20%, while energy efficiency was highest under SPK 50 DASM (+15% over control), followed by SPK 75 DASM (+8%) and SUR 75 DASM (+4%). Net energy returns were also highest under SPK 50 DASM (+40%), followed by SUR 75 DASM (+30%) and SPK 75 DASM (+25%), highlighting the economic and energy advantages of sprinkler irrigation, particularly at 50% DASM.

Sprinkler irrigation significantly improved soil microbial activity. At 30 DAS, SPK 50 DASM increased FDA by 57%, DHA by 55%, and MBC by 46% over the control due to better moisture availability. By 45 DAS, microbial activity remained higher under sprinkler irrigation, with SPK 50 DASM increasing FDA and MBC by 31% and DHA by 39% over the control. These results indicate that precision

irrigation improves soil microbial health by enhancing aeration and moisture balance, fostering a more productive rhizosphere.

CONCLUSION

Sprinkler irrigation at 50% DASM emerged as the most efficient strategy in the jute-rice-flax system, maximizing yield, water productivity, and soil microbial health while optimizing energy use. It improved fibre and grain yields, reduced water consumption, enhanced microbial activity, and demonstrated superior energy efficiency compared to conventional surface irrigation. These findings highlight the potential of sprinkler irrigation as a sustainable alternative for improving productivity and resource-use efficiency in jute-based cropping systems.

REFERENCE

Barman, D., Saha, A.R., Kundu, D.K. and Mahapatra, B.S. (2012). Rainfall characteristics analysis for jute based cropping system at Barrackpore, West Bengal, India. *Journal of Agricultural Physics* 12(1): 23-28.

Mitra, S., Sinha, M.K. and Nath, R. (2006). Growth and yield of jute as influenced by moisture stress. Annual Report central Research Institute for Jute and Allied Fibres, Barrackpore, pp. 68-71.

Mandal, K.G., Thakur, A.K. and Ambast, S.K., 2019. Current rice farming, water resources and micro-irrigation. *Current Science* 116 (4): 568-576.

Pinto, M.A.B., Parfitt, J.M.B., Timm, L.C., Faria, L.C., Concenço, G., Stumpf, L. and Nörenberg, B.G., 2020. Sprinkler irrigation in lowland rice: Crop yield and its components as a function of water availability in different phenological phases. *Field Crops Research*, *248*: 107714.

Vories, E., Rhine, M. and Straatmann, Z., 2017. Investigating irrigation scheduling for rice using variable rate irrigation. *Agricultural Water Management*, *179*: 314-323.

Oral V6T4D2

Investigation on Possibility of Mangrove Regeneration: A Case Study from Indian Sundarbans

SWETA CHATTERJEE* and GUPINATH BHANDARI
Jadavpur University, Kolkata – 700032, West Bengal, India
E-mail: swetac.swre.rs@jadavpuruniversity.in

Key Words: *Indian Sundarbans, Importance Value Index, Mangrove Regeneration, Species Diversity Indices Assessment, Temporal Dynamics of Mangrove*

INTRODUCTION

Primary problem of this micro study area underlines mangrove deforestation issues due to locals' livelihood purposes, portraying the possibility of mangrove regeneration aspects. Despite this foremost issue, new islands formation with mangrove seedling and further colonization of specifically Bain types (Avicennia) of mangrove patch is coexisted and observed through satellite imageries and clarified after field verification. Here this study area (Locally named as *Dorabagda Mangrove Patch not designated forest patch, Dakkhin Gorankati under Kultali Block, South 24 Parganas District*) belongs to naturally regenerated site, being not planted site, quite prospective for maximizing the potentiality of restoration projects over Indian Sundarbans. Objectives of this study are to comprehend the temporal dynamics of mangrove existence over the newly formed accreted island and to analyse the species diversity assessment using ground level observations.

MATERIALS AND METHODS

First halve of this study belongs to the primary data analysis from the field survey using Quadrat survey (10*10 m) covered up to 50 meters deep into the forest as density of the forest is much higher and second halve belonging to the Image classification, shoreline retreat analysis associated with bank change monitoring analysis (Ghosh et al., 2018) and mangrove health analysis with the help of several health monitoring indices for mangrove health analysis. 8 soil samples have been collected from field to analyze physico-chemical properties (*Soil Salinity, Soil Conductivity, Soil Organic Carbon, Soil Organic Matter & Soil Moisture*) and soil textural type through Ternary Diagram, utilizing PAST Software. *Species Distribution Analysis* through Biodiversity Pro Software (McAleece et al., 1997)*; Species Diversity Analysis* (Harper, 1999) through Indices Analysis (*Shannon Diversity and Simpson Dominance Index*)*; Importance Value Index (IVI)* (Panwar and Bhardwaj, 2012), (*Importance Value Index (IVI)= Relative Frequency+ Relative Dominance+ Relative Density*); *Diversity Profile Analysis* (Tóthmérész, B 1995) *and Spatial distribution of soil testing parameters* are visualized utilizing software e.g. Biodiversity Professional & Past version 4.03, Microsoft Excel (Version 2016), QGIS (Version; 2.16.3), R Studio (Version; 4.3.2) & Arc Map (Version-10.8).

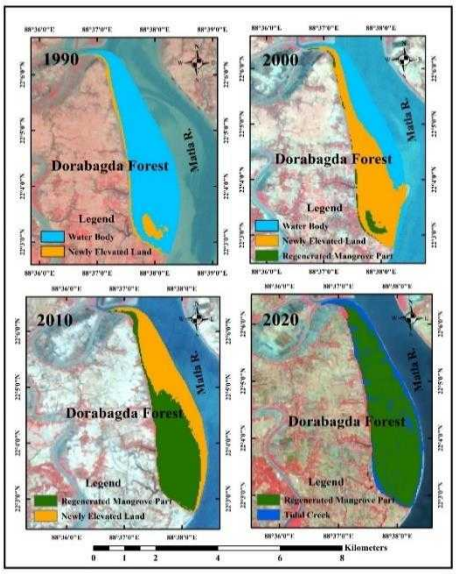

Fig. 1. Land Cover Classification (1990-2020) of Newly Formed Dorabagda Mangrove Patch

RESULTS AND DISCUSSION

Mangrove Regeneration started from 2000 & the colonization excelled since last 20 years, covering entire newly elevated land approximately 76.93% of areal coverage at Kappa statistics of 0.99761 (Figure 1). From the span of 1998 to 2023, area of whole island has been increased from 3.35 Sq. Km (1998) to 7.66 Sq. Km (2023). Area coverage from NDVI is drastically increased from 1990 to 2022 (7.34 Sq.km to 68.80 Sq.km). SAVI indexed areal coverage (1990-2022) shows no existence of colonization of mangrove in 1990, however it started to colonize after 2000 and healthy vegetation cover started to hike at the rate of 3.21% (2000) to 94.77% (2022); OSAVI also gives the insights of hike from 3.54% (1990) to 95.48% (2022); VCI also predicts the existence of tidally wet condition over the newly born mangrove patch and its areal coverage hikes wet condition from 4.11% (1990) to 99.82% (2022). All species (*Avicenni*a types being the monotypic species) are aggregately distributed over the site except one species *Bruguiera Gymnorrhiza* being randomly distributed. Importance Value Index (IVI) analysis shows *Acanthus ilicifoliu*s is the important salt tolerant species over the mangrove patch followed by *Avicennia Marina, Avicennia Officinalis, Avicennia Alba* as this place is observed as the habitat for intermediate succession, transforming the *Acanthus ilicifolius* into *Avicennia* types.

CONCLUSIONS

Natural regeneration of mangrove species can be succeeded from pioneering species (*Acanthus ilicifolius*) towards the secondary climax vegetation (*Avicennia*) enumerating the regional distribution of monotypic mangrove patch (*Avicennia)*. However, continuous deforestation of woody mangrove trees e.g. *Avicennia marina, Avicennia officinalis, Avicennia alba* for serving the livelihoods of the natives, disrupts the natural succession of mangroves. If equilibrium between deforestation and regeneration through reforestation can be attained in near future, this newly born Dorabagda mangrove patch would be the best experimental regenerated site, colonizing *Avicennia* type of salt tolerant species with other native mangrove associates, sustaining hydro-geomorphological conditions of the region.

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Authors are also indebted to Dr. Punarbasu Chaudhuri, Assistant Professor & Head, Department of Environmental Science, University of Calcutta for guiding us so that corresponding author can get the proper academic knowledge on succession on mangrove species and Indian Sundarbans as well.

REFERENCES

Ghosh, M. K., Kumar, L., and Langat, P.K. (2018). Mapping tidal channel dynamics in the Sundarbans, Bangladesh, between 1974 and 2017, and implications for the sustainability of the Sundarbans Mangrove Forest. *Environmental Monitoring and Assessment*, 190, 1-15.

Harper, D.A.T. (ed.) (1999). Numerical palaeobiology, *John Wiley & Sons.*

McAleece, N., Gage, J.D.G., Lambshead, P.J.D., Paterson, G.L.J. (1997). BioDiversity professional statistics analysis software. Jointly developed by the Scottish Association for Marine Science and the Natural History Museum London.

Panwar, P. and Bhardwaj, S.D. (2012). Handbook of practical forestry. *Agrobios, India*, 191p.

Tóthmérész, B. (1995). Comparison of different methods for diversity ordering. *Journal of vegetation Science*, 6(2), 283-290.

Oral V7T4D2

A study on coastal vulnerability in the stretch between Namkhana jetty ghat and Madanganj region

A. RAY[1*], W. ANSAR[2], D. DE[3], G. BHANDARI[4]

[1]Jadavpur University, Kolkata-700032, West Bengal, India

[2]Behala College, Kolkata- 700060, West Bengal, India

[3]ICAR, CIBA-Kakdwip Research Centre, Kakdwip-743347, West Bengal, India

[4]Jadavpur University, Kolkata-700032, West Bengal, India

E-mail: abantika@lincoln.edu.my

Key words*: Sediment Characteristics; Erosion and Pollution; Tidal Variation; Coastal Vulnerability*

INTRODUCTION

The Sundarbans, the world's largest mangrove forest, lies on the delta of the Ganges, Brahmaputra, and Meghna rivers. Indian Sundarban's flora and fauna are critical for ecotype protection and minimizing natural disasters (Chakraborty, Mondal and Mukherjee, 2016). This region is biodiversity hotspot, sheltering approximately 453 fauna species and 84 flora species including 34 mangrove species. Problem Statement**:** The Sundarbans, a transition zone from marine to freshwater and terrestrial systems, offering dynamic habitats for diverse species. The area faces threats from climate change, hydrological imbalances, and unscientific interventions, leading to land loss due to soil erosion, pollution and decreased productivity (Mondal and Bandyopadhyay, 2014). Research Gap**:** Despite the Sundarbans's ecological importance, botanical exploration and soil embankment has not kept pace with the changes in mangrove species. Objectives**:** This study focuses to the Namkhana Jetty Ghat to Madanganj region, evaluating soil erosion and pollution impacts on flora and fauna as addressing research gaps on environmental changes in this critical ecosystem.

MATERIALS AND METHODS

Fish Sampling and Flora Identification

The study was conducted from Namkhana Jetty Ghat to Madanganj, South 24 parganas, West Bengal, Southern part of Saptamukhi River of Indian Sundarban during pre-monsoon (April, 2024), monsoon (August, 2024) and both low and high tide time. Fish samples (13 species) and soil samples were collected by local boatman using fishing net and soil sampler then put into plastic zip lock and floral (24) species identification was done by local guide and botanical taxonomy. Physicochemical parameters e.g. temperature, salinity, density, PIR, prorosity, NPK and microbial activity were analyzed using standard protocols and instruments (Flame Photometer, Spectrophotometer, Pipette, Beakers, Kjeldahl Digestion Unit, Metal Cylinder). For statistical analysis (ANOVA) using Jamovi to identify the variations in ecological impacts and contamination levels (Dhara, 2019).

Soil Erosion

The soil erosion study started from the right side of the Namkhana Jetty Ghat to Madanganj by field survey, photographic documents and geospatial analysis to analyze the land loss by erosion and riverbank instability (Mukherjee and Siddique, 2024).

RESULTS AND DISCUSSION

Table 1: *Soil sample parameters including heavy metal of sampling stations*

Observatories	Namkhana Jetty Ghat	Madanganj	Namkhana Jetty Ghat	Madanganj
	(Pre-monsoon)		(Monsoon)	
Latitude (N)	$22^0$38'48.15''	$21^0$18'22.61''	$22^0$38'48.15''	$21^0$18'22.61''
Longitude (E)	$87^0$04'32.30	$88^0$15'57.27''	$87^0$04'32.30	$88^0$15'57.27''
Soil Density	1.4±2.72	1.48±0.029	1.207±0.011	1.303±0.005
Permeability Infiltration Rate (PIR) (cm/hr)	0.743±0.005	0.853±0.005	0.72±1.36	0.803±0.005

Observatories	Namkhana Jetty Ghat	Madanganj	Namkhana Jetty Ghat	Madanganj
	(Pre-monsoon)		(Monsoon)	
Porosity (%)	44.33±1.15	47.33±1.15	50.66±0.577	51.66±0.577
Temperature (°C)	32.66±1.15	32.66±1.15	30.33±0.577	30.66±1.15
Salinity(ppt)	16.3±0.173	13.76±0.251	14.4±0.346	12.62±1.15
Dew Point (°F)	74.01 ± 4.68	74.50 ± 4.80	78.60 ± 2.58	78.80 ± 2.75
Humidity (%)	55.19 ± 10.35	56.00 ± 10.50	83.30 ± 5.92	84.00 ± 6.10
Wind Speed (mph)	8.43 ± 1.91	8.60 ± 2.00	5.20 ± 2.08	5.50 ± 2.20
Sea Level Pressure (in)	29.57 ± 0.05	29.60 ± 0.06	28.11 ± 2.56	28.30 ± 2.65
Precipitation (in) Rainfall Days	4.80 ± 0.40	4.50 ± 0.00	27.50 ± 0.30	27.30 ± 0.00
Nitrogen (N) (mg/kg)	80.33±0.57	75.33±1.15	82.66±0.57	78.33±0.57
Phosphorus (P) (mg/kg)	15.66±0.28	11.66±0.28	16.33±0.28	11.34±0.29
Potassium (K) (mg/kg)	18.06±0.11	13.96±0.05	18.18±0.28	14.11±0.02

Source: Field, www.weatheratlas.com & www.wunderground.com

Currently, more than fifty vessels (from local fishermen) flow every day between the Namkhana jetty and Madanganj, impacting the waterways of the region. Besides this, soil erosion occurs along the banks due to the regular movement of vessels caused by fluctuating salinity and wind speed during the seasons (Bhattacharjee and Mukherjee, 2023). The result also includes changes in permeability and porosity, and long-term coastal stability with environmental sustainability (Chakraborty et al., 2016),

Figure 1: Soil erosion near Madanganj area (field photo) and Tidal chart from https://nautide.com

Figure 1 explains, soil erosion in the Namkhana to Madanganj is mainly driven by the changing tide heights in April and August , 2024 because seasonal fluctuations in river discharge impact on soil erosion and vessel movement including instability of riverbank and anthropogenic factors like embankment failure. Soil pollution can also degrade the soil structure, vegetation growth and land resistance power to erosion. Without understanding these patterns, it is difficult to manage the shoreline.

CONCLUSIONS

This study highlights the significant variation of seasons that affect soil characteristics and reflecting monsoonal impacts. Decreasing soil density, salinity that indicate the effect of rainfall and fresh water influx. An increasing porosity and permeability points towards increased water holding capacity. These findings underscore the essentiality to mitigate soil erosion, pollution and habitat degradation. Future research should focus on long-term monitoring and sustainable conservation strategies to protect soil health, coastal ecosystem and biodiversity.

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REFERENCES

Bhattacharjee, S., & Mukherjee, A. (2023). Microplastics in gastro-intestinal tract of estuarine fish from the mangrove ecosystem of Indian Sundarbans. *Iranian Journal of Fisheries Sciences,* 22(2), 317-338.

Chakraborty, R., Mondal, M., & Mukherjee, S. (2016). Ethnobotanical information on some aquatic plants of South 24 Parganas, West Bengal. *Plant Science Today*, 3(2), 109-114.

Dhara, S. (2019). Physical environmental setting of the Hugli–Saptamukhi estuarine deltaic complex in South West Sundarban, West Bengal. *International Journal of Emerging Technologies and Innovative Research*, 6(2), 481-495.

Mondal, I., & Bandyopadhyay, J. (2014). Coastal wetland modeling using geoinformatics technology of Namkhana Island, South 24 Parganas, W.B, India. *Open Access Library Journal*, ***1***(9), 1-17.

Mukherjee, N., & Siddique, G. (2024). Sundarbans: A physical-environmental & socio-cultural complex hitherto. *In Impact of climate change in the Indian Sundarbans region* (13-22). Cham: Springer Nature Switzerland.

Oral V8T4D2

Saline water intrusion and its impact of on coastal agriculture

S. MUKHOPADHYAY[1], G. BHANDARI[2], S. SINHA[3]

[1] Research scholar, (Presenting Author) Department of Geography, Amity Institute of Social Sciences, Amity University, Kolkata-700135, West Bengal, India

[2]Associate Professor, Jadavpur University, Kolkata-32, West Bengal, India

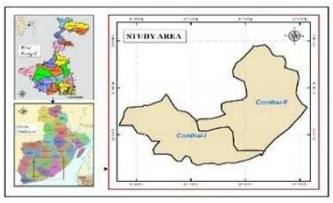
[3]Assistant Professor, Amity University, Kolkata -700135, West Bengal, India

E-mail: swarnalimukhopadhyay@gmail.com

Key Words*: Climate Change, Saline Water Intrusion, Sustainable Agriculture*

INTRODUCTION

Coastal agriculture refers to the practice of farming and cultivating crops in coastal areas, where the land meets the sea. This type of agriculture is crucial for the livelihoods of millions of people worldwide, providing food, income, and employment opportunities. However, coastal agriculture also faces unique challenges and risks. Saline water intrusion poses a significant threat to coastal agriculture worldwide. Rising sea levels, climate change induced hazard increased tidal flooding, and reduced freshwater availability exacerbate saltwater contamination of arable land. This study examines the impacts of saline water intrusion on coastal agriculture and explores adaptation strategies to mitigate these effects. Results show that saline water intrusion leads to reduced crop yields, decreased soil fertility, and increased soil salinity. However, adaptation measures such as cultivation of salt-tolerant crop varieties, can help farmers maintain productivity and reduce soil degradation. This research focuses on the open coast area of Purba Medinipur, where agricultural farmers are encountering various challenges. The agricultural farmers of coastal region of Purba Medinipur faces challenges due to climate change and climatic hazards, including rising sea levels and increasing soil and water salinity, which significantly degrade crop quality (Mahadevia et al., 2010)**.** This research highlights the importance of integrated coastal zone management and climate-resilient agricultural practices to address the challenges posed by saline water intrusion. By adopting adaptive strategies, coastal communities can minimize the impacts of saltwater intrusion and ensure sustainable agricultural production. Some research gaps are found like changing pattern of coastal agriculture with climate change, the socioeconomic impacts of saline water intrusion on coastal agriculture, including effects on livelihoods and food security, where to be required further research. The scale, intensity, and duration of ant climate induced hazard are likely to alter land use patterns in Purba Medinipore's coastal areas in West Bengal, potentially resulting in significant harm to agriculture, housing, and other sectors. Different societal segments also experience climate-related hazards unevenly, with the poorest communities suffering the most severe impacts (United Nations, 2009; Yodmani, 2001; Johnson, 2006). Consequently, low-income groups of rural cops are often the most affected by floods and other climate-induced disasters, as they are trying to implement protective measures and trying to struggle to recover from losses in property and income (Brouwer et al., 2007). The objective of this study is to investigate the impacts of saline water intrusion on coastal agriculture and to identify adaptation strategies to mitigate these effects. Specifically, the study aims to:1. Assess the soil salinity in coastal areas. 2. Evaluate the impacts of saline water intrusion on soil fertility, crop productivity. 3. Identify adaptation strategies to mitigate the impacts of saline water intrusion on coastal agriculture.



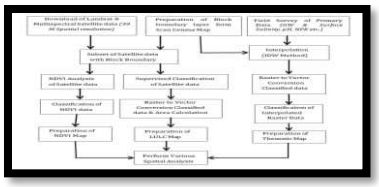


Fig:1*: Study Area* ***Fig 2****: Flow chart of Methodology*

MATERIALS AND METHODS

This study employed a mixed-methods approach, combining both qualitative and quantitative data collection and analysis methods. The study area was selected based on its vulnerability to saline water intrusion and its importance for coastal agriculture. Data collection involved: soil samples were collected from various points of Block Contai 1 and Deshopran (Contai 2).1. Field observations and surveys to assess the extent of saline water intrusion and its impacts on coastal agriculture.2. Laboratory analysis of soil and water samples to determine levels of salinity and other water quality parameters.3. Interviews with farmers and to gather information on adaptation strategies and perceived impacts of saline water intrusion.Mainly Arc GIS 10.8 and Google Earth Pro, Excel 2013 for Graph and charts were used to prepare various maps and diagrams and ERDAS Imagine 9.1 has been used to classify image. Moreover Landsat 8 image is used to detect the land use and land cover changes.

RESULTS AND DISCUSSION

The results of the study show that saline water intrusion is a significant problem in coastal areas, affecting soil fertility, crop yields, and ecosystem services. The study found that: Saline water intrusion has resulted in increased soil salinity, reducing soil fertility and affecting crop growth. Crop yields have decreased significantly due to saline water intrusion, affecting the livelihoods of farmers. According to satellite image analysis, significant changes in land use and land cover have occurred over the past 20 years, primarily driven by climate change, environmental factors and frequent climatic hazards. These climatic change events have severely impacted agricultural land, potentially altering land use patterns (Hussein et al., 2019). Field surveys indicate that climate change induced phenomena like tidal and storm surges have increased soil and water salinity (Mohsenipour et al., 2017), rendering ponds and tube wells polluted by saline floodwaters. This situation greatly affects coastal households, as these water sources are vital for daily use. Report of villagers were, that agricultural fields become saline due to storm surge flooding during climatic events, making cultivation impossible for the following 3 to 5 years.

Class name	2004(Area in %)	2024(Area in %)	% of change
Waterbody	1.65	1.28	-0.036
Sand	5.61	3.61	-2
Agricultural land	79.87	71.87	-8
Others Vegetation with Buildup area13.94	13.94	23.24	10.7

Table 1: *Area calculation Of Land use and land cover (Source: Satellite imagery)*

Coastal communities rely on natural resources for their livelihoods, predominantly engaging in agriculture and fishing. However, these sectors have been severely impacted by climatic hazards (Rahman et al., 2019). This study indicates that, over the past 5 to 10 years, the agricultural lands in the southern parts of the coastal regions have become unproductive due to the accumulation of saline water from sea water intrusion during climatic hazard. Consequently, the occurrence of climatic hazards has altered land use patterns, resulting in a decrease in average land size in the study areas of Block Contai 1 and Contai2. The agricultural lands are under threat of disappearing, imposing significant financial burdens on farmers. It has been noted that a decline in the soil quality of agricultural land has adversely affected crop production, potentially leading to shifts in livelihood (Gray et al., 2011). presented in this chapter illustrate the relationship between soil salinity and soil pH, which are interconnected with agricultural systems. This study illustrates that the socioeconomic conditions of the coastal populations in Block Contai 1 and Contai 2 are dire due to natural disasters. The loss of agricultural land further threatens farmers' livelihoods, significantly impacting their quality of life (Gray, 2011). For analysis of this study it has been observed negative slope , in statistical analysis in (Fig 4a,4b:Scatter Diagram)that , soil salinity increses, agricultural productivity decreases (value is Y=-2.45X+18.147).It is also observed negative slope in ,that as soil pH increases then agricultural productivity decreases(value is Y=-0.0895X+8.0703).it has been proved that high concentration of sodium chloride and excessive alkalinity can lead to osmotic stress and ion toxity, nutrient deficiency so this processes inhibits the plant root growth and seed germination.In this study it is found that coastal areas have extremely high soil salinity levels, exceeding 3ds/m, which leads to a soil PH >7.6.Soil salinity is most

pronounced within 20 -25 km from the coastline, causing fluctuation in pH level. Soil pH level above 7.6 is unsuitable for agriculture. Amount of ground water salinity also varied from 3 to 6 ds/m in these zone and ground water pH level varied from 7 to >7.6. As soil salinity increases from the coastline to 20 to 25 km, soil pH becomes more alkaline, leading to decreased nitrogen level. More acidic soil typically has higher nitrogen(N) level in soil. Phosphorus(P) and Potassium(k) level also vary with soil salinity and pH. Optimal agricultural conditions require balanced NPK levels and a neutral soil pH(6.6 to 7).However soil salinity has rendered agricultural land infertile.The findings of this study are consistent with previous research on the impacts of saline water intrusion on coastal agriculture. The study highlights the need for adaptation strategies to mitigate the impacts of saline water intrusion on coastal agriculture. The study identified several adaptation strategies, like cultivate Salt-tolerant crops, mulching processed agriculture to cope up with soil salinity and conservation agriculture and planning of Integrated coastal zone management.

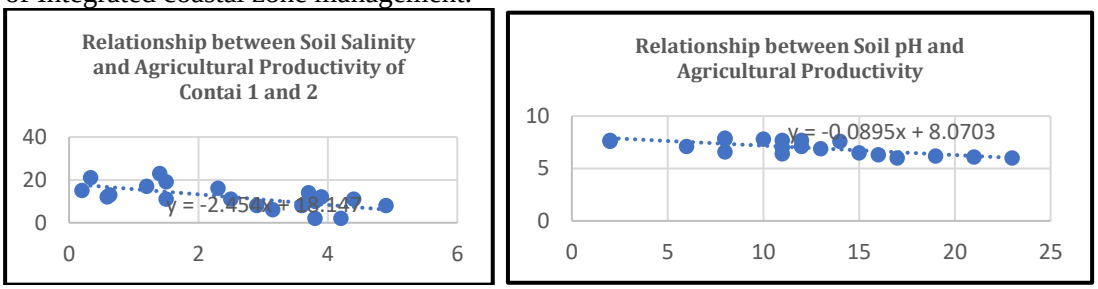


Fig: 3a,3b: Scatter Diagram

CONCLUSION

This study demonstrates the significant impacts of saline water intrusion on coastal agriculture, affecting soil fertility, crop yields, and ecosystem services. The study highlights the need for adaptation strategies to mitigate these impacts and promote sustainable coastal agriculture. Some of coastal farmers are trying to mitigate salinity by using straw, hays, tamarind in soil after post monsoon season and some of them are trying to cultivate salt tolerant crop like Mung dal, pigeon pea, brinjal, chilli, watermelon, tomato, cucumber, carrot, coconut in coastal area. The study's findings have important implications by recognizing the interconnectedness of environmental, social, and economic factors, stakeholders, including government bodies, NGOs, and the community itself, can work together to create a more equitable and sustainable future for these vulnerable populations.

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Earnest gratefulness is stretched to those, who encouraged me to write this research work and creative observations and valuable propositions to expand the overall quality of this document. We are really gratified to Prof. Santanu Bhattacharya for his guidelines throughout the research of the topic. We would also like to express my sincere gratitude to the office staffs, exclusively Irrigation Department and RRI Digha Purba Medinipore, Digha, Sankarpur Development authority and River Research Institute, Haringhata, WB for cooperation in collecting the secondary data.

REFERENCES

Bruckner, M.Z. (2012) Water and Soil Characterization- pH and Electrical Conductivity, Microbial Life Educational Resources. Montana State University Bozeman, 2012.

Brouwer, R.; Akter, S.; Brander, L.; Haque, E. (2007) Socioeconomic vulnerability and adaptation to environmental risk: A case study of climate change and flooding in Bangladesh. Risk Anal. 27, 313–326.

Center on Integrated Rural Development for Asia and the Pacific (CIRDAP), (1991). Development of Modules for Training on Integrated Approach to Rural Development and Disaster Management in Bangladesh, Final Report of UNCRD-CIRDAP; CIRDAP: Dhaka, Bangladesh.

Gray, C.L. (2011) Soil Quality and Human Migration in Kenya and Uganda. Glob. Environ. Chang., 21, 421–430.

Mahadevia, K.; Vikas, M (2010) Climate Change–Impact on the Sundarbans: A Case Study. International Scientific Journal Environmental Science 7-15 http://environment.scientific-journal.com

Mohsenipour, M. (2017) The Impact of Cyclone Aila on the Sundarban Forest Ecosystem. Int. J. Ecol. Dev., 32, 88–97.

Rahman, S.; Rahman, H.; Shahid, S.; Khan, R.U.; Jahan, N.; Ahmed, Z.U.; Khanum, R.; Ahmed, M.F.; Ahsan, R.; Kellett, J.; Karuppannan, S. (2014) The International Journal of Climate Change: Impacts and Responses Volume 5. Available online: https://on-climate.com/journal (accessed on 7 November 2019).

Poster T4P1

An advanced technique of soil fertility estimation for land use practices and soil characterization

TANUSHREE ADHIKARY* and SANJIB KAR
University of Calcutta, 700019, West Bengal, India
E-mail: sanjib_cu@yahoo.co.in, tannuadhikary7@gmail.com

Key Words: *Soil Fertility, Soil Characterization*

INTRODUCTION

Since the 1950s, there have been three philosophies driving soil fertility recommendation concerning certain base cations (Ca2+, Mg2+, K+). They include build and maintain approach, sufficiency level, and base cation saturation ratio (BCSR). The theory of an "ideal" BCSR in the soil has been extensively discussed and used to a limited extent throughout the Midwest by some soil testing labs to guide fertility recommendations. However, this theory has been a subject of great debate in terms of its utility for affecting crop yields and farmer profitability. Numerous studies have found flaws in the BCSR method and showed no proven yield increases (Eckert and McLean, 1981; McLean et al., 1983). So, we need an easy way to assess soil fertility. Soil fertility assessment is an important part of modern soil fertility management. The primary goal of soil fertility testing is to quantify a soil's ability to give nutrients for plant growth. A soil's CEC affects fertilization and liming practices. Objective of this study were to assess Net charge along with present base saturation to find out any relationship between soil fertility and net charge of any soil system.

MATERIALS AND METHODS

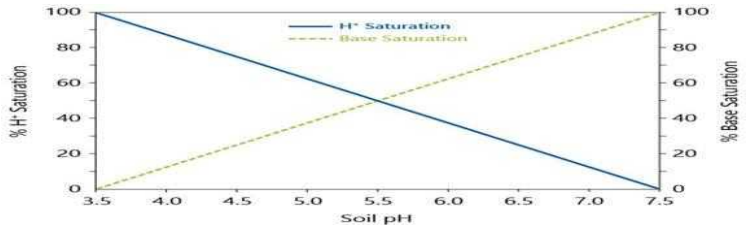
We assessed 25 surface soil samples were collected from four different states of east and north east india. We assess and estimate physico-chemical properties, net charge, variable charge and % base saturation on these soil samples by chemical analysis, potentiometric titration and ion retention methods.

Soil physical and chemical analysis and CEC estimated by(Spark 1996)

- For CEC estimation we followed distillation process.
- For Na+ and K+ we used flame photometer.
- For Ca and Mg we followed EDTA titration method.
- For other micronutrients DTPA solution is used**.**
- For Net charge estimation we used potentiometric titration method.

RESULTS AND DISCUSSION

The base saturation is a property closely related to CEC. Base saturation is frequently considered to be an indicator of soil fertility. The case with which adsorbed cation are related to plants also depends on degree of base saturation. A soil is considered very much fertile if the percentage of base saturation ≥80, medium fertile if percentage base saturation is 80-50% and low-fertile when the % base saturation is < 50. From our observation we observed that soil having base saturation range 80-50% are having net charge from 10-40. Soils having BS% greater than 80 have net charge greater than 40 and soils with BS% less than 50 having net charge lesser 10.



CONCLUSIONS

A positive correlation exists between percentage base saturation with soil pH, CEC and net charge. Generally, we can see from our dissertation data that the amount of net charge is high if soil CEC is high. From our observation we can conclude that if the amount of CEC ≥40 that soil is considered as high fertile soil whereas amount of CEC ranges between 10-40 is considered as medium fertile soil and soils with amount of net charge ≤10 is low fertile.

ACKNOWLEDGEMENT

I would like thank Department of Agricultural Chemistry and Soil Science, University of Calcutta for the laboratory and reagent access.

Units:

Na, K, Fe, Al (mg/Kg). N, OC, Base saturation (%). Ca, Mg (meq/100g), CEC (cmol/Kg)

REFERENCES

Baker, D.E. and M.C. Amacher. 1981. The development and interpretation of a diagnostic soil-testing program. Pennsylvania State University Agricultural Experiment Station Bulletin 826. State College, PA.

Bear, F.E., A.L. Prince, and J.L. Malcolm. 1945. Potassium needs of New Jersey soils. N.J. Agric. Exp. Stn. Bull. No. 71.

Bear, F.E. and S.J. Toth. 1948. Influence of calcium on availability of other cations. *Soil Sci*. 65:69-96.

Graham, E.R. 1959. An explanation of theory and methods of soil testing. Bull. 734. Missouri Agric. Exp. Stn., Columbia.

Hunter, A.S. 1949. Yield and composition of alfalfa as influenced by variations in the calcium-magnesium ratio. *Soil Sci.* 67:53-62.

Poster T4P2

Evaluation of groundwater quality, heavy metal pollution and human health risk assessment in a part of Mahanadi basin area of Odisha

P. SAMAL[1,2*], A. K. MOHANTY[3], S. KHAOASH[1], S.K JENA[2] and P. MISHRA[1]

[1] Department of Geology, Ravenshaw University, Cuttack, Odisha, Pin – 753003

[2]ICAR- Indian Institute of Water Management, Bhubaneswar, Odisha, Pin- 751023

[3]CSIR-National Geophysical Research Institute, Hyderabad, Pin – 500007

E-mail: samalpriyajit01@gmail.com

***Key Words**: Groundwater Quality, Heavy Metal, Hazard Index, Irrigation Water*

INTRODUCTION

Groundwater is an important bulwark against climate change. Owing to demand and over exploitation of the scarce water resources in arid and semi-arid regions, a spurt in industrial and agricultural activities, rapid urbanisation, a teeming population touching the eight billion mark, inadequate sanitation, and variation in seasonal patterns of precipitation and anthropogenic inputs, the groundwater quality has severely deteriorated (Panahi et al. 2021). In coal mining area, spontaneous combustion, coal extraction and processing, large amount of toxic and radioactive elements are released into the aqueous environment which has a deleterious effect on human health. High concentration of ions in irrigation water affects crops quality. Salinity problems in irrigated crops arise when drainage is poor, causing Na salts to accumulate in the root zone. The present study aims to assess the groundwater quality on the basis of major ions and heavy metals, and human health risk assessment in a part of Mahanadi basin area.

MATERIALS AND METHODS

The study area is located in the northeastern part of the Mahanadi basin, Odisha. The study area is approximately 300 Km^2, enjoys subtropical humid climate and average annual rainfall is about 1340 mm and 70-80% of the rain received during rainy season. The area is characterized by an undulating topography and the geomorphic features that dot the landscape which consist of hill ranges, plateaus, inter montane valleys, residual hills, pediplains, and river valleys with Gondwana sediments. There are extensive and sporadically occurring laterite cappings over the older formations, which hold good potential aquifer zone and are suitable for dug wells. The physicochemical analysis of 80 groundwater samples was carried out using the standard procedure suggested by American Public Health Association (APHA, 2017). The pH, Electrical Conductivity (EC) and Total dissolved solid (TDS) were measured in table top pH and EC-TDS meter respectively. Ca^{+2}, Mg^{+2}, Cl^-, HCO_3^- were measured in volumetric titration method. Na^+ and K^+ were analyzed by using flame photometer. SO_4^{2-}, F^- and NO_3^- were measured by UV–Vis. Spectrophotometer. The heavy metals were analyzed using an inductively coupled plasma-mass spectroscope (ICP-MS). Water Quality Index, Heavy metal Pollution Index (HPI) and Irrigational parameters like Sodium Adsorption Ratio (SAR), Sodium Percentage (Na%), Permeability index (PI) and Kelly's ratio (KR) were calculated by mathematical formula.

RESULTS AND DISCUSSION

The results of the groundwater quality analysis were compared with drinking water standard values recommended by the World Health Organization (WHO, 2008) and the Bureau of Indian Standards (BIS 2012). The groundwater is slightly acidic to slightly alkaline. The TDS value of the study area varies between 151 - 1088 mg/l, with a mean value of 503 mg/l. The groundwater chemistry shows the major cations and anions are in order of $Ca^{+2}>Na^+>Mg^{+2}>K^+$ and $HCO_3^->SO_4^{2-}>Cl^->NO_3^->F^-$

respectively. The major hydrochemical facies Ca-Mg-HCO_3 and Ca-Mg-Cl-SO_4, indicates the dissolution of carbonate phase minerals with favourable hydrodynamic conditions. The relative abundance of heavy metals concentrations in water samples was found as Fe>Zn>Al>Ba>Mn>Sr>Ni>Ag>Cu>Pb>V>Cr>Co>Cd, respectively. As per WQI values, about 86% of the groundwater belongs to excellent to good category, while the rest 14 % belongs to poor category. Based on HPI the majority of the groundwater samples are low to moderately contaminated. Based on EC and TDS values, all the samples are under permissible class and suitable for irrigation. The USSL diagram shows that only in 1% samples are under high salinity and medium alkalinity class. The permeability index indicates that about 6% of the samples are unfit for irrigation. Based on Kelly's ratio, 3% samples are unsuitable for irrigation. Around 9% and 16% of the water samples for children and adults respectively exceed the safe limit for Hazard Index (HI) and may have serious implications for human health as these have a strong potential non-carcinogenic quotient.

CONCLUSION

Groundwater quality evaluation by indexing methods demonstrates that the water is moderate to good quality in major part of the area. Based on irrigation parameters, only 5% of the samples are unsuitable for agriculture. Hazard index calculated amongst children and adults show that adults are more prone to non-carcinogenic risk as compared to the risk involved in case of children.

ACKNOWLEDGEMENT

The authors are thankful (Late) Dr. Rabba Govindaiah, Senior Scientist at C-MET, Hyderabad for his kind help in the ICP- MS analyses of heavy metals.

REFERENCES

APHA. (2017). American Public Health Association. Standard Methods for the Examination of Water and Waste Water, 23rdedn., American Public Health Association, American Water Works Association, Water Environ. Fed., co-publishers, Washington, D.C.

BIS. (2012). Indian Standard for Drinking- water specifications. Bureau of Indian Standards IS: 10500, Indian Standard Institute, India.

Panahi G, Eskafi MH, Rahimi H, Faridhosseini A, Tang X (2021) Physical–chemical evaluation of groundwater quality in semi-arid areas: case study—Sabzevar plain, Iran. Sustain Water Resour Manag. https://doi.org/10.1007/s40899-021-00576-y

WHO. (2008). Guidelines for drinking-water quality (3rd ed., 9789241547611). World Health Organization.

Poster T4P3

Assessment of groundwater quality in a costal aquifer of Puri district of eastern India

YUGAJYOTI BARIK[1*], S. K. JENA[2] and V.K. TRIPATHI[3]

[1,2]ICAR- Indian Institution Water Management, Bhubaneswar – 751023, Odisha, India

[3]Banaras Hindu University, Varanasi - 221005, Uttar Pradesh, India

E-mail: yugajyotibarik2000@gmail.com

Key Words: *Water Quality Index (WQI), Groundwater Quality, Sodium Adsorption Ratio (SAR).*

INTRODUCTION

Water is a vital resource for various purposes, including industry, agriculture, and daily work. Groundwater, a renewable source of drinking water, is the largest and most important source for the human population. Groundwater sustains ecosystems and human livelihoods, providing drinking water for billions worldwide, especially in regions with scarce surface water. It also supports global food production by providing dependable irrigation supplies. Groundwater also supports the health of lakes, rivers, and wetlands by preserving water quality and aquatic habitats. However, over-extraction and contamination of groundwater pose significant challenges, necessitating sustainable management and conservation efforts. India, the largest groundwater user globally, uses a significant amount of groundwater, accounting for over a quarter of the global total. This study aims to assess groundwater quality in the coastal aquifer of Puri district, addressing a knowledge gap in understanding hadrochemical dynamics and factors influencing water quality deterioration.

MATERIALS AND METHODS

The study investigated groundwater quality in Puri district, focusing on drinking and domestic purposes. Twelve locations were chosen for three seasons (Pre-Monsoon, Monsoon and Post-Monsoon), and water samples were analyzed for electrical conductivity, pH, total dissolved solids, total hardness, calcium, magnesium, sodium, potassium, nitrate, carbonate, fluoride, and bicarbonate

by adopting the standard method and also compared with BIS-2012 and WHO-2004 standards for desired and permissible rates. After that, the Water Quality Index was done. WQI, indicating the water quality in terms of index number, offers a useful representation of the overall quality of water for public use or for any intended use. Kelly's ratio and sodium adsorption ratio (SAR) were used to analyze irrigation water quality in the study area. As per the Kelly's ratio, with values less than 1 indicating good quality water and values above 1 suggesting a risk of soil sodicity, which can negatively impact soil permeability and crop growth. SAR forecast the possibility that sodium could build up in the soil as a result of continuing usage of sodic water (Tabbal, 2012).

RESULTS AND DISCUSSION

The study examines water samples for pH, EC, TDS, and total hardness. It reveals that slightly alkaline samples have a pH range of 6.7 to 8.1, and EC is low in most areas. The maximum concentration of calcium in drinking water is below the WHO's limit of 75 mg/l, which can cause health issues. Magnesium and sodium concentrations are safe for drinking, while fluoride, bicarbonate, sulphate, nitrate, and chloride concentrations pose risks to human health and agricultural sustainability. From WQI is generally good to excellent, with good to excellent categories in pre-monsoon, monsoon, and post-monsoon seasons. Irrigation suitability is highest in monsoon and post-monsoon seasons, with low to medium salinity hazards. Most water samples fall into excellent to good categories during these seasons.

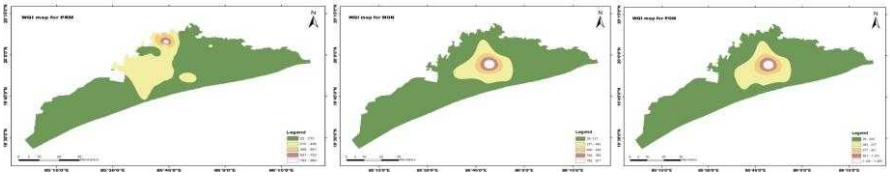


Fig. 1*:* Spatial distribution of map for WQI (Prm,Mon,Pom)

Table 1: *Water quality Classification based on WQI value for the year 2022 in Puri district (Pre-Monsoon, Monsoon and Post-Monsoon)*

WQI value	Water types	%Samples		
		PRM	MON	POM
< 50	Excellent	30.0	25	33
50-100	Good	33.3	50	25
100-150	Poor	13.3	8	8
150-300	V.Poor	6.7	8	8
>300	Unsuitable	16.6	17	17

CONCLUSIONS

The Puri district's groundwater samples are generally within ideal ranges due to nitrate and sodium concentrations, with some being saline. However, some samples fall under the desirable limit due to salinity hazards and high EC content. Palatability and sodium concentrations also fall within desirable limits. Water quality in the Puri region is generally good to excellent, with good to excellent categories for pre-monsoon, Monsoon and post-monsoon seasons. Irrigation suitability is highest during the monsoon and post-monsoon seasons, with low to medium salinity hazards. The majority of water samples during these seasons fall into the excellent to good category, making them safe and suitable for irrigation.

ACKNOWLEDGEMENT

The authors are thankful to the administration of Department of Soil and Water Engineering, Banaras Hindu University, Varanasi (U.P.) for providing the required facilities of the study.

REFERENCES

Behera, A. K., Chakrapani, G. J., Kumar, S., & Rai, N. (2019). Identification of seawater intrusion signatures through geochemical evolution of groundwater: a case study based on coastal region of the Mahanadi delta, Bay of Bengal, India. *Natural Hazards*, 97, 1209-1230.

Alaya, M. B., Saidi, S., Zemni, T., & Zargouni, F. (2014). Suitability assessment of deep groundwater for drinking and irrigation use in the Djeffara aquifers (Northern Gabes, south-eastern Tunisia). *Environmental earth sciences*, 71, 3387-3421.

Amiri, V., Nakhaei, M., Lak, R., & Kholghi, M. (2016). Assessment of seasonal groundwater quality and potential saltwater intrusion: a study case in Urmia coastal aquifer (NW Iran) using the groundwater quality index (GQI) and hydrochemical facies evolution diagram (HFE-D). *Stochastic Environmental Research and Risk Assessment*, 30, 1473-1484.

Poster T4P4

Assessment of chemical properties of soil from different blocks of coastal areas, Ganjam District of Odisha

SUMANJEET PANIGRAHI[1*], NARENDRA SWAROOP[2] and S. K. JENA[3]
[1,3]ICAR- Indian Institution Water Management, Bhubaneswar – 751023, Odisha, India
[2]Sam Higginbottom University of Agriculture, Technology and Sciences Prayagraj, Uttar Pradesh
E-mail: sumanjeetpanigrahi.241@gmail.com

Key Words: *Chemical; Parameters; Nutrient Distribution; Coastal Areas; Ganjam; Odisha.*

INTRODUCTION

The soil is a complex organization being made up of some six constituents' namely inorganic matter, organic matter, soil organisms, soil moisture, soil solution and soil air. Crop production primarily depends on the soil fertility status which may provide a basis for implementing the advanced technologies to achieve sustainable crop production with higher profitability. Crops do not only take nutrients from surface layer but also draw a part of their nutrient requirement from subsurface layer of the soil. Therefore, the knowledge of vertical distribution of nutrients is very important in recommending management practices (Sankar and Dadhwal, 2010). A balanced application of organic and inorganic fertilisers could be beneficial to both soil nutrient availability, soil health and crop growth (Das *et al*., 2021)

MATERIALS AND METHODS

The research work was conducted at the department of soil science and agricultural chemistry, Naini Agricultural Institute, Prayagraj to analyse the chemical properties of soils of different blocks of coastal areas of Ganjam district of Odisha. The entire study area was divided into three regions. Three different blocks from the district were looked out under study; viz., Chatrapur (Block $_1$), Rangeilunda (Block $_2$) and Chikiti (Block $_3$) with three different sites were taken from each block. For this purpose, the soil samples were collected at three depths: 0-15 cm, 15-30 cm, and 30-45 cm, from nine different villages of three different blocks of coastal areas, a total of 27 samples collected and analysed for their chemical parameter by using standard Laboratory Technique.

RESULTS AND DISCUSSION

This study incorporates that The Soil pH of different villages varied in between (V_4) 5.17 to (V_6) 6.00. The pH of soils of all the 3 blocks of Ganjam district was found moderately acidic. The soil EC of different villages varied in between (V_3) (V_4) 0.02 to (V_6) (V_9) 0.07 dS m^{-1}. The soils of the villages under study are not saline even if being situated in coastal zone. The Soil Organic Carbon (%) of different villages varied in between (V_5) 0.21 to 0.45 (V_1). The soil available nitrogen reported (V_1) 294.55 kg ha^{-1} to (V_5) 180.54 kg ha^{-1}. The soil samples are categorized under high nitrogen content is 29% while 71% samples are under low and medium in nitrogen content. The soil available phosphorus and potassium of different villages recorded in between (V_5) 7.03 to (V_1) 16.35 kg ha^{-1} and (V_2) 131.54 to (V_3) 272.07 kg ha^{-1} respectively. The Exchangeable Calcium and Magnesium of different villages reported (V_1) 2.06 to (V_2) 3.48 and (V_9) 2.04 to (V_4) 2.66 [c mol (P+) kg^{-1}] respectively. The Available sulphur of different villages varied between (V_3) 3.54 to (V_8) 7.56 ppm.

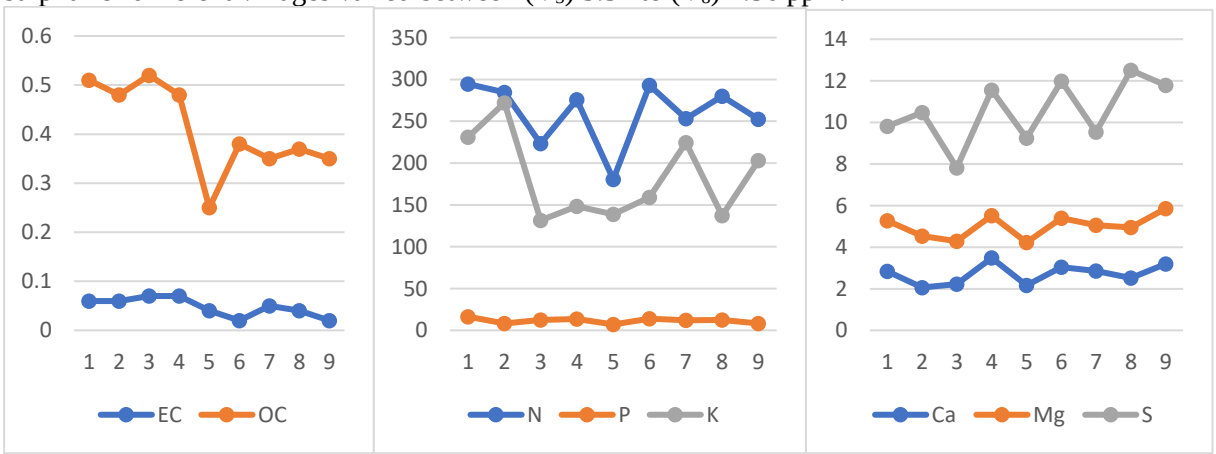


Fig. 1: *Chemical parameters of soil samples*

Table 1: *Mean value of chemical parameters in different villages of coastal blocks of Ganjam district*

Block	Village	pH	EC	OC	N	P	K	Ca	Mg	S
Chatrapur (B_1)	**V1**	5.44	0.06	0.45	294.55	16.35	231.09	2.84	2.43	4.55
	V2	5.99	0.06	0.42	284.74	8.34	272.07	2.06	2.47	5.94
	V3	5.9	0.07	0.45	223.15	12.27	131.54	2.23	2.05	3.54
Rangeilunda(B_2)	**V4**	5.17	0.07	0.41	275.8	13.4	148.45	3.48	2.04	6.04
	V5	5.44	0.04	0.21	180.54	7.03	138.73	2.17	2.06	5.01
	V6	6.00	0.02	0.36	293.13	13.79	159.13	3.04	2.35	6.6
Chikiti (B_3)	**V7**	5.96	0.05	0.3	253.15	12.19	224.32	2.85	2.2	4.49
	V8	5.38	0.04	0.33	280.07	12.49	137.14	2.52	2.43	7.56
	V9	5.38	0.02	0.33	252.43	8.3	202.97	3.2	2.66	5.93

CONCLUSIONS

The study assessed that the soil samples taken from the villages of coastal blocks of an acidic pH and non-saline EC. The soil organic carbon content was found to be in medium range, and the available nitrogen and phosphorus content were rated low to medium. The available potassium content, however, was found to be medium, and the available sulphur, exchangeable calcium, and magnesium levels were medium. Therefore, the study suggests that farmers in these villages should use appropriate soil amendments and fertilizers to improve soil fertility and crop productivity.

ACKNOWLEDGEMENT

The authors are thankful to the administration of Department of Soil Science and Agricultural Chemistry, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, for providing the required facilities of the study.

REFERENCES

Das, R., Kumar, M., Singh, S. K., Jha, S., & Sahoo, S. (2021). Soil Physico-chemical Properties as affected by Long-term Application of Organic and Inorganic NPK Fertilisers under Rice-wheat Cropping System in Calcareous Soil of Bihar. International Journal of Environment and Climate Change, 100–107. https://doi.org/10.9734/ijecc/2021/v11i330380

Sankar and Dadhwal. (2010). sankar-dadhwal-2010-vertical-distribution-of-available-macro-and-micronutrients-cation-in-red-soils-of-tamil-nadu

Poster T4P5

Long-term impact of conservation agriculture on soil quality under rice-based cropping system in coastal saline soils of Sundarban

S. TRIPATHY[1*], S. BISWAS[1], D. MANDAL[1], T. J. PURAKAYASTHA[1], U. K. MANDAL[2]

[1]Division of Soil Science and Agricultural Chemistry, ICAR-Indian Agricultural Research Institute, New Delhi-110012, India

[2]ICAR-CSSRI, Regional Research Station, Canning-743329, West Bengal, India

E-mail: tripathysalonii@gmail.com

Key Words: *Residue, Salinity, Soil Quality, Zero Tillage*

INTRODUCTION

Salt-affected soils cover a significant portion of India, with nearly 38% occurring in coastal regions (Chaudhary, 2023). Limited information is available on sensitive indicators for evaluating soil quality in the coastal saline soils of the lower Indo-Gangetic Plains. Therefore, this study aimed to identify key soil quality indicators and develop a soil quality index (SQI) for the coastal saline soils of Sundarbans under the influence of conservation agriculture.

MATERIALS AND METHODS

Soil samples were collected from a depth of 0–15 cm in an eleven-year-old field experiment conducted at the ICAR-Central Soil Salinity Research Institute (CSSRI), Regional Research Station, Canning Town. The study was based on a split-plot experimental design involving a rice-potato cropping system with three tillage treatments—zero tillage (ZT), reduced tillage (RT), and conventional tillage (CT)—as the main plots, and residue retention (+R) or removal (-R) as subplots. SQI was determined using the soil management assessment framework, applying a weighted additive indexing method (Andrews et al., 2001).

$$SQI = \sum_{i=1}^{n} W_i X S_i \quad \text{(Eq 1)}$$

W = Principal component weightage factor and S = indicator score

RESULTS AND DISCUSSION

Tillage and residue management significantly influenced soil quality in the rice-potato system. Residue retention led to a marked reduction in soil electrical conductivity and salt content. ZT treatments exhibited higher plant-available nutrient content and enzyme activities than conventionally tilled plots. The SQI ranged from 0.77 to 0.96, with pH, β-glucosidase activity, and alkaline phosphatase activity identified as key indicators, explaining 82% of the observed variability (*Fig 1*). Among all treatments, ZT+R recorded the highest SQI. Better quality under ZT treatments might be due to increased soil organic matter, improved soil physical environment, and reduced soil salinity (Mandal et al., 2021).

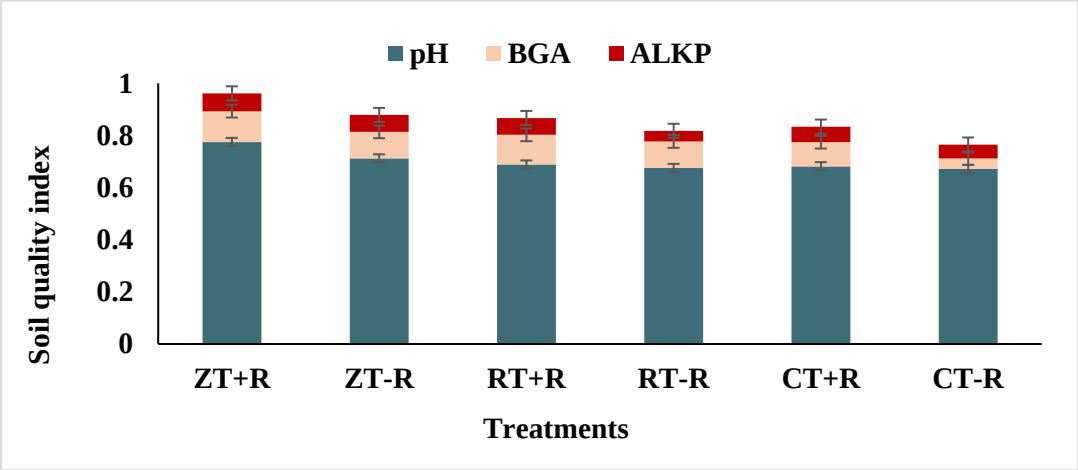


Fig 1: Principal component analysis-based soil quality index in different treatments

CONCLUSIONS

The findings highlight the multiple benefits of zero tillage and residue retention in improving soil properties and overall soil quality. Therefore, adopting zero tillage with residue retention is strongly recommended for maintaining soil health in the salt-affected regions of the Ganges Delta.

ACKNOWLEDGEMENT

The first authors would like to acknowledge UGC for the fellowship provided during this study.

REFERENCES

Andrews, S.S. and Carroll, C.R. 2001. Designing a soil quality assessment tool for sustainable agro-ecosystem management. Ecological Applications 11: 1573-1585.

Chaudhary, D. R. (2023). Microbial populations and soil fertility in the coastal lands of India. In *Climate Change and Legumes* (pp. 153-170). CRC Press.

Mandal, U. K., Bhardwaj, A. K., Lama, T. D., Nayak, D. B., Samui, A., Burman, D. and Raut, S. (2021). Net ecosystem exchange of carbon, greenhouse gases, and energy budget in coastal lowland double cropped rice ecology. *Soil and Tillage Research*, 212, 105076.

Poster T4P6

Assessment of soil fertility constrains at four selected blocks of coastal Sundarbans

D. K. SINGH[1], A. GHOSH[1]*, H. MANDAL[1], P. K. MANI[1], T. MITRAN[2]

[1]Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia 741252, West Bengal, India.

[2] National Remote Sensing Centre, Balanagar, Hyderabad 500037, Telengana, India.

E-mail: arijitghoshgtrs@gmail.com

Key Words: *Acid Soil, Soil Salinity, Soil Fertility, Sundarbans*

INTRODUCTION

Coastal regions, home to a large and growing proportion of the world's population, are undergoing environmental decline. The problem is particularly acute in developing countries. The reasons for environmental decline are complex, but population factors play a significant role. In coastal areas of India, salt affected soils stand to be one major challenge in preventing agricultural activities. The coastal area is generally mono-cropped with only rice during the monsoon season. In this region,

soil salinity, imbalance of nutrients, unfavourable pH, lack of good quality irrigation water etc. account for poor yields of crops (Sen and Bandyopadhyay, 2001). Continuous cropping of the land by almost a single crop along with non-scientific fertility management has resulted in low soil productivity. The investigation was carried out to identify the soil fertility constraints of the coastal saline zone.

MATERIALS AND METHODS

A total of 77 GPS based soil samples (0-20 cm depth) containing 20 samples each from the four blocks of coastal Sundarbans namely Kakdwip, Nimpith, and Canning of South-24 Parganas and Sandeskhali of North-24 Parganas, respectively during May 2012. The pH of the soil was determined followed by the method of Jackson (1973). Electrical conductivity of the soil saturation extract was determined by the method as described by Jackson (1973). Determination of soil organic carbon of the samples was done by Walkley and Black's (1934) rapid titration method. Estimation of Available N was done by alkaline permanganate method (Subbiah and Asija, 1956). Available phosphorus in soil was determined following ascorbic acid reluctant method as outlined by Bray and Kurtz (1945). Available potassium of the soil samples was measured by a Flame Photometer as described by Jackson (1973). The available DTPA extractable Fe, Mn, Zn and Cu of the soil samples were estimated using atomic absorption spectrophotometer (AAS) following the method of Lindsay and Norvell (1978). Available sulphur (S) was estimated by turbidmetrically barium chloride procedure as described by Chesnin and Yien (1951). Nutrient index values (NIV) calculated from the proportion of soils under low, medium and high available nutrient categories.

RESULTS AND DISCUSSION

The soil reaction was highly acidic to neutral in nature. The pH of the soil samples at the surface soil under Kakdwip, Sandeshkhali, Canning and Nimpith ranged from 5.15 to 7.26, 4.25-6.59, 5.13-6.60 and 5.31-6.85, respectively. The extreme acidity (<4.8) was observed in some of the soil samples irrespective of sites, might be due to the occurrence of acid sulphate soils at such particular sites. The soils were marginally saline to saline in nature. In some of the locations soil shows higher salinity level i.e > 4.0 dS m-1 which was critical for crop cultivation. Among the four sites, Kakdwip showed comparatively higher EC with highest value of 11.8 dSm^{-1} whereas lowest value of 0.31 dSm-1 was recorded with sample collected from Nimpith. In some of the locations soil showed higher salinity level i.e. > 4.0 dSm^{-1} which indicates critical condition for crop cultivation. On an average the studied area was marginally saline to saline in nature. There was a decreasing trend in EC had recorded with higher level of organic carbon content irrespective to the sampling sites. This might be due to the fact that carbon content improves soil physical properties *i.e.* soil structure, permeability, infiltration rate etc; which facilitates the leaching and drainage of soluble salts. Tripathi *et al*. (2006) reported that the organic C content of soil decreased by increasing salinity (r= -0.38; p <0.01). Kaur *et al*. (1998) also reported significant negative relationship between organic C and EC. On an average the organic carbon content of the studied area are medium to high in nature. The organic carbon content of the surface soils collected from Kakdwip, Sandeshkhali, Canning and Nimpith ranged from 2.8 to 9.2 g kg^{-1}, 4.53 to 9.83 g kg^{-1}, Canning ranged from 2.6 to 10.5 g kg^{-1} and 7.92 g kg^{-1}. However, among the sites soil samples from Canning showed comparatively higher organic carbon content (10.5 g kg^{-1}) compared to others. Lowest values (2.10 g kg^{-1}) of Organic Carbon were associated with the samples collected from Nimpith. The Soils were poor in available nitrogen and medium to low in available P and Zn. Higher availability status of K, Mn, Cu, Fe and S were, however found in the soils. Nutrient Index value for the available N, P, K, S, Zn, Fe, Mn and Cu ranged from 1.00 to 1.31, 1.92 to 1.99, 2.94 to 3.0, 2.75 to 3.0, 1.22 to 1.76, 2.52 to 3.0, 2.64-2.81 and 3.00 respectively.

CONCLUSIONS

The soils of the coastal Sundarbans are naturally saline and agriculture is severely constrained. Rice is the principal crop of this area, which is mainly grown during monsoon season. Organic C showed a positive significant correlation (r = 0.77**) with N, positive correlation (r = 0.43**) with P and positive correlation (r = 0.48**) with Cu content of soils. Nitrogen based fertilization supplemented with organic inputs should be recommended for the studied area for optimum growth and yield of crops.

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REFERENCES

Kaur B, Aggarwal AK and Gupta SR (1998). Soil microbial biomass and nitrogen mineralization in salt affected soils. *International Journal of Ecology and Environmental Sciences* 24: 103-111.

Sen HS and Bandyopadhyay BK. (2001). Problems and prospects of managing coastal ecosystem in India with special reference to eastern ecosystem. Proceedings National Workshop on "*Development and Management of Problem Soils for Sustainable Agriculture Production*" December 21-22, India.

Tripathi S, Kumari S, Chakroborty A, Gupta A, Chakroborty K and Bandyopadhyay BK.(2006). Microbial biomass and its activity in salt affected coastal soils. *Biology and Fertility of Soils* 42: 273-277.

Poster T4P7

Organic input interactions: Modulating yield and quality of safed musli (*Chlorophytum borivilianum*)

PRIYA DHAYAL[1]*, A.B. AGE[1], A. A. MAGDUM[1]

[1]Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Krishinagar-444104, Akola, Maharashtra, India

E-mail: priyadhayaljobner@gmail.com

***Key Words**: Enriched Compost, Fiber Content, Fresh Root Yield, Humic Acid, Saponin Content*

INTRODUCTION

Safed Musli (*Chlorophytum borivilianum)* is one of the important medicinal root herbs for its high saponin content, making it valuable in pharmaceutical and nutraceutical industries. With the rising global and national demand for medicinal plants, optimizing their cultivation through sustainable agricultural practices is crucial. Organic nutrient application significantly enhances plant quality (Khan et al., 2015). Organic amendments like enriched compost (enriched with NPS by adding urea, rock phosphate, and gypsum) improves soil fertility, while humic acid (extracted from vermicompost) stimulate plant growth and consequently yield and quality by improving physiological processes such as cell respiration, photosynthesis, protein synthesis, water and nutrient uptake, enzyme activities (Nardi *et al.*, 2002). However, limited research exists on the combined effects of NPS enriched compost and humic acid on yield and quality of Safed musli. This study aims to study the impact of enriched compost and foliar application of humic acid on yield and quality of Safed musli.

MATERIALS AND METHODS

The field experiment was conducted at Research Farm, Nagarjun Medicinal Plant Garden, Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during kharif season 2021-22. A randomized block design (RBD) with nine treatments and three replications was used. The treatments included; T_1- Absolute control, T_2 - Vermicompost @ 5 t ha^{-1}, T_3- NPS Compost @ 3 t ha^{-1}, T_4- Vermicompost @ 2.5 t ha^{-1} + 2 sprays of 0.5% humic acid at 60 and 90 DAP, T_5- Vermicompost @ 5.0 t ha^{-1} + 2 sprays of 0.5% humic acid at 60 and 90 DAP, T_6- Vermicompost @ 7.5 t ha^{-1} + 2 sprays of 0.5% humic acid at 60 and 90 DAP, T_7- NPS Compost @ 1.5 t ha^{-1} + 2 sprays of 0.5% humic acid at 60 and 90 DAP , T_8- NPS Compost @ 3.0 t ha^{-1} + 2 sprays of 0.5% humic acid at 60 and 90 DAP, T_9- NPS Compost @ 4.5 t ha^{-1} + 2 sprays of 0.5% humic acid at 60 and 90 DAP. The experiment site had a 10-year history of Safed Musli cultivation with organic inputs such as compost, FYM, and biogas slurry, without any chemical fertilizers. The soil was shallow black, swell-shrink clay, classified under Inceptisols. At the start of the experiment (kharif 2019–20), the soil was slightly alkaline (pH 8.11), saline (0.42 dS m^{-1}), and had moderately high organic carbon (5.24 g kg^{-1}), low in nitrogen (226 kg ha^{-1}), medium in phosphorus (15.83 kg ha^{-1}), high in potassium (267 kg ha^{-1}), and marginal in sulfur (10.88 mg kg^{-1}). The field was ploughed and harrowed, followed by plot layout (Gross: 2.10 × 3.00 m², Net: 1.80 × 2.80 m²). Sprouted Safed Musli tubers were planted at 30 × 10 cm spacing. Vermicompost and enriched compost were applied post-planting, while humic acid was extracted using NaOH extraction method, was sprayed at 60 and 90 DAP. After harvesting, fasciculated root count, diameter (cm), and yield (t/ha) were recorded. Saponin content (%) was analyzed using the Gravimetric method with chloroform and ethyl acetate (Brik *et al*., 1963), while fiber content (%) was estimated via the Acid-Alkali method (Maynard, 1970). Data were analyzed using ANOVA in a randomized block design (RBD) as per Gomez and Gomez (1984).

RESULTS AND DISCUSSION

The application of enriched NPS compost in combination with humic acid significantly influenced the yield attributes, and biochemical composition of safed musli. The highest number of fasciculated roots (11.11) was observed with the application of NPS compost at 4.5 ha^{-1} along with two foliar sprays of 0.5% humic acid at 60 and 90 days after planting (DAP). This was statistically on par with the application of NPS compost at 3.0 t ha^{-1} combined with two sprays of 0.5% humic acid (10.83), both of which showed significant improvement compared to the control. The enhancement in root

proliferation can be attributed to the synergistic effects of nutrient availability and improved plant metabolism facilitated by humic substances, as reported by Gaikwad *et al.* (2014) and Jaisankar (2018). Root diameter followed a similar trend, with the maximum root diameter (3.46 cm) recorded in plots treated with NPS compost at 4.5 ha^{-1} combined with humic acid. This improvement is likely due to the role of humic acid in enhancing plant growth processes such as cell permeability, respiration, photosynthesis, and cell elongation (Dulal *et al*., 2021). The improved physiological efficiency under these treatments contributed to increased root development and biomass accumulation. A notable increase in fresh root yield was also observed, with the highest yield (3.55 t ha^{-1}) recorded under the treatment of NPS compost at 4.5 t ha^{-1} with humic acid, followed closely by NPS compost at 3.0 ha^{-1} (3.34 t ha^{-1}). The increased yield can be attributed to sustained nutrient release, enhanced nutrient uptake, and greater leaf area development, which collectively improved photosynthetic efficiency and dry matter production (Jaisankar, 2018). Biochemical composition analysis revealed a significant impact of treatments on saponin content, with values ranging from 6.03% to 7.27%. The highest saponin content (7.27%) was recorded for the treatment involving NPS compost at 4.5 ha^{-1} combined with humic acid, followed by NPS compost at 3.0 ha^{-1} with humic acid (7.18%). This enhancement in saponin synthesis may be attributed to optimal nitrogen uptake, which plays a crucial role in secondary metabolite biosynthesis and plant metabolic activity (Gaikwad *et al*., 2014). Furthermore, the highest fiber content (4.63%) was recorded under the treatment of NPS compost at 4.5 ha^{-1} with two sprays of 0.5% humic acid, surpassing the control (3.21%).

CONCLUSION

The findings underscore the beneficial role of NPS compost and humic acid in enhancing root characteristics, yield attributes, and quality parameters of safed musli. The combined application of NPS compost at 4.5 ha^{-1} with 0.5 % humic acid at 60 and 90 DAP demonstrated the most promising results, indicating its potential for sustainable yield improvement and biochemical enhancement in safed musli production.

Table 1*: Effect of NPS enriched compost and foliar application of humic acid on yield and quality of Safed musli*

Treatments	Yield attributing parameters			Quality parameters	
	No. of fasc. roots $plant^{-1}$	Diameter of fasc. roots (cm)	Fresh root (t ha^{-1})	Saponin content (%) in roots	Fiber content (%) in roots
T_1	9.11	1.64	2.42	6.03	3.21
T_2	9.25	2.49	2.87	6.49	3.97
T_3	9.55	3.01	2.96	6.53	4.32
T_4	9.67	2.22	2.90	6.29	3.59
T_5	9.91	2.50	3.02	6.63	4.11
T_6	10.04	2.79	3.17	6.90	4.32
T_7	9.25	2.28	2.91	6.27	3.53
T_8	10.83	3.22	3.35	7.18	4.42
T_9	11.11	3.46	3.55	7.27	4.63
SE (m) ±	0.38	0.28	0.123	0.13	0.43
CD at 5 %	1.16	0.83	0.369	0.39	1.29

REFERENCES

Brik, Y., B. Gestiner and I. Ishyya. (1963). A thermostuble hemolytic factor in Soybean. *Nature.* 197:1089-1090.

Dulal, D., Baral, D., Poudel, A., Kafle, K. and Shrestha, B., (2021). Effect of different doses of vermicompost on growth, yield and quality of radish (Raphanus sativus L. cv. Mino Early). *Archives of Agriculture and Environmental Science,* 6(3): 354-359.

Gaikwad, P.J., Shitap, M.S. and Patel, J.B., (2014). Response to FYM, Nitrogen and Phosphorus on Growth and Yield of Safed musli (*Chlorophytum borivilianum*, *Santapau* and *Fernandes*). *Trends in Biosciences*, 7(23): 4002-4004.

Gomez, K. A. and A. A. Gomez, (1984). Statistical procedure for agricultural Research Jhon wiely and sons, New York.

Jaisankar, P., (2018). Effect of integrated nutrient management on growth and yield of radish (*Raphanus sativus L.*) cv. Pusa Chetki. *International Journal of Current Microbiology and Applied Sciences*, 7(11): 461-466.

Khan, K., U. Pankaj, S. K. Verma, A. K. Gupta, R.P. Singh, and R. K. Verma, (2015). Bio-inoculants and vermicompost influence on yield, quality of Andrographis paniculate, and soil properties. *Industrial Crops and Products*, 70: 404-9.

Maynard, A.J., (1970). Crude Fibre. Methods in Food Analysis. Academic Press, New York, 176-180.

Nardi, S., D. Pizzeghello, A. Muscolo and A. Vianello, (2002). Physiological effects of humic substances on higher plants. *Soil Biology Biochemistry* 34, 1527-1536.

Poster T4P8

Resource conservation technologies (RCTs) in climate-smart agriculture under diverse agro-climatic conditions: Scope and opportunities

DEVIKA T. M.[1*], R. SAHA[2], S. MITRA[2], S.P. MAZUMDAR[2], K.M. HATI[3], S. SAHA[2], ALKA PASWAN[2], G. KAR[2], LOPAMUDRA SAMAL[1], TAMANASH DAS[1] and PRITI KAPOOR[1]

[1]ICAR-Indian Agricultural Research Institute-Education Hub-Kolkata, Barrackpore, Kolkata-700121, West Bengal, India

[2]ICAR-Central Research Institute for Jute and Allied Fibers, Barrackpore, Kolkata-700121, West Bengal, India

[3]ICAR- National Bureau of Soil Survey and Land Use Planning, Regional Centre, Kolkata-700091, West Bengal, India

E-mail**:** devikatm99@gmail.com

Key Words*: Climate-Smart Agriculture, Crop Production, Resource Conservation Technology, Soil Health*

INTRODUCTION

Resource degradation, declining factor productivity and shrinking farm profitability under the climate change scenario of Indian agriculture are well known. Climate-smart agricultural practices include any new technology i.e. new cultivars, more efficient implements, reduced or minimal tillage, soil, water and crop management practices that are cost-effective and environmentally friendly. The conservation agriculture (CA)-based RCTs, practiced over an estimated 100 M ha area worldwide and across a variety of climatic, soil and geographic zones, have proved to be energy and input efficient, besides addressing the emerging environment and soil health problems (Saharawat et al., 2010). The CA technologies involving no or minimum tillage with direct seeding and bed planting, residue management (mainly residue retention) and crop diversification have the potential for improving productivity and oil quality, mainly by soil organic matter (SOM) build-up (Bhattacharyya et al., 2013). The RCTs bring many possible benefits including reduced water and energy use (fossil fuels and electricity), reduced greenhouse gas (GHG) emissions, soil erosion and degradation of the natural resource base, and increased yields and farm incomes. The efficiency and sustainability of any production system depend on system-based management optimization of crop yields, economic benefits, and environmental impacts.

PRINCIPLES

Targeting resource-conserving technologies offers new opportunities to provide better livelihoods for resource-poor, densely populated, small, and marginal farmers in eastern Gangetic plains. Various approaches of climate-smart agricultural practices are as follows:

- No tillage or Minimum tillage involves the use of a tillage implement that creates a narrow slot for the seed and does not disturb or turn over the soil in the process of planting the crop. The advantages NT provides over CT are: improved soil health, fuel savings (75%) and improved level of organic carbon. In addition, the soil properties like bulk density, penetration resistance, aggregation and infiltration were improved remarkably under NT as compared to conventional tillage systems. NT has a direct mitigation effect as it converts greenhouse gases like CO_2 into O_2 in the atmosphere and enriches soil organic matter (Venkateswarlu and Shanker 2009).
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- Crop residues are the parts or portion of a plant or crop left in the field after harvest, or that part of the crop which is not used domestically or sold commercially or discarded during processing. CA practices require a critical level of crop residues with the objective, of protecting the soil against weather aggressions and water erosion, maintaining soil moisture (Lal, 1997), suppressing weed growth and providing shelter and food for the soil biota.
- Use of crop rotations or intercropping is considered vital in CA systems, as it offers an option for higher diversity in plant production and thus in human and livestock nutrition, and pest/weed management that are no longer realized through soil tillage. An effective crop rotation in a cropping system not only helps to increase crop productivity and soil fertility but also improves water use efficiency by reducing weeds, providing a conducive micro-climate for plant growth and development.
- Green manuring can be defined as a practice of ploughing or turning down tender and fresh green biomass into the soil to improve the fertility and physical condition of the soil. Ideal green manure crop should be faster growing in nature, tolerant to adverse climatic conditions, and should be effective nitrogen fixers with adequate *Rhizobium* nodulation potential and quickly decomposable.

CONCLUSIONS

Agriculture, the dynamic system governed by several biotic and abiotic factors, needs to be sustained. Residue management along with conservation agriculture is the best direction of the farming community rather than a destination. The long-term fertility of the soil can be maintained only if the output of plant nutrients is compensated with the addition of crop residues and through green manuring, crop mulching etc.

REFERENCES

Bhattacharyya, R., Tuti, M.D., Kundu, S., Bisht, J.K. and Bhatt, J.C. (2012). Conservation tillage impacts on soil aggregation and carbon pools in a sandy clay loam soil of the Indian Himalayas. *Soil Science Society of America Journal*. 76: 617–627.

Lal, R. (1997). Residue management, conservation tillage and soil restoration for mitigating greenhouse effect by CO2 enrichment. *Soil and Tillage Research*. 43: 81-107.

Saharawat, Y. S., Singh, B., Malik, R. K., Ladha, J. K., Gathala, M., Jat, M. L. and Kumar, V. (2010). Evaluation of alternative tillage and crop establishment methods in a rice–wheat rotation in North Western IGP. *Field Crops Research*. 116: 260-267.

Venkateswarlu, B. and Shanker, A. K. (2009). Climate change and agriculture: Adaptation and mitigation strategies. *Indian Journal of Agronomy*. 54: 226-230.

Poster T4P9

Stratification of soil potassium in maize-wheat system of inceptisol under conservation agriculture

M. ASH[1]*, M. C. MEENA[2], S.P. DATTA[3], D. DAS[2]

[1]ICAR-Central Institute of Brackishwater Aquaculture (ICAR-CIBA), Kakdwip Research Centre, South 24 Pargans-743347, West Bengal, India

[2]Division of Soil Science and Agricultural Chemistry, ICAR-Indian Agricultural Research Institute, New Delhi-110012, India

[3]ICAR-Indian Institute of Soil Science (ICAR-IISS), Berasia Rd, Navi Bagh, Bhopal-462038, Madhya Pradesh, India

E-mail: moumitaiari2019@gmail.com

Key Words: *Conservation Agriculture, Potassium Fraction, Potassium Stratification*

INTRODUCTION

Potassium (K) is an essential primary nutrient for healthy plant growth and soil quality, participating in key physiological processes such as starch, protein, and biomolecule synthesis. Despite its importance, K fertilizer application remains significantly lower than nitrogen (N) and phosphorus (P), leading to extensive depletion of soil K reserves, particularly in the Indo-Gangetic Plain (IGP) (Sileshi *et al*. 2022). Annually, India experiences a net depletion of approximately 10.2 million tons of K, corresponding to a mining index of 8, indicating a severe negative K balance in soil (Ramamurthy *et al*. 2017). Since past three decades, conservation agriculture (CA) has emerged as a major way forward to achieve the twin targets of food security and sustainability. Cereal straws consists of 1.2 to 1.7% K, serving as alternative and valuable nutrient sources (Singh *et al*. 2018). In the soil system, plants acquire K primarily through the soil solution. However, assessing available K is not sufficient to predict the K

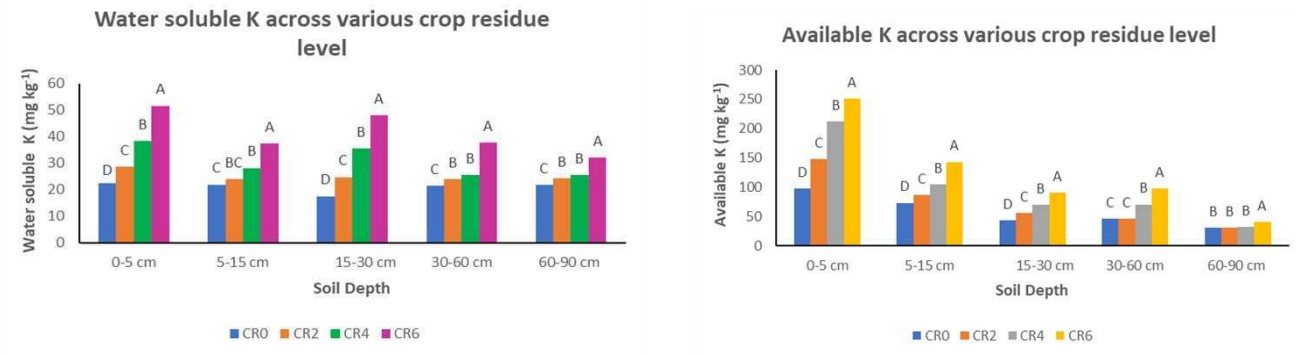
availability in soil as non-exchangeable K plays a crucial role in long-term K supply, particularly when the readily available forms are depleted. The potential of CA in minimizing the K mining in soil through crop residue management options has not been explored so far. With this background, the present investigation has been undertaken to quantify the role of CA in maintaining appropriate amounts of different K forms under various soil depths *i.e.* K stratification of a maize-wheat system under CA.

MATERIALS AND METHODS

The experiment was conducted in a split-plot design at the ICAR-IARI research farm, New Delhi, in a CA field established in 2013 under a maize-wheat-green gram cropping system. The main plots included four crop residue (CR) retention levels: CR_0 (0 t ha^{-1}), CR_2 (2 t ha^{-1}), CR_4 (4 t ha^{-1}), and CR_6 (6 t ha^{-1}), while the sub-plots had five K fertilization treatments: RDK_0 (0% K), RDK_{50} (50% K), RDK_{100} (100% K), RDK_{150} (150% K), and RDK_{50}+KSB (50% K + potassium-solubilizing bacteria). Soil samples (2018-2020) were collected from the above-mentioned CA experiment plots from 0-5, 5-15, 15-30, 30-60, 60-90 cm soil depths. Potassium distribution into different fractions *i.e*. water-soluble K (WSK), available K (Hanway and Heidel, 1952), boiling HNO_3 non-exchangeable K (Wood and De Turk, 1941) and total K (Page *et al.* 1982) were analyzed.

RESULTS AND DISCUSSION

The fig. 1 represents the effect of different levels of crop residue on different potassium fractions across various soil depths. Water soluble K (WSK) decreased with depth across all CR levels, with CR_4 and CR_6 increasing topsoil (0–5 cm) WSK b1.7 and 2.3 times over CR_0, and stratification ratio of 1.36 (0-5 cm/60-90 cm) indicating pronounced upper-layer stratification. Available K increased significantly with higher crop residue retention and fertilizer doses, with CR_6 showing the highest K levels (218 to 296 mg kg^{-1} in surface soil), while CR_4 ranged from 185 to 228 mg kg^{-1}, benefiting both surface and subsurface layers (5–30 cm) though diminishing at deeper layers (30–90 cm). The boiling HNO_3-



extractable non-exchangeable K (NEK) concentrations increased significantly with higher crop residue levels and K fertilization, showing greater accumulation at deeper soil layers compared to surface layers. NEK ranged from 1308 mg kg^{-1} (CR_0) to 1416 mg kg^{-1} (CR_6) at 0–5 cm and peaked at 1488 mg kg^{-1} (CR_6) at 60–90 cm. Total K increased consistently with higher crop residue levels across all soil depths, with the highest values observed under CR_6. However, statistical analysis showed no significant impact of CR, RDK or their interaction factor on total

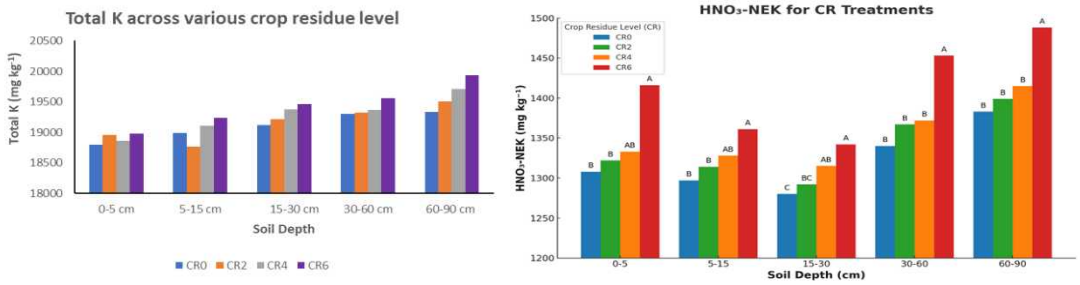


Fig.1 *Effect of different levels of crop residue on different potassium fractions across various soil depths*

The observed enhancement in WSK and available K can be attributed to the organic matter contributed by crop residue (CR), which promotes K release and retention in the upper soil layers (Toppo *et al*. 2023). Vertical stratification of available potassium in soil had distinct and contrasting trend as compared to that of non-exchangeable potassium, which was apparently related to extraction of K by plant root (Zhu *et al*. 2020).

CONCLUSIONS

The study confirms significant K stratification, with elevated K concentrations in surface layers attributed to minimal tillage and residue retention, while deeper soil layers exhibited reduced K availability. This underscores the need for precise nutrient management strategies to maintain uniform K distribution. These findings also underline the importance of integrated soil fertility management, focusing on residue retention, optimized K inputs, and bio-inoculants (KSB) and conservation agriculture practices to enhance K availability in maize-wheat systems.

REFERENCES

Hanway, J. J. and Heidel, H. (1952). Soil analysis methods as used in Iowa State College Soil Testing Laboratory. *Iowa Agriculture.* 57: 1-13.

Jackson, M. L., Miller, R. H. and Forkiln, R. E. (1973). Soil chemical analysis. *Prentice-Hall of India Pvt. Ltd*.

Page, A. L., Miller, R. H. and Keeney, D. R. (1982). *Methods of Soil Analysis Part 2: Chemical and Microbiological Properties*. American Society of Agronomy, Inc., and Soil Science Society of America, Inc., Madison, Wisconsin, USA.

Ramamurthy, V., Naidu, L. G. K., Chary, G. R., Mamatha, D. and Singh, S. K. (2017). Potassium Status of Indian Soils: Need for Rethinking in Research, Recommendation and Policy. *International Journal of Current Microbiology and Applied Sci*ences. 6: 1529-1540.

Sileshi, G. W., Kihara, J., Tamene, L., Vanlauwe, B., Phiri, E. and Jama, B. (2022). Unravelling causes of poor crop response to applied N and P fertilizers on African soils. *Experimental Agriculture* 58: e7.

Singh, V. K., Dwivedi, B. S., Singh, S. K., Mishra, R. P., Shukla, A. K., Rathore, S. S. and Jat, M. L. (2018). Effect of tillage and crop establishment, residue management, and K fertilization on yield, K use efficiency, and apparent K balance under rice-maize system in north-western India. *Field Crops Research.* 224: 1-12.

Toppo, M., Sinha, A. K., Upadhay, A. K. and Mahapatra, P. (2023). Effect of long-term application of inorganic fertilizers, organic manure, and lime on different forms of potassium in soil under maize-wheat cropping system. *International Journal of Plant & Soil Science.* 35: 469-480.

Zhu, D., Lu, J., Cong, R., Ren, T., Zhang, W. and Li, X. (2020). Potassium management effects on quantity/intensity relationship of soil potassium under rice-oilseed rape rotation system. *Archives of Agronomy and Soil Science.* 66: 1274-1287.

Poster T4P10

Jute retting water: An alternative source of irrigation and plant nutrition

LOPAMUDRA SAMAL[1*], B. MAJUMDAR[2], S. P. MAZUMDAR[2], S. SARKAR[2], R. K. NAIK[2], S. SAHA[2], G. KAR[2], A. PASWAN[2], S. BARAI[2], DEVIKA T. M.[1], T. DAS[1], P. KAPOOR[1]

[1]ICAR-Indian Agricultural Research Institute-Education Hub-Kolkata, Barrackpore, Kolkata-700121, West Bengal, India

[2]ICAR- Central Research Institute for Jute and Allied Fibres, Barrackpore, Kolkata-700121, West Bengal, India

E-mail: 125lopamudrasamal@gmail.com

Key Words: *BOD, COD, Jute, Plant Nutrients, Retting Water*

INTRODUCTION

Jute retting is a bio-degradation process that breaks down non-cellulosic materials, primarily pectin and xylan, through the enzymatic action of microbes in retting water, resulting in the lingo-cellulosic jute fiber. The traditional retting method requires a large volume of water (1:20 ratio of plant to water). During the retting process, various biodegradable materials are released into the water, including degraded pectins, hemicelluloses, gums, and mucilaginous compounds. Post-retting water typically contains elevated levels of nitrogen (N), phosphorus (P), iron (Fe), manganese (Mn), zinc (Zn), and copper (Cu) due to microbial activity during the process. These materials are non-hazardous to the environment and contribute to the bio-degradability of the retting water. The study was conducted with the objective to analyse the physico-chemical parameters of retting water to determine the viability of using retting water as a source of irrigation and plant nutrients for subsequent crop production.

MATERIALS AND METHODS

Collection of retting water samples:

The retting water samples were collected in sterilized 250ml plastic containers and maintained in an ice bucket for transport to the laboratory, where they were subsequently preserved at 4°C in the refrigerator.

Analysis of retting water samples:

The obtained retting water samples were examined in laboratory for various physico-chemical characteristics using standard protocol. The pH and EC of retting water sample was determined by using 1:2.5 soil: water suspension as per the standard protocol. The total nitrogen (N) content in the retting water samples was calculated using the The Kjeldahl Apparatus. The ascorbic acid method given by Watanabe and Olsen(1965) was used to determine the total P (phosphorus) in retting water. The K content of retting water was ascertained by using the Flame photometer method as per the standard procedure. Water samples were neutralized at pH 7.0 in order to assess their BOD. Then, using the standard method outlined by Rice et al. (2012), the BOD was calculated by titrating with sodium thiosulphate solution. The closed refluxed method given by ASTM D1252-06 (2012), was applied for the COD analysis of retting water samples. The concentration of Calcium and Magnesium was analysed using the Versenate titration method (Diehl et al. 1950). The bicarbonate content in the water sample was determined by titrating against standard H_2SO_4 (Thomas and Lynch1960).

Statistical Analysis:

Statistical analysis was done using R Software.

RESULT AND DISCUSSION

The pH of S1, S2, S6, S7, and S8 was found to be slightly acidic due to release of various organic acids like acetic, lactic and butyric acid during jute retting process. The pH of water sample S3, S4, S5 was found to be near neutral to slightly alkaline. Due to the addition of calcium, magnesium, and iron salts that were liberated from the jute plants during the retting process, the EC of the water samples were found to be slightly higher. The total nitrogen, phosphorus and potassium contents in the retting water samples found to be near a mean value of 13.40, 2.82 and 16.53 (mg/l) which indicates that the retting water samples are rich in primary nutrients. The BOD and COD values found, suggested that the BOD and COD of the retting water samples were within the permissible limit of the environmental control. The Calcium and Magnesium concentration was found to be range from 73.54 -92.41 ppm of the collected retting water samples. The presence of bicarbonate in retting water leads to increased hardness, yet the concentration is not concerning.

CONCLUSION

As the jute retting water biodegradable and non- hazardous to environment and was found to be a efficient source of primary and secondary nutrients, the huge amount of retting water can be reused as a source of irrigation along with plant nutrients. Given the growing concerns over water scarcity, due to reduced groundwater availability and depletion of water levels, post-jute retting water—rich in nutrients—can be a valuable resource. This water can be reused for subsequent crop production, particularly for rice cultivation, offering a sustainable solution to the region's water challenges.

REFERENCES:

Akhter, M. S. (2014). A study on pre-retting and post-retting water of waterbodies from a selected area of Bangladesh. *Journal of Advances in Agriculture*, 2(1), 38–41.

Das, S., Majumdar, B., Saha, A. R., Sarkar, S., Jha, S. K., Sarkar, S. K., &Saha, R. (2018). Comparative study of conventional and improved retting of jute with microbial formulation. Proceedings of the National Academy of Sciences, India Section B: Biological Sciences, 88(4), 1351–1357.

Haque, M. S., Ahmed, Z., Asaduzzaman, M., Quashem, M. A., & Akhter, F. (2002). Distribution and activity of microbiological population of jute retting and their impact on water of jute growing areas of Bangladesh. *Pakistan Journal of Biological Sciences*, 5(6), 704–706.

Majumdar et al.(2019).Impact of conventional retting of Jute(*Corchorus spp.)* on the environmental quality of water: a case study. *Environ Monit Assess* 191:440.

Majumdar B, Sarkar S, Kar G.(2020). Jute retting water; A potential source of essential plant nutrients. *Indian Farming*. 70(01): 21–23, Kolkata (India).

Sample	pH	Electrical conductivity (dS/m)	Total N (mg/l)	Total P (mg/l)	Total K (mg/l)	Biological oxygen demand (mg/l)	Chemical oxygen demand (mg/l)	Total Ca+ Mg (ppm)	Bicarbonate (me/l)
S1	6.45	0.536	10.68	1.38	19.80	54.61	192.05	88.65	5.28
S2	6.90	0.623	13.59	1.86	15.64	55.13	210.63	92.41	5.14
S3	7.38	0.854	9.40	2.54	15.74	54.39	212.54	85.26	3.85
S4	7.12	0.876	16.89	2.68	13.55	62.84	256.84	82.51	3.40
S5	7.24	0.761	13.36	2.39	18.69	60.92	198.65	78.95	4.82
S6	6.75	0.583	15.48	3.08	15.35	56.32	165.39	75.43	4.12
S7	6.83	0.734	15.83	2.48	18.44	55.72	241.56	73.54	4.63
S8	6.44	0.753	12.03	3.16	15.07	60.45	254.60	75.24	5.76

Table 1*. Physico-Chemical Parameters of retting water*

Poster T4P11

Soil carbon pools and carbon stocks of the major coastal zone ecosystems of north Kerala

E. PURANDHAR[2], SREELATHA. A. K[1]* and K. S. ANIL KUMAR[3]
[1]Rice Research Station (KAU), Vyttila, Kerala, India-682019
[2]College of Agriculture (KAU), Thrissur, Kerala, India-680656
[3]NBSS&LUP (ICAR), Regional Centre, Bangalore, India-560024
E-mail: sreelatha.ak@kau.in

Key Words: *Carbon Pools, Coastal Lands, Soil Carbon Stocks, Wetland Ecosystems*

INTRODUCTION

Wetlands provide crucial ecosystem services, including wildlife habitat, water supply, and carbon sequestration. Wetlands are highly efficient carbon reservoirs, storing three times more carbon per unit area than tropical forests, with over 90% of it in the soil. However, climate change and human activities are rapidly depleting these ecosystems. Wetland reclamation for land use releases greenhouse gases, altering soil carbon storage. Understanding soil organic carbon (SOC) dynamics across depths and time is essential for evaluating carbon accumulation. Given their significant role in mitigating atmospheric carbon, protecting and managing wetlands sustainably is crucial. Studying carbon dynamics in wetland soils can aid their conservation and rejuvenation, ensuring long-term ecological and environmental benefits.

MATERIALS AND METHODS

The study sites were natural Kole lands (Alappad, Thrissur, 3 m below sea level), altered Kole lands (Edappal, Malappuram, at sea level), natural mangroves (Ezhome, Kannur, 6 m below sea level) altered mangroves (same village (3 m below sea level), Kaipad lands (Cherukunnu (natural, 3 m below sea level) and Pallikkara (altered, 2 m below sea level). The region receives about 3000 mm of annual rainfall and has a tropical humid climate. Kole lands are low-lying, waterlogged areas used for seasonal rice cultivation, mainly in the Thrissur and Malappuram districts. Kaipad lands are saline coastal wetlands in northern Kerala, supporting traditional rice-fish farming. Mangroves are coastal forests found along estuaries and backwaters, providing critical biodiversity and coastal protection. Soil samples collected from the above land use at depths 0.30cm, 30-60 cm, 60-90 cm and 90-120 cm were analysed for Water-soluble Carbon (WSC) (Ghani et al., 2003), Particulate Organic Carbon (POM), (Cambardella & Elliott, 1993), Permanganate Oxidizable Soil Carbon (POXC), (Weil et al., 2003), Total Organic Carbon (TOC) - (Nelson & Sommers, 1996), and Glomalin Carbon (GC), (Reyna & Wall, 2014).

RESULTS AND DISCUSSION

Natural mangroves showed the highest WSC across depths, with a peak of 234.50 mg kg^{-1} at 0-30 cm, while altered Kole wetlands recorded the lowest (45.12 mg kg^{-1} at 90-120 cm). Waterlogged, low-oxygen conditions in mangroves slow organic matter decomposition, leading to prolonged release of WSC. Natural mangroves recorded a maximum POC of 102.77 g kg^{-1} at 0-30 cm depth. Their high primary productivity, driven by photosynthesis, promotes POC accumulation. Nutrient inputs from riverine inflows and tidal exchange further enhance productivity and sediment carbon storage. Natural mangroves recorded a maximum POSC of 1407.90 µg C g^{-1} at 0-30 cm depth, showing a strong positive correlation with soil organic carbon. As buffers between land and sea, mangroves trap sediments,

preventing their export and facilitating organic carbon retention. Tides influence these ecosystems by bringing nutrients and organic matter from adjacent marine environments, further enhancing carbon accumulation. Natural mangroves recorded the highest GC (1.90 mg kg^{-1}) at 0-30 cm depth, outperforming other ecosystems. The lowest value (1.10 mg kg^{-1}) was recorded in Kaipad wetlands at 90-120 cm depth. The high Glomalin carbon in mangroves is likely due to their high plant productivity and rapid organic matter production through photosynthesis. Additionally, sediment trapping in mangrove ecosystems creates favourable conditions for arbuscular mycorrhizal (AM) fungi, contributing to elevated glomalin carbon accumulation.

Soil organic carbon stocks (SOC):

Natural Kole wetlands recorded maximum carbon stock (70.022 Mg ha-1) and the minimum carbon stock was recorded in altered Kaipad wetlands (13.633 Mg ha-1). The high carbon stock in natural Kole wetlands is primarily due to organic matter input from surrounding rice cultivation. Soil carbon stock is influenced by factors such as physiography, altitude, bulk density, organic matter input, tree density, and disturbance. Flooded paddy fields enhance carbon accumulation through plant residue deposition and support wetland vegetation growth, further boosting carbon sequestration. The unique hydrological regime of the Kole wetlands also plays a key role in maintaining high carbon stocks.

Table 1. *Mean values of soil organic carbon stocks (SOC) (Mg ha^{-1})*

Land use types	SOC
Natural *Kole* wetlands	70.022[a]
Altered *Kole* wetlands	30.413[c]
Natural mangroves	29.226[d]
Altered mangroves	28.706[e]
Natural *Kaipad* wetlands	42.018[b]
Altered *Kaipad* wetlands	13.633[f]
SE (d)	0.017
SE (m)	0.012
C.D.	0.035

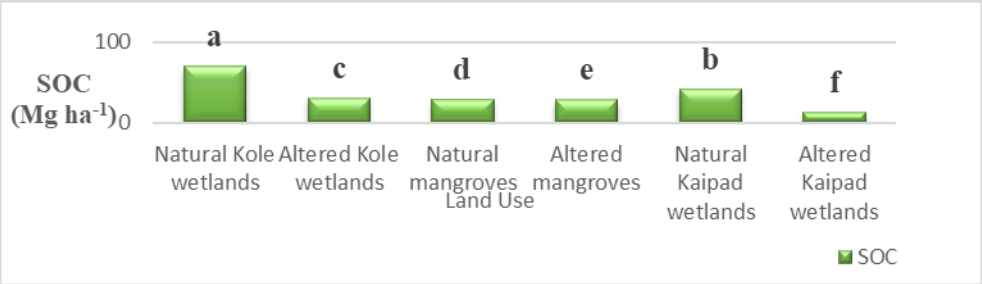


Fig. 1. *Mean values of soil organic carbon stocks (SOC) (Mg ha^{-1})*

CONCLUSIONS

Soil is essential to terrestrial ecosystems and life on Earth. Wetland ecosystems, particularly in north Kerala, are crucial for regulating the global carbon cycle, acting as significant carbon sinks that capture and store atmospheric carbon dioxide due to their unique characteristics and potential for carbon sequestration. In conclusion, natural mangroves in north Kerala exhibited the highest carbon values across various pools, including water-soluble carbon, glomalin carbon, SMBC, POXC, and particulate organic carbon, particularly at the 0-30 cm depth. Altered Kole wetlands showed a significant decrease in carbon values, while natural Kole wetlands had the highest carbon stock (70.022 Mg ha^{-1}) compared to altered Kaipad wetlands (13.633 Mg ha^{-1}). The strong relationship between POXC and soil organic carbon further emphasizes the role of these ecosystems in carbon sequestration. Overall, natural wetlands, especially mangroves, are crucial in carbon storage and ecosystem health.

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REFERENCES

Cambardella, C. A. and Elliotte, E. T. (1993). Methods for physical fraction and characterization of SOM fractions. Geoderma, 56: 449-457.

Ghani, A., Dexter, M. and Perrott, K. W. (2003). Hot water extractable carbon in soils: A sensitive measurement for determining impacts of fertilisation, grazing and cultivation. *Soil Biol. Biochem.* 35(9): 1231-1243.

Nelson, D. W. and Sommers, L. E. (1996). Total carbon, organic carbon, and organic matter. Methods of soil analysis: Part 3 Chemical methods, 5: 961-1010.

Reyna, D. L. and Wall, L. G. (2014). Revision of two colorimetric methods to quantify glomalin-related compounds in soils subjected to different managements. *Biol. Fertil. Soils*, 50:3 95-400.

Weil, R. R., Kandikar, R. I., Melissa, A. S., Joel, B. G., and Susan, E. S. L. (2003). Estimating active carbon for soil quality assessment: A simplified method for laboratory and field use. American *Journal of Alternative Agriculture*, 18 (1): 3- 17.

Poster T4P12

Soil aggregation and its impact on carbon sequestration in coffee agroforestry systems of Kodagu district

NANDITA SINHA[1*], M. S. NAGARAJ[1], S. RAGHAVENDRA[2], GANAPATHI[1], CHAMPA B. V.[3]

[1]Department of Soil Science, KSN University of agricultural and horticultural sciences, Shivamogga-577201, Karnataka, India

[2]Department of Biochemistry, KSN University of agricultural and horticultural sciences, Shivamogga-577201, Karnataka, India

[3]Department of Horticulture, KSN University of agricultural and horticultural sciences, Shivamogga-577201, Karnataka, India

E-mail: sinhaanandita6@gmail.com

***Key Words**: Carbon Sequestration, Coffee Agroforestry Systems, Macro and Micro Aggregates*

INTRODUCTION

Soil acts as dynamic system due to continuous addition and decomposition of plant biomass, which is influenced by environmental factors such as climate, vegetation and topography. Plant biomass is the major source of soil organic matter (SOM), contributing to carbon sequestration through photosynthesis, which helps to mitigate atmospheric CO_2 levels (Lugato *et al*., 2021). Organic matter helps in maintaining soil structure by aggregate formation through its binding properties. These aggregates protect SOM and are further categorized into macro (>0.25 mm) and microaggregates (0.25 – 0.053 mm). Agroforestry, a land-use practice that combines perennial trees with agriculture, consistently supplies plant litter, promoting aggregate formation. The carbon sequestration in agroforestry systems for climate change mitigation must slow or even can reverse the increasing atmospheric concentration of CO_2 by storing soil organic carbon. Coffee-based agroforestry systems offer a unique opportunity to study aggregate formation and its role in carbon sequestration, which helps mitigate climate change. Humic substances bound to these aggregate fractions are generally considered to be recalcitrant (Stevenson, 1994). Therefore, the study of humic fraction enhances the effectiveness of assessment of role of aggregates and the biomass turnover in carbon sequestration. A study conducted in Arabica and Robusta coffee plantations, under both native and exotic shade trees in Kodagu district, involved segregating soil macro and micro-aggregates through wet sieving and analyzing humus carbon. This study will enhance understanding of the SOC storage potential in these systems, paving the way for carbon credit opportunities and promoting sustainable coffee farming for millions of farmers.

MATERIAL AND METHODS

The study site was located in eastern slopes of the western ghats of Karnataka, India (Fig.1). A total of 30 soil and plant litter samples were collected from ten coffee agroforestry systems, 15 from each evergreen and moist deciduous vegetations using three replications (8×3). Among soil samples, three sets of samples were collected, in first set, soil clods (~ 1 kg) were sampled while in second set, composite soil samples (~ 500 g) were collected. The last set of soil samples was collected from 20 cm depth for bulk density estimation using metallic core sampler after removing the surface litter layer manually.The plant litter samples were first sun-dried and homogenized using stainless steel mixer. Total elemental nutrients namely carbon (C), nitrogen (N) and sulphur (S) were determined using CHNS analyzer (Elementar, Vario EL) based on Pregl-Dumas principle (Thompson, 2008). Total plant litter phosphorus was estimated by vanadomolybdate yellow colour method. The amount of cellulose, phenol and lignin content of litter was determined using standard procedures. Cellulose and phenol were analyzed by colorimetric method (Sadasivam & Manickam, 2015). Lignin was also determined colorimetrically (Bruce and West, 1989).

Soil organic carbon stock was estimated using soil organic carbon content and corresponding bulk density values. The bulk density values were calculated using the formula-

$$Bulk\ Density\ (Mg\ m^{-3}) = \frac{Mass\ of\ oven\ dried\ soil}{Volume\ of\ soil}$$

Bulk soil samples were air-dried in shade, ground using pestle and mortar and sieved to pass through 0.2 mm sieve. The organic carbon was determined by modified Walkley and Black's method (Lu, 2000)

by heating at 180 ˚C for 30 minutes. The stock of soil organic carbon (Mg ha^{-1}) in bulk soil followed the equation:

$$Soil\ organic\ carbon\ stock = \frac{H \times BD \times \%OC \times 10000}{100}$$

Where, H is soil depth (m); BD is bulk density (Mg m^{-3}); OC is organic carbon (%); 10,000 is the conversion factor to convert in hectares from cubic meters.

Humus fractions were extracted by alkali extraction method (Stevenson, 1994). The impurities present in the humus fractions were purified using PVP (Polyclar) resin and dialyzed through membrane (500-1000 D cutoff) for 24 h using milliQ water. The data obtained were statistically analysed using analysis of variance (ANOVA) outlined by Gomez and Gomez (1984) using R software. The level of significance used in 'F' test was at 5 per cent.

RESULT AND DISCUSSION

Elemental and Biochemical composition of the litter biomass:

The carbon (45.69 to 53.43 %), nitrogen (3.33 to 4.46 %) and phosphorus (0.14 to 0.53 %) in litter biomass varied significantly across the land use systems. However, the litter sulphur did not vary significantly. The litter carbon and nitrogen were higher in evergreen natural forest and coffee plantations than moist deciduous type, it might be due to production of leaves with longer life span and low photosynthetic capacity so as to assimilate more carbon and nitrogen over long growing season (Givnish *et al*., 2002). In contrast, moist deciduous trees produce short-lived leaves with higher photosynthetic rates and low carbon and nitrogen contents. The natural forests litter had higher carbon and nitrogen than coffee plantations in both bio-climatic regions. Similar reports on increased litter carbon and nitrogen due to diverse plant species was reported by Chen *et al.* (2020). Among coffee plantations, the plots with native trees recorded higher litter carbon and nitrogen than plots with silver oak. The robusta plantations had higher carbon and nitrogen fractions compared to arabica plantations. Contrastingly, the phosphorus in litter was found higher in coffee plantations than natural forests. Higher phosphorus content in coffee may be attributed to its additions through fertilizers for the crop (Wairegi and Asten, 2012). Higher cellulose in moist deciduous forests and coffee plantations may be due to the adoption of the native vegetation to escape dry periods (Loranger *et al*., 2002; Akpor *et al.,* 2005; Teklay, 2007). Higher litter phenol and lignin in coffee plantations might be due to their concentrations in coffee litter (Melillo *et al*., 1982; Kumar and Babitha 2006; Silva *et al*., 2015). Higher quantities of lignin and phenol in a plant system are an escape/defensive mechanism developed against any stress factor. Higher lignin and phenol in coffee-silver oak plantations litter might have been contributed due to high lignin contents in silver oak (Perdani and Pranowo, 2019).

Distribution of Aggregates and Aggregate associated carbon:

Higher macro-aggregate fractions in natural forests may be due to higher biomass additions and no disturbances. The disturbances by cultivation practices in coffee plantations might have reduced the macro-aggregate fractions (Six *et al.,* 2000; Verchot *et al.,* 2011). Higher proportions of macro aggregates in evergreen might be due to high biomass additions. coffee plantations recorded higher proportion of micro-aggregate. This may be attributed to disturbances caused by agricultural management practices in coffee plantations that lead to conversion of macro-aggregate into micro-aggregates (Blanco-canqui and Lal, 2004; Six *et al*., 2000; Beare *et al*., 1994; Gale *et al*., 2000).

The observations in the study are in concurrence to higher organic-C in macro-aggregates as reported by Besnard *et al.* (1996) and Rabbi *et al.* (2014). In the theory of aggregate formation, it is well explained that the micro-aggregates are formed first. These micro-aggregates are arranged later and cemented together by organic mucilaginous low molecular weight substances (Tisdall and Oades, 1982) to form macro-aggregates. This may be the reason for observing more organic carbon in macro-aggregate compared to micro-aggregate. Frequent and high organic matter turnover in natural forest resulted in more quantity of macro-aggregate and also with high organic carbon content (Sharrow and Ismail, 2004). Same explanation holds good for observing lower organic-C in micro-aggregates. The coffee plantations recorded significantly lesser proportions of organic-C than natural forests in all the aggregate fractions. Lower amounts of organic-C in all the aggregate fractions of coffee plantations may be attributed to its loss by cultivation practices (Six *et al.,* 2000). Similar reports on loss of carbon with cultivation in soil aggregates are well documented (Besnard *et al*., 1996; Jastrow *et al*., 1996).

E4/E6 ratio of humic acid and fulvic acid fractions in macro and micro aggregates:

The E_4/E_6 ratio indicated aromaticity and aliphaticity of humic fractions present in aggregates. Lower E_4/E_6 ratio suggested higher aromaticity while more aliphaticity was indicated by higher E_4/E_6 ratio. Macro-aggregates had lesser values for E_4/E_6 ratio suggesting presence of complex and aromatic

carbon while, higher E_4/E_6 ratio in micro-aggregates indicated the presence of more aliphatic carbon (Haynes and Swift, 1990) Natural forests had least values of E_4/E_6 ratio indicating more aromaticity (Reddy *et al.*, 2018). Higher E_4/E_6 ratio for fulvic acid in both aggregate fractions indicated presence of more aliphatic carbon and less polymerized form of carbon (Stevenson, 1994).

CONCLUSION

The study on aggregation and its impact on carbon sequestration in coffee agroforestry systems indicated that the soil organic carbon in a system is determined by both quantity and quality of biomass added. Among aggregate fractions, macro-aggregate was higher than the micro-aggregate fractions across coffee agroforestry systems. The macro-aggregates had higher proportions of humic acid than fulvic acid. Contrastingly, the fulvic acid proportion was higher in micro-aggregates. It appears that the soil aggregates are physically protecting the organic matter. Higher polymerization and complex nature of humic acid fraction of organic matter gets it chemically protected. Humic acid and fulvic acid fractions in soil aggregates were significant in terms of their aromaticity and aliphaticity. Characterization in terms of E_4/E_6 ratio showed structural variations in aromaticity and aliphaticity of humus fractions in macro and micro aggregates. Thus, there is a scope to protect the soil organic carbon in coffee plantations from its decomposition by understanding soil humus fractions in different sized aggregates.

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REFERENCES

Lugato, E., Lavallee, J. M., Haddix, M. L., Panagos, P. and Cotrufo, M. F., 2021, Different climate sensitivity of particulate and mineral-associated soil organic matter. *Nature Geoscience*, 14(5): 295-300.

Silva, J. O., Espirito-Santo, M. M. and Morais, H. C., 2015, Leaf traits and herbivory on deciduous and evergreen trees in a tropical dry forest. *Basic Applied Ecology*, 16(3): 210-219.

Six, J., Elliott, E. T. and Paustian, K., 2000, Soil macro-aggregate turnover and micro-aggregate formation: a mechanism for C sequestration under no-tillage agriculture. *Soil Biology Biochemistry*, 32(14): 2099-2103.

STEVENSON, F. J., 1994, *Humus Chemistry: Genesis, Composition, Reactions*. John Wiley & Sons. Inc. New York, USA. pp.1-49.

Thompson, M., 2008, CHNS elemental analysers, AMC Technical briefs, *Royal Society of Chemistry, 29(4): 1-2*.

Technical session 5: Climate change and disaster occurrence: impact and risk mitigation strategies

Lead Lect-1T5D2

Crop damage due to climatic extremes: A geospatial approach

ABHISHEK CHAKRABORTY
Head, Agro-ecosytem and Modeling Division,
National Remote Sensing Centre, ISRO, Balanagar, Hyderabad
E-mail: jeet.abhishek@gmail.com

Significant increase in global mean air temperature has already been reported by Intergovernmental Panel on Climate Change (IPCC) sixth assessment, which led to increase in the climatic extremes (both flood and drought) over India. The intensity and frequency of cyclonic storm have increased significantly over both east and west coasts. Such altered climatic condition has also brought out associated climate driven hazards like hailstorm, frost, unseasonal rainfall, hot/cold wave, disease and pest prevalence etc. Geospatial technology, which includes space based observational and navigational system along with GIS, has significant role in monitoring, forewarning and post-facto damage assessment due to these extreme events.

Disaster Management Support Programme of ISRO has been catering to the need to monitor and assess identified disasters like flood, landslide, forest fire, earth quake etc. The drought situation over India has been constantly monitored by the NADAMS. The multi-temporal optical data of moderate resolution is used to generate different vegetation indices like NDVI, NDWI, LSWI etc to detect the deviation of current year crop growth progression as compared to normal year towards declaring drought at near-real time. The synthetic aperture RADAR data is used to map flood inundation (riverine or cyclonic) with a time delay of 1-3 days. Such geospatial products are very useful in assessing the cropped area affected due to these disasters for further rehabilitation and relief. Recent examples of the usage of satellite data are also there to assess the delay/failure of crop sown area, damage of crop due to unseasonal rainfall. Pre and post-events satellite data (SAR & Optical) are also found to be useful to assess localized damage of the crop due to hailstorm/lodging/ cyclone. Satellite based assessment of pest and disease infestation is limited. But, potential area suitable for pest and disease infestation can be mapped using eco-climatic modeling in geospatial framework. Hence, there is an urgent need for a consorted effort by the knowledge institutes to utilize the existing and upcoming technologies such as mobile, UAV, proximal sensing etc towards informed decision making.

Lead Lect-2T5D2

Coastal vulnerability and subsequent resilience

GUPINATH BHANDARI
Professor, Department of Civil Engineering &
Coordinator, Centre for Disaster Preparedness & Management
Jadavpur University, Kolkata 700032, India
E-mail: gupinath.bhandari@jadavpuruniversity.in

The Indian Sundarbans Delta (ISD) is part of the delta of the Ganga-Brahmaputra-Meghna (GBM) basin in Asia. The ISD lies in between 21˚40'04"N and 22˚09'21"N latitude, and 88˚01'56"E and 89˚06'01"E longitude. The total area of Sundarban comprise of 25500 km^2, out of which 9630 km^2 area is covered by Indian Sundarbans and the remaining part is covered by Bangladesh Sundarbans.

Hazard is an event that is reasonably likely to cause harm or damage to humans, other organisms, or the environment. Coastal hazards like, cyclone, storm surge, flood etc. are one such fatal natural event which bears threatening effects on the coastal regions creating an imbalance in the normal ecosystem base. Henceforth, a sustainable management option with the implication of satellite Remote Sensing and GIS sounds to be most fruitful. And works of Mazda *et al*. (1997), Primavera and Esteban, 2008; Erwin, 2009; Powell *et al*., 2011, Nayak et al. 1991, Jagtap et al. 2001 etc can be put forward in such context . But most of these works are being done on the ocean coastline, which may not be applicable in estuarine delta coasts with complex geomorphic set up and thus leaves us with a scope to work more on estuarine delta coasts, The Sundarban delta spanning across about 25,000 km^2 over West Bengal and Bangladesh is such an estuarine delta with rich natural resources, strong biodiversity and considerable human settlement, that suffers from multiple hazards regularly.

The principal objective of the present discussion is to provide a management options during construction with special reference to provision of rescue and safety measures over the tidal rivers in Sundarban. With time the huge construction in the name of development may disturb the Sundarban ecosystem and degrade the mangrove density. A model should be developed to study this, which can be done by developing a model against coastal hazards for Indian part of Sundarban, with the local resources using satellite Remote Sensing and Geographical Information System (GIS) with due consideration on the environment, biodiversity and socio- economic conditions of the region. The model will be developed based on the Sustainable Livelihood Framework originally developed by DfID (1999).

This has to be developed by considering the data of river dynamics, sediment characters, mangrove degradation pattern, water and air pollution etc. A sustainable management option may come out, with a modification of Sustainable Livelihood Framework originally developed by DfID (1999), to protect Sundarban and the inhabitants of this area, from coastal hazards and alleviation of socio-economic condition with the aid of natural resources.

Hazard is any biological, chemical, mechanical, environmental or physical agent that is reasonably likely to cause harm or damage to humans, other organisms, or the environment in the absence of its control (Sperber and William 2001). Hazards can be caused by naturally occurring events, or they can be due to man-made events. Hazards are usually of two types: rapid onset and slow onset. Hazards that arise suddenly, or whose occurrence cannot be predicted far in advance, trigger rapid-onset disasters. Earthquakes, cyclones and other windstorms, landslides and avalanches, wildfires, floods and volcanic eruptions are usually categorized as rapid-onset events. Whereas slow-onset disasters concentrate on one hazard: drought. Coastal Hazards fall under the category of rapid-onset events and henceforth causes immense destruction to the coastal regions and the economy of the concerned areas. Depending on the type of hazards, the rescue system has to be developed.

In case of West Bengal Coastal Zone there are two categories; 1) Open Coast, such as Digha, and 2) Estuarine Coast, such as Sundarban. Three districts come under this area, East Medinipur, North 24 Parganas, and South 24 Parganas. These districts do have already implemented or in plan total 251 cyclone shelters. These cyclone shelters have been planned for multipurpose disaster shelters. Sundarban is more cyclone prone area than Digha; also Sundarban is protecting Kolkata from cyclone. Hence Sundarban is acting as cyclone shelter for Kolkata. On the other than apart from these natural disasters, there is man-animal conflict particularly in Sundarban.

Hence during the planning of Disaster Rick Reduction (DRR), multi hazards are normally considered.

Inv-01T5D2

Climate adaptive smart drainage for enhancing productivity in coastal saline ecosystems

D.S. BUNDELA
Division of Irrigation & Drainage Engineering
ICAR-Central Soil Salinity Research Institute, Karnal-132001
E-mail: ds.bundela@icar.gov.in

Abstract

Waterlogging and salinity are the twin major problems in coastal ecosystems of India and worldwide, particularly in coastal lowlands which are affected by tides, cyclones and sea water ingression and further aggravated by the climate change. The coastal ecosystems including deltaic areas and coastal lowlands are spread in nine coastal states and three union territories of the country where waterlogging and drainage congestion problems are caused by heavy rainstorms, flooding from discharge of inland rivers and the sea tides, congestion and inadequacy of drainage network etc. In such situations, rice is the only crop grown during the monsoon season with supplementary irrigation needed in case of long dry spells whereas irrigation is often required to grow winter crops. Saline soils and acid sulphate soils originated from the marine environments are also major constraints in the coastal ecosystems. In the older areas especially where pump drainage is practised, salts have mostly been leached from the upper soil layers and the upper groundwater has become rather of good quality. In the younger areas as well as in some poorly drained older soils, saline groundwater is still found at a shallow depth, climate adaptive surface and sub-surface drainage can be applied for timely planting of crops in coastal lowlands ecosystems. In acid sulphate soils, controlled sub-surface drainage has been found to be effective in alleviating the deleterious effects of acidity and salinity with a controlled water table condition without exposing sulphur compounds sub-soil layers for oxidation and suitable management strategies for enhancing rice productivity. Drainage systems have been modified from conventional drainage to controlled drainage and further to climate adaptive drainage (CAD) so as to meet the drainage and irrigation requirements of coastal environments. These systems have been tested and developed climate adaptation scenarios for enhancing rice productivity under various coastal saline ecosystems. Water storage pond with micro-irrigation in CAD system also provides a feasible and cost effective solution for growing winter crops. Thus, climate adaptive smart drainage holds the key for developing climate adaptation scenarios and enhancing crop productivity under various coastal saline ecosystems.

Inv-02T5D2

Reverse climate change in coastal ecosystem addressing SDGs

Jayanta Chakraborty
Chairperson
Agri-Horti-Food Processing & Rural Development, National Committee
Bengal Chamber of Commerce & Industry, Kolkata
and
Consultant, Indofil Industries Limited

BCC&I (Bengal Chamber of Commerce & Industry-Kolkata) Creates a Replicable Model for Coastal Ecosystem Protection and Augmentation

The Bengal Chamber of Commerce and Industry (BCC&I) has taken up the initiative for creating a replicable model for protection and augmentation of coastal ecosystem which plays a crucial role in maintaining the biodiversity and balance of an entire economy.

The Sundarbans mangrove forest, one of the largest such forests in the world which covers an area of approximately140,000 ha. The mangrove forest lies on the delta of the Ganges, Brahmaputra and Meghna rivers on the Bay of Bengal. Sundarbans has been inscribed as a World Heritage site in 1987. The site is intersected by a complex network of tidal waterways, mudflats and small islands of salt-tolerant mangrove forests, and presents an excellent example of on-going ecological processes. The area is known for its wide range of fauna, including 260 bird species, the Bengal tiger and other threatened species such as the estuarine crocodile and the Indian python.

Despite being a goldmine of natural treasure of flora and fauna, Sundarbans is now reeling under the massive impact of climate change and man-environment conflict. Indiscriminate destruction of forest and turning mangrove land into fish farming ponds, have posed a serious threat before the mangrove. Various research and analysis of historical data shows that the mangrove cover, which acts as a natural shield against extreme weather incidents, is being cut mainly for livelihood purposes.

BCC&I has been creating a replicable model for reclaiming the forest cover of the mangrove and taking care of livelihood generation as well. The project has been designed in such a way so that the livelihood generation is focussed on activities which are intertwined with the protection of mangrove trees.

The capacity building and skill development for the community people has already been started in two blocks of Gangasagar and Currently, 5000 people of Sundarbans, more than 90 per cent women, are now being trained under NSDC for mangrove nursery raising and plantation work. They have already raised more than 5 lakhs trees in different nurseries and more than 2 lakhs are already planted.

The project stands on three pillars which include capacity building of local community, creation of livelihood in opportunities and return on investment of the investors. The project focuses on creating high quality carbon.

Interestingly, a mangrove sequestrates about 12 kg of Carbon dioxide every year which is 5 times more than the terrestrial forest. The carbon dioxide which is set off by mangrove trees is called Blue Carbon. The price of blue carbon is much higher than its terrestrial counterpart. Till date, The Bengal Chamber has created 36,000 person days of work at a daily wage rate of RS 375.

We have chosen the mangrove ecosystem as mangrove trees are masters of absorbing carbon dioxide from the air. They sequestrate carbon dioxide 5 times more than terrestrial plants and the return-on-investment for the investors is high.

Along with mangrove restoration, BCC&I has also started working on silvo-fishery which is aimed to plantation of mangrove saplings in fish farming ponds which were earlier made by encroaching the forest land.

Besides that, Silvo- fishery, the planting of mangroves in aquaculture ponds- a sustainable approach that combines mangrove restoration with aquaculture production yielded positive impact both in reverse climate change as well as towards livelihood development. It is a working model that is utilized in other countries such as Indonesia.

Till date, BCC&I have already covered 200 ha of land and planted about 6,00,000 of tree and according to global estimation, this plantation will generate about 72,000 carbon credits per annum. Till date, 3,60,000 person-days of work has been generated by the project and with a wage bill of Rs. 12,60,00,000.

Inv-03T5D2

Impact assessment of extreme weather events on rice productivity in coastal region of India

B. DAS*, A. RAIZADA, K.K. MANOHARA and PARVEEN KUMAR
ICAR-Central Coastal Agricultural Research Institute, Old Goa – 403 402, Goa, India
E-mail: bappa.iari.1989@gmail.com

Key Words: *Climate Change, Crop Productivity, Extreme Weather Events, Thresholds*

INTRODUCTION

The frequency, magnitude, and severity of extreme weather events (EWEs) have escalated globally as a result of climate change and global warming. EWEs negatively affect agricultural productivity by elevating the probability of crop failure. In this context, quantifying yield loss attributable to EWEs and identifying principal climatic factors are essential for formulating climate-smart policies and solutions (Beillouin *et al.*, 2020). Although EWEs are becoming common globally as a result of climate change, their frequency, extent, severity, and consequences exhibit spatial and temporal variability (Chakraborty *et al.*, 2018). Therefore, a regional and crop-specific impact assessment of EWEs is essential for the formulation of local mitigation and adaptation measures. The coastal ecosystem is very susceptible to EWEs and experiences adverse effects from droughts, floods, tropical cyclones, excessive precipitation, and heat waves on agricultural production. Therefore, it is essential to examine the influence of EWEs on the productivity of principal crops cultivated in the Indian coastal region to formulate suitable mitigation and adaptation methods.

MATERIALS AND METHODS

Various extreme weather indices proposed by Expert Team on Climate Change Detection and Indices (ETCCDI) were computed for the coastal regions using daily maximum, minimum, and rainfall data collected from India Meteorological Department. The Mann-Kendall and Spearman's rho tests were used to determine the trend in extreme weather indexes. Productivity data for rice were obtained from the Department of Agriculture and Cooperation and the State Department of Agriculture. The technological influence on productivity was eliminated by fitting linear regressions. The normalized productivity anomaly index (PAI) was constructed using the following equation.

$$\mathbf{PAI} = \frac{\mathbf{Y_i} - \mathbf{TY_i}}{\mathbf{TY_i}} \times \mathbf{100}$$

where Yi and TYi represent the actual yield and trend forecast yield for rice in the coastal region.
All extreme weather events were utilized as input, and PAI was used as output, to develop appropriate machine learning models to identify the major extreme weather events causing rice yield loss in coastal India.

RESULTS AND DISCUSSION

The trend analysis using Mann-Kendall test indicated that extreme weather events pertaining to both temperature and rainfall is increasing over the years with ~ 65% indicators across coastal districts showing positive trends. Rising temperature-related indicators had a primarily negative influence on rice production over the threshold. The precipitation-based extreme weather indicators had a generally beneficial impact on rice yield (74%). The threshold values will aid in the development of climate resilient cultivars appropriate for coastal locations. The Boruta feature selection method was employed to identify significant temperature and precipitation-based extreme weather indicators that contribute to rice yield loss (Fig. 1). The indicators selected through Boruta method was used to train machine learning models to predict the rice yield.

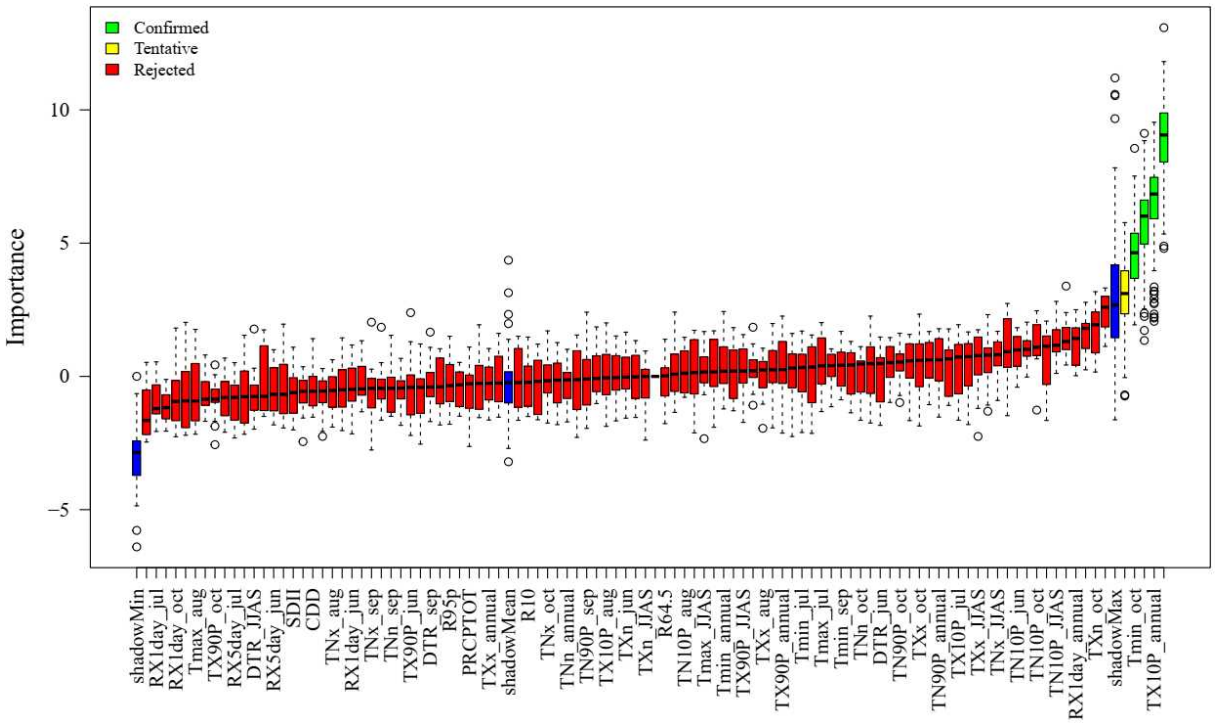

Fig. 1*. Results of Boruta algorithm for identification of important temperature and precipitation based extreme weather indices causing rice yield loss for Thiruvananthapuram district*

CONCLUSIONS

The study highlighted the rising frequency and intensity of EWEs in India's coastal regions, with temperature-related indicators showing an upward trend that has had a detrimental influence on rice yield. In contrast, precipitation-based EWEs had a positive influence on rice yield. The use of machine learning models, combined with the Boruta feature selection approach, was successful in identifying significant EWEs that influence rice yield loss. These findings highlight the need of developing climate-resilient rice cultivars and region-specific adaptation measures for mitigating the negative consequences of climate change.

ACKNOWLEDGEMENT

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REFERENCES

Beillouin, D., Schauberger, B., Bastos, A., Ciais, P. and Makowski, D. (2020). Impact of extreme weather conditions on European crop production in 2018: Random forest - Yield anomalies. *Philosophical Transactions of the Royal Society B: Biological Sciences* **375**: 20190510. https://doi.org/10.1098/rstb.2019.0510

Chakraborty, D., Sehgal, V.K., Dhakar, R., Varghese, E., Das, D.K. and Ray, M. (2018). Changes in daily maximum temperature extremes across India over 1951–2014 and their relation with cereal crop productivity. *Stochastic Environmental Research and Risk Assessment* **32**: 3067–3081. https://doi.org/10.1007/s00477-018-1604-3

Inv-04T5D2

Climatic vulnerability of major vegetable crops and its management

A V V KOUNDINYA*, DEEPA SAMANT, SATYAPRIYA SINGH, P SRINIVAS and G C ACHARYA

Central Horticultural Experiment Station (ICAR-IIHR), Aiginia, Bhubaneswar, 751019, Odisha

E-mail: koundinya.avv@icar.gov.in

Key Words: *Abiotic Stress, Biotic Stress, Climate Change, Adoption, Mitigation, Vegetables*

INTRODUCTION

Climate change is a long-term shift in climate patterns due to natural or human factors (IPCC, 2007). Vulnerability reflects a system's inability to cope with adverse impacts, while risk combines impact magnitude and occurrence probability (IPCC 2007). Vegetables, vital for nutrition and income, are highly sensitive to environmental extremes. High temperatures and low soil moisture reduce yields by affecting key physiological processes, a challenge worsened by climate change. Rising temperatures accelerate pest life cycles, alter reproduction, drive migrations, and increase outbreaks while reducing bio-control effectiveness (Das *et al.*, 2011). Higher temperatures also intensify fungal diseases, weaken host resistance, and promote aggressive pathogen strains, heightening epidemic risks, especially in genetically uniform crops. Adaptation strategies include genetic improvement, grafting, and agronomic practices like resource conservation, mulching, and agroforestry. Protected cultivation, post-harvest technology, and predictive models further enhance climate resilience in vegetable production.

EFFECT OF CLIMATE VAGARIES ON VEGETABLES

Potato productivity in India is expected to decline, with a 16% decrease in West Bengal by 2050 without adaptation strategies. In Meghalaya, the warm, humid climate boosts vegetative growth but reduces female flower production in cucurbits, lowering yields. Moisture stress and heavy rains reduce French bean productivity, while in Colocasia, early vegetative growth pests like beetles and diseases like blight affect yield. Onions are highly sensitive to saline soils, while cucumbers, eggplants, peppers, and tomatoes show moderate sensitivity. High temperatures disrupt tomato lycopene development, pollination, and fruit set. In okra, high heat reduces seed germination and causes flower drop above 42°C. French bean suffers from flower abscission and ovule abortion above 35°C. High temperatures also induce bolting in cole crops, affecting production. Salinity reduces seed germination and growth in cabbage. Drought reduces water content and quality in leafy vegetables and hampers seed germination in onions and okra, and tuber sprouting in potatoes. In pepper, high temperatures after pollination inhibit fruit set, while in chilli, heat stress affects color, flower drop, and fruit set. Germination in cucumber and melon is suppressed at high temperatures, while temperature fluctuations delay ripening and reduce sweetness in melons. High temperatures cause flower and pod abscission, reducing size and seed count, while high night temperatures affecting pod development (Koundinya *et al.*, 2014).

MANAGEMENT OF CLIMATE CHANGE IN VEGETABLES

The following few management and adoption strategies improve vegetable productivity under climate change (Adhikary *et al.*, 2015; Koundinya *et al.*, 2018).

Strategy	Example
Genetic Improvement	Tomato: Pusa Sadabahar (High night temperature tolerance), Arka Vikas (Drought tolerance); Cassava: Sree Kaveri (Drought tolerance); Onion: Hisar-2 (Salinity tolerance); Potato: Kufri Surya (high night temperature tolerance)
Biotechnology	Moisture stress tolerance Osmotin gene has been transferred to potato through genetic engineering technique
Grafting	High-temperature tolerance in tomatoes can be achieved by grafting onto Solanum melongena EG 203. Drought tolerance in watermelon plants can be achieved by grafting on wax gourd plants.
Cropping Systems	N_2O emissions from legume-based rotations are low, with emissions from vegetable pea ranging from 0.0014 to 0.44 mg/m²/ha. The highest Baby Corn Equivalent Yield was recorded in baby corn + cowpea (150.8 q ha^{-1}), followed by baby corn + okra (122.6 q ha^{-1}) and baby corn + brinjal (120.9 q ha^{-1}). The highest Benefit:Cost ratio was observed in baby corn + cowpea (3.34), followed by baby corn + okra (3.29), baby corn + brinjal (3.28), and baby corn + chilli (3.15).
Perennial Vegetables	Drumstick is drought tolerant and grows well in arid regions. The farmers in the drought-prone district Ahmednagar of Maharashtra, India are cultivating drumstick with a benefit-cost ratio of 3:1
Water and Nutrient Management	Reduced water requirement: Mulching, drip & sprinkler irrigation, sensor-based irrigation; Reduction of emissions from chemical fertilizers: biofertilizers (Azospirillum, Azotobacter, Rhizobium and potash mobilising biofertilisers) and organic fertilizers
Protected Cultivation	Protected cultivation improves the productivity of vegetables such as tomato (30-50%), cucumber (40-60%), and bell pepper (35-55%). Besides, Soilless cultivation (hydroponics and aeroponics) avoids problems like weeds, salinity, alkalinity, acidity and soil-borne pests and diseases
Forecasting Systems	Models for potato (INFOCROP, EH5OM, HadCM3Q, CCAM-Mark, RegCM3, WOFOST and PRECIS); sweet potato (Madhuram)

REFERENCES

Adhikary, S., Koundinya, A.V.V., Pandit, M.K. and Bhattacharya, B. (2015). Evaluation of the efficiency of baby corn-based vegetable intercropping systems. *International Journal of Plant and Soil Science* 5(6): 366-374.

Das, D.K., Singh, J. and Vennila, S. (2011). Emerging crop pest scenario under the impact of climate change – A brief review. *Journal of Agricultural Physics* 11: 13-20.

Koundinya, A., Sidhya, P. and Pandit, M.K. (2014). Impact of climate change on vegetable cultivation – A review. *International Journal of Agriculture, Environment and Biotechnology* **7**(1): 145-155.

Koundinya, A.V.V., Pradeep Kumar, P., Ashadevi, R.K., Hegde, Vivek and Arun Kumar, P. (2018). Adaptation and mitigation of climate change in vegetable cultivation: A review. *Journal of Water and Climate Change* 9(1): jwc2017045.

IPCC (2007). Assessing key vulnerabilities and the risk from climate change. In: Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK, 779-810.

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Prospects and potential of sea weed in sustainable crop management: Special reference to coastal agriculture

MAHUA BANERJEE[1], G.C. MALIK[1], ARUP GHOSH[2]
[1]Dept. of Agronomy, Institute of Agriculture, Visva-Bharati, Sriniketan, West Bengal, India
[2]CSMCRI, Bhavnagar, Gujarat, India
E-mail: mahua.banerjee@visva-bharati.ac.in

***Key Words**: Gracillaria, Sargassum, Groundnut, Potato*

INTRODUCTION

Seaweed extracts are biodegradable, non-toxic, non-polluting and non-hazardous to humans, animals and birds (Pramanick *et al*., 2017). Seaweed extracts contain major and minor nutrients, amino acids, vitamins, cytokinin, auxins and abscisic acid and have been reported to stimulate the growth and yield of plants, develop tolerance to environmental stress (Garai *et al*., 2019), increase nutrient uptake from soil and enhance antioxidant properties. *Sargassum* (Phaeophyceae) seaweed is a type of brown algae, typically found in the Sargasso Sea, an area in the North Atlantic Ocean. It is also found in other parts of the Atlantic, Pacific, and Indian Oceans. *Sargassum wightii* contains several bioactive compounds. *Gracilaria* is a seaweed under Rhodophyta have a branching bushy or filamentous structure with varying colour of red, pink, or brownish red. *Gracilaria* sp. are rich in vitamin and dietary fibre. The usage of sea weed liquid fertilizer in conjunction with chemical fertilizer, as well as their right management, is critical for improved growth and productivity

MATERIALS AND METHODS

A field experiment were conducted at Agricultural farm of Palli Siksha Bhavana, Visva-Bharati, Sriniketan, Birbhum, West Bengal during to study the "Performance of seaweed extract on groundnut and potato in the laterite soil of West Bengal". In groundnut, the experiment was laid out in a randomized block design with 8 treatments replicated thrice. Treatment consisted of seaweed sap of *Sargassum sp.* applied in different concentrations i.e. 1.5, 3.5, 5.5, 7.5, 9.5, 11.5% with 75% recommended dose of fertilizer along with two control plots at 100 and 75% RDF with water spray. The foliar spray of seaweed extracts was applied twice at 35 days after sowing and 55 days after sowing as per treatments. In potato, the experiment was carried out by using *Sargassum* + *Gracilaria* sap along with reduced rate of recommended dose of fertiliser (200 kg ha^{-1} N- 150 kg ha^{-1} P_2O_5 – 150 kg ha^{-1} K_2O) of total eight treatments i.e. 0.5 % SG Sap + 75 % RDF(T1), 1 % SG Sap + 75 % RDF(T2), 2.5 % SG Sap + 75 % RDF(T3), 5 % SG Sap + 75 % RDF(T4), 7.5 % SG Sap + 75 % RDF(T5), 10 % SG Sap + 75 % RDF(T6), Water spray + 75 % RDF(T7), Water spray + 100 % RDF(T8), which were replicated thrice and laid out in randomized block design (RBD). Each treatment had a net area of 4 m x 4 m. Kufri Jyoti variety seed tuber was planted for this experiment.

RESULTS

In groundnut, results revealed that foliar application of seaweed extracts significantly enhanced growth, productivity and nutrient uptake of plant. The maximum plant height, no. of branches per plant, dry matter accumulation, LAI and CGR was also achieved with the application of 11.5% seaweed extract. The highest dry matter production, seed yield nutrient uptake was recorded with applications of 11.5% *Sargassum* sap + 75% recommended dose of fertilizer (RDF), followed by 9.5% *Sargassum* sap + 75% recommended dose of fertilizer (RDF), extract resulting in an increased percentage of growth and nutrient uptake by the plant, respectively compared to the control. In potato, the results showed the crop receiving 10 % SG Sap along with 75 % RDF was recorded highest growth attributes and yield parameters of potato. The highest nutrient contents on tuber and haulm, nutrient uptake by crop, net return and return per rupee invested were observed in treatment have 10 % SG Sap along with 75 % RDF and the lowest were recorded in treatment have only 75 % RDF with water spray. So, the results support the recommendation of the treatment, 7.5% SG Sap + 75% RDF as a viable strategy for enhancing potato productivity and profitability in West Bengal's laterite soil regions.

CONCLUSION

A wide range of beneficial effects have been reported from the use of liquid seaweed extracts, including increased crop yields, increased gross and net returns and higher return per rupee invested. Hence, this simple practice of application of eco-friendly seaweed liquid fertilizers to crops may be useful for the growers for attaining better crop growth and yield parameter.

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REFERENCES

Garai, S., Brahmachari, K., Sarkar, S., Kundu, R., Pal, M., and Pramanik, B. (2019). Crop growth and productivity of rainy maize-garden pea cropping sequence as influenced by *Kappaphycus* and *Gracilaria* saps on alluvial soil of West Bengal, India. *Current Journal of Applied Science and Technology*, 36(2), 1-11.

Pramanick, B., Brahmachari, K., Mahapatra, B. S., Ghosh, A., and Ghosh, D. (2017). Growth, yield, and quality improvement of potato tubers through the application of seaweed sap derived from the marine alga *Kappaphycus alvarezii*. *Journal of Applied Phycology*, 29, 3253–3260.

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Sustainable & eco-friendly jute retting: Minimizing requirement and pollution of water

B. MAJUMDAR, R. K. NAIK, S. SARKAR, S. SAHA, R. SAHA, S. P. MAZUMDAR, LIPI CHATTOPADHYAY and SHRESTHA BARAI

Division of Crop Production, ICAR-CRIJAF, Barrackpore

E-mail: Bijan.Majumdar@icar.gov.in

Abstract

Jute retting is a microbial degradation process that breaks down non-cellulosic materials, primarily pectin and xylan, to yield lingo-cellulosic jute fibre. This study compares three improved retting methods with the traditional method to determine the most suitable option for widespread adoption in jute-growing regions, given the challenges of water scarcity and inconsistent rainfall. The free-flowing water retting method used only 7,135 liters of water per quintal of dry jute fibre, compared to 25,840 liters in the conventional method. This method also produced significantly higher fibre recovery by 7.5%, 6.0%, and 22.4% compared to stagnant water in concrete tanks, in-situ retting, and the conventional method. Additionally, the post-retting water quality was considerably better, with lower levels of EC (0.54 dS/m), Ca^{2+} + Mg^{2+} (35.8 mg/l), BOD (45.1 mg/l), COD (157.6 mg/l), chloride (4.2 mg/l), and hardness (65 mg/l). The use of the microbial consortium "CRIJAF SONA" reduced the retting time by 6 to 10 days, while improving fibre quality. With a higher fibre strength of 26.5 g/tex and lower root (2.3%) and defect (0.55%) content, the free-flowing water retting method proved superior. Given its water efficiency and fiber quality, this method is recommended for jute production in regions facing water shortages or irregular rainfall in South East Asia.

Oral V1T5D2

Specific soil components highly enhance carbon sequestration to mitigate climate change

SANJUKTA CHAKRABORTY and SANJIB KAR

Department of Agricultural Chemistry & Soil Science, Institute of Agricultural Science, University of Calcutta, 35, B. C. Road, Kolkata-700019, India.

E-mail: sanjuktachakraborty92@gmail.com

Key Words: *Soil Carbon, Soil Chemical Constituents, Conservation Agriculture, Carbon Sequestration and Climate Change*

INTRODUCTION

To avoid the most dangerous effects of climate change, the Paris Accord recommends limiting global warming to less than 2°C above pre-industrial level. Achieving that will most likely involve removing carbon dioxide from atmosphere, according to the intergovernmental panel on climate change. But strategies like capturing and storing the carbon emission from bio fuel burning power plants, or planting new forests to absorb carbon dioxide, can create their own problems. Sequestering carbon in soil however is a relatively natural way of removing carbon dioxide from the atmosphere with fewer impacts on land management. Soil acts as the largest reservoir and its importance has been realized with the rising concerns of climate change and global warming (Lal,2020). Soil C sequestration is a strategy to achieve food security through improvement in soil quality while reducing the rate of enrichment of atmospheric concentration of CO2. For a sustainable agricultural production system, SOM is vital as soil chemical, physical and biological properties are regulated by it and it also plays a major role in nutrient cycling (Chowdhury et al., 2020). Humic substances represent the recalcitrant carbon pools of SOM. Soil physico-chemical properties are influenced by different land management practices and have

an effect on SOC stability (Tian et al., 2016). E4/E6 ratio shows degree of aliphaticity and aromaticity of humic substances (Zalba et al., 2016). Examining the spectral characteristics of separate fractions of organic matter can provide important information on how to improve soil quality (Oades et al., 1987). FTIR spectroscopy assesses the stability of humic carbon extracted from soils. NMR spectroscopy determines the aromaticity of humic acid carbon.

Thus, the aim of this study was i) to assess the humic acid, humin and fulvic acid content and ii) to characterize the functional groups of various humic substances acid by FTIR, ^{13}C NMR spectroscopy, E4/E6 ratio in aggregates collected from soils under different management systems.

MATERIALS AND METHODS

Soil samples were collected from 40 different types of fields all over India and investigated soil samples were categorized as *1. forest 2. pasture 3. tea 4. horticulture 5. Agriculture 6. Fallow land 7. Jhum cultivated land.* Physico-chemical analysis of soils: pH, EC, CEC, SOC, N, P, K, Ca, Mg, Fe Al, Si and various fractions of humic substances were determined. Soil carbon pool determination: Active (very-labile, labile) and passive (less-labile, nonlabile) carbon pools are determined from soil. Extraction and purification of humic substances were done. Experimental analysis FTIR, 13C NMR spectroscopy and E4/E6 ratio of humic substances are determined.

RESULTS AND DISCUSSION

Soils collected from different land use were slightly acidic to neutral in nature. Soil organic carbon was positively correlated with CEC. Higher CEC value favours carbon sequestration because organic matter colloids have higher quantity of negative charge which can hold cations strongly. SOC is positively correlated with some specific soil components. Significant variation in HA yield is observed among soil samples. The E4/E6 ratio is considered to be inversely related to the degree of aromaticity and humification. The E4/E6 ratio of HA is recorded lowest for forest land and highest in fallow and jhum cultivated land. FTIR spectra for humic acid showed higher number of functional groups for forest followed by pasture and arable lands. The main characteristics of these bands are as follows; 3600-3800cm^{-1} correspond to bonded/non-bonded hydroxyl groups,3400 cm^{-1} for OH and NH stretching of various functional groups, 3000 to 2850 cm^{-1} belong to asymmetric and symmetric C–H stretching of CH2 groups, 1720 cm^{-1} for C=O stretching of COOH and other carbonyl groups, 1640–1600 cm^{-1} correspond to aromatic C=C skeletal vibrations, 1512–1508 cm^{-1} preferentially ascribe to N–H deformation and C=N stretching of amides, 1458–1454 cm^{-1} for C–H bending of CH3 groups); 1269–1261 cm−1 (C=O stretching of aryl esters); 1045–1041 cm−1 (C–O stretching of polysaccharides and Si–O of silicate impurities), 840 cm−1 (aromatic C-H vibrations) (Stevenson 1994). CPMAS 13C NMR spectroscopy was used to characterize the HAs from different land use type. There are four regions i.e. aliphatic (0-50ppm), carbohydrate (51-110ppm), aromatic (111-160ppm) and carboxyl(161-190ppm). Aliphatic and carbohydrate peaks were strongest for fallow land followed by conventional tillage practices whereas aromatic peaks were more enhanced for forest land and in some lands enriched with specific soil chemical components.

CONCLUSIONS

SOC content varied across different land use type depends on some soil components. Carbon sequestration efficiency is positively correlated with those soil components. With improved land management and controlled soil components, carbon sequestration will be higher and climate change will be restored in future.

REFERENCES

Chowdhury, S., Bolan, N., Farrell, M., Sarkar, B., Sarker, J.R., Kirkham, M.B., Hossain, M.Z., Kim, G., 2020. Role of cultural and nutrient management practices in carbon sequestration in agricultural soil. Adv. Agron.

Lal, R., 2020. Soil organic matter content and crop yield. J. soil water conserve. 75(2), 27A-32A

Oades J.M., Vassallo A.M., Waters A.G., Wilson M.A. Characterization of organic matter in particle size and density fractions from a red-brown earth by solid state 13C NMR. Aust. J. Soil Res. 1987;25:71-82

Tian, Q.X., He, H.B., Cheng, W.X., Bai, Z., Wang, Y., Zhang, X, 2016 factors controlling soil organic carbon stability along a temperate forest altitudinal gradient. Sci. rep. 6,1-9.

Zalba P, Amiotti NM, Galantini JA, Pistola S. soil humic and fulvic acids from different land-use systems evaluated by E4/E6 ratios. Communications in soil science and plant analysis. 2016;47(13-14): 1675-1679.

Oral V2T5D2

Trends in temperature and rainfall extremes in the Indian Sundarbans

T.D. LAMA[1]*, U.K. MANDAL[1], D. BURMAN[1], K.K. MAHANTA[1], S. RAUT[1] and N.R. PRAKASH[2]
[1]ICAR-Central Soil Salinity Research Institute, Regional Research Station, Canning Town - 743 329, West Bengal, India
[2]ICAR-Central Soil Salinity Research Institute, Zarifa Farm, Karnal - 132 001, Haryana, India
E-mail: tashidorjee@yahoo.com

Key Words: *Climate Extremes, Mann-Kendall Test, Rainfall Trends, Sen's Estimator, Temperature Indices*

INTRODUCTION

Climate change poses a significant threat to fragile coastal ecosystems, particularly affecting agriculture and water resources. The Sundarbans Delta in West Bengal is highly vulnerable to extreme weather events, including heavy rainfall, flash floods, and extreme temperature fluctuations. Several studies have emphasized the increasing intensity and frequency of extreme weather events globally (Manikandan *et al*., 2018; Naqi *et al*., 2021; Karim *et al*., 2024) which have been attributed to climate change phenomena. It has been expected that in the Ganges Delta, the occurrence of extreme events is likely to increase in the far future. Extreme weather events like heavy rainfall during the crop establishment stages can cause crop failures or high temperatures during the reproductive stage can lead to reduced yields which can have severe impacts on the agricultural productivity and livelihood of the farmers in the region. It is therefore essential to understand the occurrence of these events at the local scale to develop region-specific mitigation strategies. This study aimed to evaluate the long-term trends in extreme rainfall and temperature events using the historical long period, 1976-2023 weather data recorded at ICAR-CSSR, RRS, Canning Town.

MATERIALS AND METHODS

The daily temperature and rainfall data for the period 1976-2023 recorded from the Agrometeorological Observatory of ICAR-CSSRI, Regional Research Station, Canning Town was analyzed using CLIMPACT ver.3.1.6 software (www.climpact-sci.org) developed by WMO-Expert Team on Sector-Specific Climate Indices (ET-SCI). Prior to the computation of the indices, the data was checked for invalid data and outliers were identified and removed based on threshold values. A total of 25 extreme climate indices (14 temperature and 11 rainfall indices) were evaluated. Temperature indices included warm days, warm nights, cold days, cold nights, diurnal temperature range, consecutive heatwaves, etc. Rainfall indices assessed parameters such as heavy precipitation events, maximum consecutive dry and wet days, and total precipitation trends. The missing daily data was compensated from the average monthly values. The non-parametric Mann-Kendall (MK) test which is robust against outliers and is widely used to analyse time series weather data was applied to determine trend significance and the magnitude of the trend was computed using Sen's estimator. A positive value of the MK statistic (τ) indicates an upward or increasing trend and a negative gives a downward or decreasing trend. Statistical significance was considered at a 95% confidence level.

RESULTS AND DISCUSSION

The annual mean maximum and minimum temperatures showed a significant increasing trend at 0.016°C year^{-1} and 0.012°C year^{-1}, respectively. This is consistent with global patterns, where warming trends have been widely observed due to increased greenhouse gas emissions. The occurrence of hot days (TX>35°C), warm days (TX>90th percentile), and warm nights (TN>90th percentile) increased significantly over the last 48 years (Fig. 1). Conversely, cool days (TX<10th percentile) and cool nights (TN<10th percentile) displayed significant decreasing trends, indicating overall warming. The rise in night temperature can have serious implications on the food security of the region as studies have revealed that an increase in night temperature can reduce grain quality and yield of rice, which is the most important cereal crop (Manikandan *et al*., 2018). Annual precipitation exhibited an increasing trend, though not statistically significant. The number of rainy days ($R \geq 2.5$ mm) declined at a rate of 0.064 days per year, though insignificantly. The maximum number of consecutive dry days increased significantly at 0.714 days per year (Fig. 1), suggesting prolonged dry spells which can exacerbate drought conditions and stress water resources. The simple daily intensity index, very wet days (R>95th percentile), heavy rainfall days (R≥64.5 mm), and maximum consecutive 3- and 5-day precipitation totals all showed increasing trends, though not statistically significant. The declining number of rainy days combined with increased intensity and rainfall amounts can lead to increased flood risks in the

region. These results emphasize the importance of adaptive water management and infrastructure improvements to mitigate potential agricultural and hydrological challenges in the Sundarbans Delta.

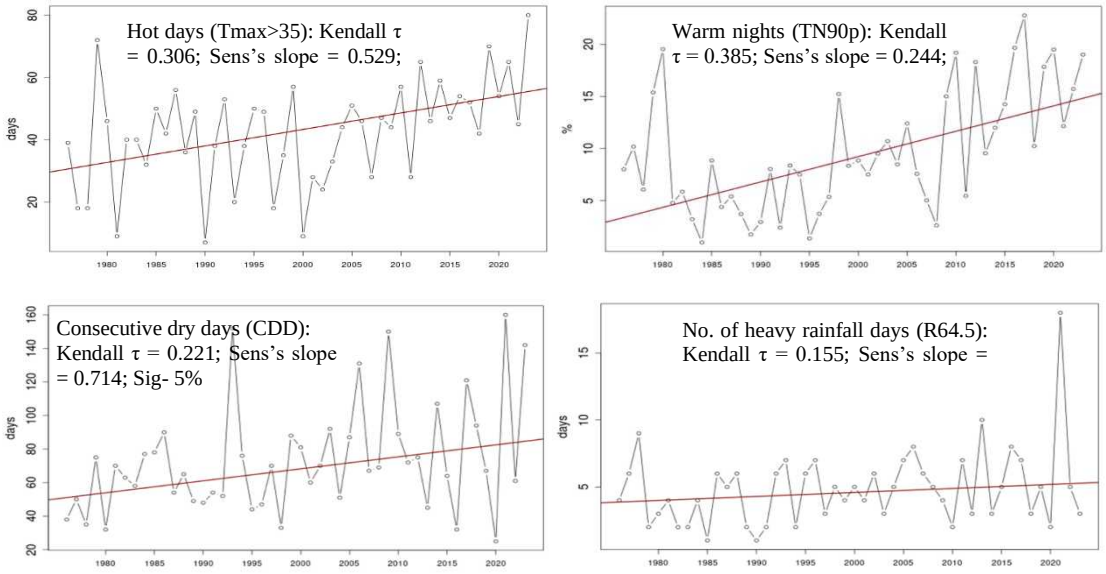

Fig. 1. *Trends of extreme temperature and rainfall indices*

CONCLUSIONS

The study highlights significant changes in the temperature and precipitation patterns in the coastal delta region of West Bengal, with increasing trends in hot days, warm nights and consecutive dry days. The decrease in cool days and nights, along with the variability in rainfall patterns, poses serious challenges to crop productivity, which is highly sensitive to both temperature and water availability. There is an urgent need for adaptive agricultural strategies such as improved irrigation, climate-resilient crops, and early warning systems that can help mitigate the impacts of climate change.

REFERENCES

Naqi, N.M., Al-Jiboorib, M.H. and Al-Madhhachi, A-S. T. (2021). Statistical analysis of extreme weather events in the Diyala River basin, Iraq. *Journal of Water and Climate Change*. 12(8): 3770. https://doi.org/10.2166/wcc.2021.217

Manikandan, N., Das, D.K., Mukherjee, J., Sehgal, V.K. and Krishnan, P. (2019). Extreme temperature and rainfall events in National Capital Region of India (New Delhi) in the recent decades and its possible impacts. *Theoretical and Applied Climatology*. 137(3-4): 1703-1713. https://doi.org/10.1007/s00704-018-2652-9

Karim, F., Yu, Y., Kamruzzaman, M., Mandal, U.K., Zahan, T., Paul, P.L.C. and Mainuddin, M. (2024). Assessing changes in climate extremes using CMIP6 and its implications for agriculture in the Ganges Delta. *Journal of the Indian Society of Coastal Agricultural Research*. 42(1): 24-40. https://doi.org/10.54894/JISCAR.42.1.2024.147069

Oral V3T5D2

Evaluating climate change risks and vulnerability in agriculture for resilient farming in the Ganges Delta

UTTAM KUMAR MANDAL*, AMIT GHOSH, D BURMAN, SONALI MALLICK, TD LAMA, DIBYENDU BIKAS NAYAK, PRIYANKA CHOUDHURY, KK MAHANTA, S RAUT, DEVIKA S and RINCHEN NOPU BHUTIA

ICAR-Central Soil Salinity Research Institute, Regional Research Station, Canning Town- 743 329, West Bengal, India

E-mail: uttam_icar@yahoo.com

Key Words: *Climate Hazards, Exposure, Vulnerability, Risk, Sundarbans, Bangladesh, West Bengal, Coastal Zone*

INTRODUCTION

The Ganges Delta supports a unique coastal ecosystem that is highly susceptible to global climate change. The Sundarbans, the largest single tract of mangrove ecosystem in the world, the Ramsar World Heritage site is in this region. The necessity to protect this most populous and the largest delta of the world from the sea level rise and extreme climate events demands a rigorous assessment of

vulnerability. This study aimed to develop a framework for creating an integrated vulnerability index for the Ganges Delta at the sub-district level (Upazila in Bangladesh and Block in India). The framework incorporates both social and biophysical data, with climate hazards derived from CMIP6 GCM data.

MATERIALS AND METHODS

The study examined how risk emerges from the interaction of vulnerability, exposure and hazard. Climate hazards for the 89 administrative units (Upazila in Bangladesh and Block in India) were assessed using future climate data from the IPCC's 6th assessment report. Hazard levels were quantified by integrating the effects of four temperature extremes and five rainfall extremes relevant to crop growth. Through an extensive literature review, 17 biophysical and socioeconomic variables were identified as critical and policy-relevant, with three relating to exposure and 14 to vulnerability (Fig. 1). Data were normalised within a dimensionless range of 0 to 1 for all indicators to vulnerability and risk assessment. The risk was calculated by multiplying hazard, exposure and vulnerability index (Mandal *et al.*, 2025). The value for hazard, exposure, vulnerability and risk indexes ranges from 0 to 1, with higher values reflecting higher degree. The entire range has been equally divided into five categories and each is assigned qualitative index of hazard, exposure, vulnerability and risk from very low to very high. To visualize the results in a geographic context, maps have been prepared using ArcGIS software 10.5.

RESULTS AND DISCUSSION

Three upazilas in Bangladesh were under very high climate hazard. Exposure score was relatively high in Indian coast compared to Bangladesh coast. Out of 89 administrative units, five upazilas in Bangladesh and two blocks in India were identified under very high category of vulnerability index, covering 18.6% the area and 8.13% of the total population. Combining vulnerability and climate hazard, three upazilas in Bangladesh and one block in India were identified under very high risk to agriculture (Fig. 2).

CONCLUSION

We developed an integrated framework to assess the spatial variability of agricultural vulnerability and risk to climate change impacts in Ganges delta. The proposed framework considers spatial variations in climatic variability, demographic pressure, agricultural land utilization, availability of basic amenities like education, medical, drinking water, telephone, agricultural credit facility, electricity infrastructure development, and agro-technology use. Besides, the proposed framework, on the other hand, would assist in identifying the most socio-economically vulnerable geographic regions as well as distinguishing the causal factors that led to current vulnerability and risk. The results of this study are expected to help policy makers and planners to prioritize appropriate adaptive measures for the development of agriculture in the region.

ACKNOWLEDGEMENT

The authors would like to acknowledge the support and funding received from ACIAR, Australia, ICAR-NICRA and DST for the study.

REFERENCE

Mandal, U.K., Karim, F., Yu, Y., Ghosh, A., Zahan, T., Mallick, S., Kamruzzaman, M., Chandra Paul, P. L. and Mainuddin, M. (2025). Assessing vulnerability and climate risk to agriculture for developing resilient farming strategies in the Ganges Delta. *Climate Risk Management* 47: 100690.

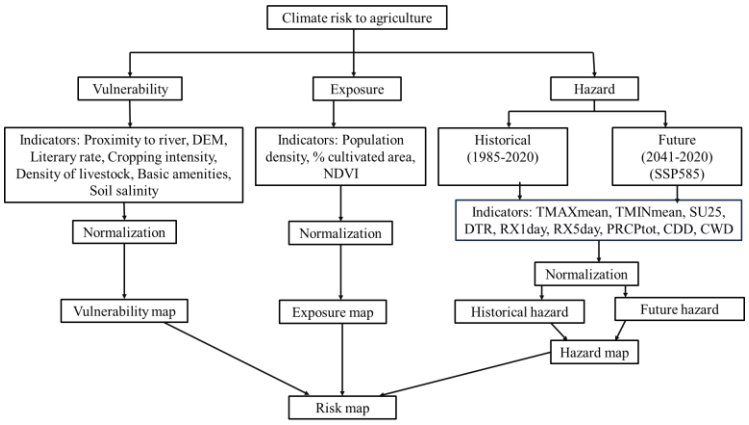

Fig. 1. *Flow chart of procedure for vulnerability and risk mapping*

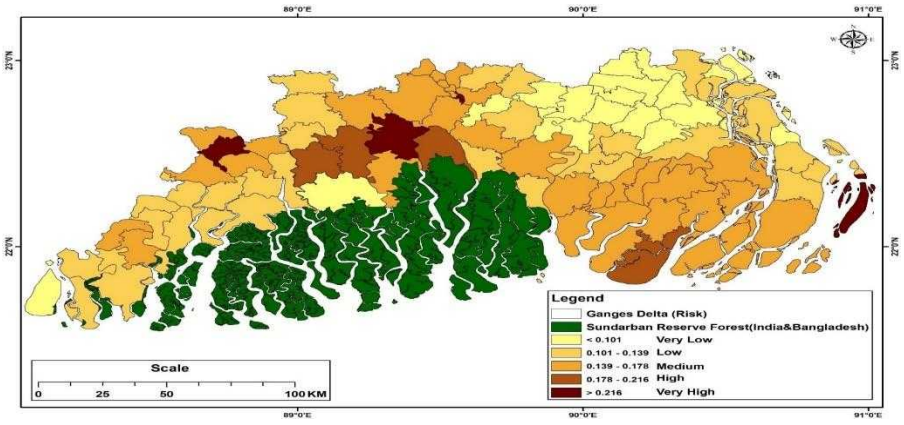

Fig. 2. *Upazila level in Bangladesh and Block level in India for risk map of the Ganges delta*

Oral V4T5D2

Water-efficient jute farming: integrating deficit irrigation and modelling for enhanced productivity and mitigating dry spell

DEBARATI DATTA*, A.K. SINGH, SOURAV GHOSH, D. BARMAN, N.M. ALAM, R.K. NAIK, GOURANGA KAR

ICAR-Central Research Institute for Jute and Allied Fibres-700121

E-mail: myselfdebarati@gmail.com

Key Words: *AquaCrop, Deficit Irrigation, Jute, Modelling, Water Productivity.*

INTRODUCTION

In India, about 85% of the jute area is still rainfed, with only 15% of it under irrigation (MAFW 2023). According to farmers, about 40% of jute crops suffer damage due to prolonged dry spells during the initial stage of crop growth, i.e., 15–60 DAS (Singh et al. 2019). In the early and peak vegetative stages of jute, the absence of seasonal rain causes a temporary drought. Again, rising temperatures result in higher evapotranspiration and varied crop yields, including water productivity. Based on a Markov chain analysis (Schoof and Pryor 2008) of weekly climate data (1990–2020), it can be inferred that the most reliable probability level of 70% for dry spells (rainfall < 20 mm) occurs between mid-March and mid-April (13 − 15 meteorological weeks), while 50% probability occurs between mid-April and mid-June (16–24 meteorological weeks) Deficit irrigation, where water is applied below full crop needs, is essential when rainfall is inadequate. This study uses the AquaCrop model to simulate jute growth under deficit irrigation in eastern India, aiming to bridge dry spells and improve crop productivity.

MATERIAL AND METHODS

Field experiments were conducted at ICAR-Central Research Institute for Jute and Allied Fibres, Barrackpore, India. The research focused on optimizing deficit irrigation scheduling during the critical early and peak vegetative growth stages (April and May) using available soil moisture depletion (DASM) and crop evapotranspiration (ETc) to maximize jute (JRO 204) productivity. The applied water treatments included 50% DASM with 50% ETc, 50% DASM with 75% ETc, 75% DASM with 75% ETc, 75% DASM with 100% ETc, moisture maintained at field capacity, farmers' practice, and control (rainfed) under surface irrigation. Irrigation timing was determined by soil moisture depletion, and irrigation depths were based on maximum allowable depletion of total available soil water (TAW). Crop and soil data were collected at 10-day intervals, including emergence, canopy cover, root length, biomass, and fibre yield. Soil properties were analyzed following standard methods. AquaCrop v.6.1 was used to simulate crop responses to various irrigation treatments, and model validation was performed using statistical indicators like RMSE, R^2, and Willmott's index of agreement.

RESULTS AND DISCUSSION

Irrigation scheduled at 75% DASM with 100% ETc significantly improved plant height and basal diameter compared to the control treatment. The water productivity of the crop increases significantly under deficit irrigation compared to full irrigation, primarily because small amounts of irrigation increase crop ET linearly to a point that maximizes yield, while additional irrigation does not increase yield more (Mabhaudhi et al. 2021). The greatest canopy cover was observed at 30 days after sowing (DAS) under the 75% DASM with 100% ETc treatment. Additionally, the Leaf Area Index (LAI) at 45 DAS showed a 35% increase over the control treatment. The highest fibre yield was achieved

under 75% DASM with 100% ETc irrigation schedule, followed closely by the 50% DASM with 75% ETc treatment, resulting in a 23-44% yield increase compared to the stressed control. Furthermore, water productivity improved significantly, with a 20-24% increase in water use efficiency under the 75% DASM with 100% ETc treatment, while irrigation water savings reached 51.5% compared to fully irrigated conditions. The AquaCrop model effectively simulated soil moisture, biomass, and canopy cover across various treatments. The highest model efficiency coefficients were observed under fully irrigated conditions, and a strong correlation ($R^2 = 0.93$) between measured and simulated canopy cover values validated the model's accuracy. Overall, this study underscores the benefits of optimal irrigation scheduling in improving jute yield and water efficiency.

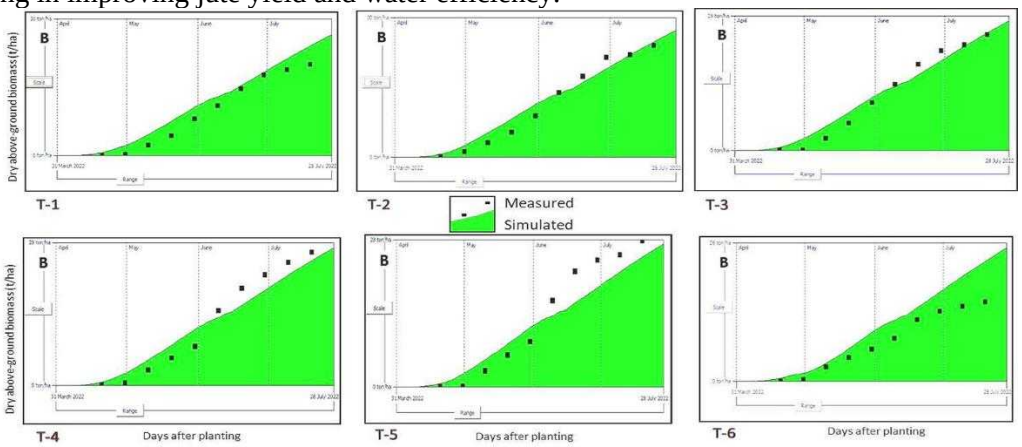

Fig. 1. *Simulated and measured dry above-ground biomass yield of jute plants (t/ha) from germination to maturity*

CONCLUSION

This study highlights the significance of irrigation timing for maximizing crop and water productivity. Regulated deficit irrigation, particularly during the initial growth stages, helps maintain yields close to full irrigation levels while using up to 50% less water. The AquaCrop model proves effective for simulating jute growth under deficit irrigation, offering valuable insights for managing water resources in water-scarce regions. The approach can be adapted to other sub-tropical jute-growing regions worldwide, contributing to sustainable water management and improved crop productivity.

REFERENCES

Mabhaudhi T, Nhamo L, Mpandeli S (2021) Enhancing crop water productivity under increasing water scarcity in South Africa. *Clim Change Sci*. 2021:1–18.

MAFW (2023) Agricultural statistics at a glance 2022. Ministry of Agriculture & Farmers Welfare Government of India. Department of Agriculture & Farmers Welfare Economics & Statistics Division, New Delhi

Singh AK, Jha SK, Majumdar B, Roy ML, Sarkar S, Ghorai AK (2019) Impacts of climate smart jute farming on resource use efficiency, productivity and economic benefits in rural eastern India. *Outlook Agric*. 48(1):75–82

Schoof JT, Pryor SC (2008) On the proper order of Markov chain model for daily precipitation occurrence in the contiguous United States. *J Appl Meteorol Clim*. 47(9):2477–2486

Oral V5T5D2

Impact of climate change on estuarine coastal tourism

KAMALIKA MONDAL[1] and GUPINATH BHANDARI[2]

[1]Research Fellow, Centre for Disaster Preparedness & Management, Jadavpur University, Kolkata
kamalikamondal2025@gmail.com

[2]Professor, Department of Civil Engineering, Jadavpur University, Kolkata.
E-mail: gupinath.bhandari@jadavpuruniversity.in

Key Words: *Climate Change, Estuarine Coast, Coastal Tourism, Tourist Intensity, Community Participation, Tourism Infrastructure*

INTRODUCTION

Earth's temperature has risen by an average of 0.087 degree Celsius per decade since 1880 (www.climate.gov) (Dyre, 1979). Increasing SST results the frequent occurrence of cyclone like AILA (2009), TITLI (2018), FANI (2019), BULBUL (2019), AMPHAN (2020), YAAS (2021), and lastly DANA (2024). Mousuni Island is threatened by Climate Change and subsequent severe cyclonic

occurrence (WWF India, 2010) (Das, 2022). The vulnerability in tourism practice is increasing due to Sea Level Rising, Embankment Breaching, Cyclone and Storm Surge. The objective of the study is to analyze the impact of Climate Change on estuarine coastal tourism in Mousuni Island.

METERIALS AND METHODS

Study area:

Mousuni Island, is a small Island near Namkhana, West Bengal, India, is a hidden gem awaiting your discovery. Located at 21.6624°N, 88.2023°E, on NH 117. It does not take a long journey to reach from Kolkata, and hence Mousuni Island is more attractive to Kolkata people for a short trip of tourism. Also, the estuarine area gives a good attraction for tourists, than open coastal belt.

In pre field survey different maps and literatures of this associated topic have been reviewed. The primary data has been collected on the field and the community perception towards tourism. The collected data were analyzed by different Statistical and Geospatial Techniques to clarify the impacts of climate change on the tourism of Mousuni Island.

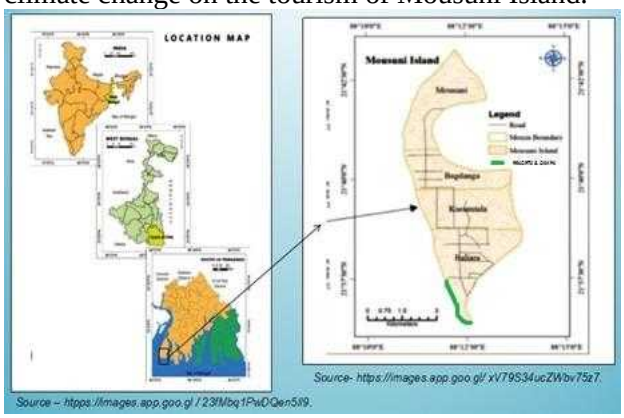

***Fig1**: Location of Mousuni Island*

RESULT AND DISCUSSION

Climate Change has a significant and direct impact on tourism. Extreme weather events can significantly affects the tourism, loss of infrastructure and the viability of tourism, affects in the economies (Bardhan et al., 2019).

Impact on Tourism Infrastructure:

There were about 50 resorts along the south western coastline of this island and about 4 resorts lost their existence due to beach erosion, sea level rise and cyclone effect. The owners of the established resorts need to invest significantly in infrastructure repairing and maintenance in every year. During the flood, land transportation is totally damaged and further more different recreational structures of bamboo on the beach were also destroyed.

Impact on Economic Losses:

Local people are engaged with this tourism practice as labour, manager, maintenance worker and chef. The resort's authority hire 5 to 10 maintenance worker in peak season (November to February) and 2 to 3 worker in lean season from local community, at a minimum daily wages. But climate change ultimately lead to reduce tourism revenue and job losses.

Impact on the Number of Visitors:

Climate change lead to a decline in tourist arrivals. Annual tourist visit is about 17,000, to be precise 16050, still it is decreasing. A growth was observed during 2016 to 2017, however, the same was declined during 2020 to 2023.

CONCLUSION

The increasing trend of disastrous events in the present scenario the estuarine coastal tourism of this island is drastically effected, especially due to Climate Change. The vulnerability may be reduced by creating mangrove buffers and by following the rule of CRZ. The vulnerability assessment in appropriate way the capacity building may be observed. Crucially the ensuring community participation need to be assessed, in tourism practice for sustainable tourism development. As a consequence, it would be emerged as an alternative livelihood apart from agriculture and fishing.

REFERENCE

Dyre, K.R. 1979. Estuaries and estuarine sedimentation. In Dyer, K.R.(editor): Estuarine Hydrology and Sedimentation, Cambridge University Press, Cambridge: 1 - 18.

Das, K.(2022). Vanishing islands and vulnerabilities, case studies from selected sites of Indian Sundarban. Sundarbans, society, *Environment and development*. pp 181 - 206.

Das, K. (2022). Premature reclamation and settlement change: case study from Canning (Piali-Bidyadhari interfluve) and Basanti, Indian Sundarban. Sundarban, society, *Environment and Development*,181- 206.

Bardhan, S., Sanyal, P., and Sarkar, S. (2019). Community perception towards tourism development in the Indian Sundarban: case study of Jharkhali Island. IJERT, 8(12), 526-539.

Bose, T., Das, S., Mondal, K., Das, K., and Das, K., (2023). Combating climate change with sustainable measures: A case study of Mousuni Island, Indian Sundarbans. pp 1- 13.

Poster T5P1

Sustaining Pulicat lake fisheries: Present status, emerging threats, and conservation strategies in the context of climate change

DIBAKAR BHAKTA*, SANJOY K. DAS, CANCIYAL JOHNSON, SANGEETHA M. NAIR, AMIYA K. SAHOO, APARNA ROY, SANJIB K. MANNA and BASANTA KUMAR DAS
ICAR-Central Inland Fisheries Research Institute, Barrackpore, Monirampore, Kolkata-700 120, West Bengal, India.
E-mail: dibakar.bhakta@icar.gov.in

***Key Words**: Pulicat Lake Fishery, Emerging Threats, Conservation Strategies*

INTRODUCTION

Pulicat Lake, the second-largest brackish water lagoon in India, is essential for regional biodiversity, the sustenance of local fishing people, and the ecological integrity of the area. The lake, located in Andhra Pradesh and Tamil Nadu, is essential for several aquatic species, including commercially important fish and shellfish, and it is also a breeding site for numerous migratory birds. The health of the ecosystem intricately depends on the lake's fisheries, which have been vital to local populations for millennia. In recent years, Pulicat Lake's fisheries have encountered considerable obstacles due to both natural and human-induced issues. The overexploitation of fish stocks, habitat destruction, pollution, and unregulated fishing techniques have led to diminishing fish yields (Jesintha *et al*., 2022). The effects of climate change, such as increasing salinity, unpredictable monsoon patterns, and severe weather occurrences, have exacerbated these problems. These alterations not only disturb the lake's fragile ecological equilibrium but also jeopardise the socioeconomic stability of reliant populations (Akila *et al*., 2022). The imminent dangers to Pulicat Lake fisheries highlight the necessity for prompt and coordinated conservation initiatives. Strategies for guaranteeing sustainability must incorporate ecological restoration, the adoption of sustainable fishing practices, and the engagement of residents in management choices. This study investigates the current condition of Pulicat Lake's fisheries, identifies significant upcoming concerns, and evaluates alternative conservation methods.

MATERILS AND METHODS

The execution involved field surveys, stakeholder consultations, environmental monitoring, and secondary data analysis. Samples were mostly collected from locations where fishing activities were ongoing, areas of ichthyoplankton reproduction, and regions experiencing environmental changes. Ichthyological data were gathered from notable fishing villages and landing sites across the lake (Figure 1). Field observations and conversations with fishermen documented data on species composition, fishing gear, and applied strategies. Fisheries departments and academic publications supplied historical fishing data, encompassing annual landings and trends in species diversity. Water samples were collected from several locations across Pulicat Lake to assess certain characteristics.

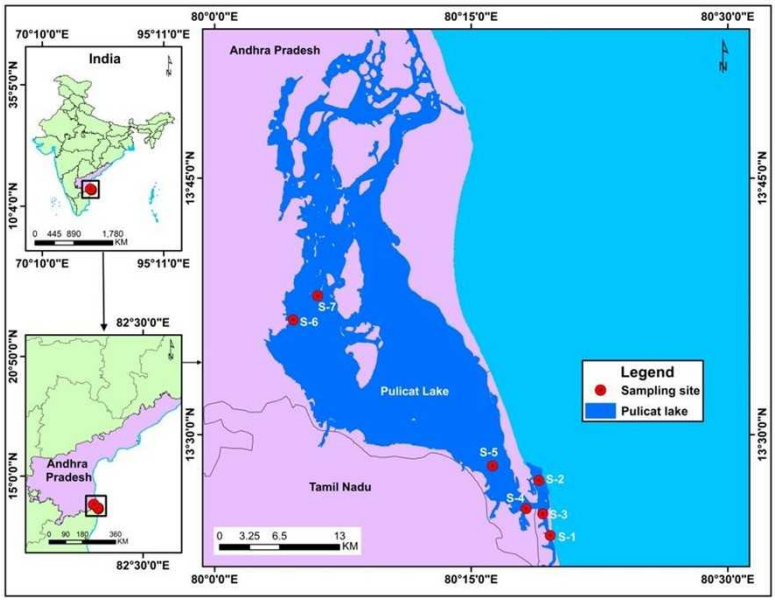

***Fig. 1.** Study area under Pulicat Lake*

RESULTS AND DISCUSSION

The data gathered on fish caught during the study reveal a decrease in total fish landings over the past decade. Significant reductions in abundance were observed in key species such as mullets

(*Mugil* spp.), prawns (*Penaeus* spp.), and crabs (*Scylla* spp.), all of which hold economic importance. There have been changes in the seasonal patterns of fish availability, with a big drop happening before the monsoon season. This is likely because of higher salinity levels and habitat loss. The effects of climate change on Pulicat Lake are clearly observable through changes in rainfall patterns, a higher occurrence of extreme weather events, and elevated temperatures. In recent years, there has been an increase in salinity levels attributed to diminished freshwater inflow during the dry season, which affects the survival and reproduction of species that are tolerant to freshwater conditions. Interviews conducted with fisherfolk indicated a significant reliance on fine-mesh nets, resulting in the capture of juvenile fish and prawns. The phenomenon of overfishing has led to diminished stock sizes, posing a significant threat to the sustainability of fisheries in the long run. The reduction in fish catches has significantly affected the livelihoods of local communities (Thirunavukkarasu and Sumithraa, 2022), with numerous fishers indicating a decrease in income of as much as 50% over the past decade (Table 1). The lack of access to alternative livelihoods increases their vulnerability, compelling some individuals to engage in unsustainable fishing practices. The findings suggest several conservation strategies.

- Restoring mangrove forests and seagrass beds to create essential habitats for fish and crustaceans.
- Guaranteeing sufficient freshwater inflows to counteract salinity rises and formulating strategies to tackle climate-related vulnerabilities.
- Implementing gear restrictions, seasonal fishing bans, and community-managed fishing zones to facilitate the recovery of fish stocks.
- Enhancing the capabilities of local communities via training initiatives, diverse livelihood alternatives, and inclusive decision-making frameworks.

The findings highlight the critical necessity for cohesive management approaches to tackle the issues confronting Pulicat Lake fisheries. Habitat degradation and unregulated fishing practices, exacerbated by climate change, present a complex issue that endangers ecological health and the livelihoods of communities that rely on these resources. The rise in salinity and the loss of habitat are especially significant, as they interfere with the lifecycle of essential species. Similar patterns have been seen in many coastal lagoons around the world, such as Chilika Lake, where conservation efforts have successfully increased fish populations by restoring habitats and getting people involved (Nair and Nayak, 2023). Restoring the ecological balance of Pulicat Lake necessitates a multifaceted approach that includes regulatory measures, habitat restoration, and active community involvement. It is essential that policies prioritise climate adaptation, ensure equitable resource management, and develop alternative livelihoods to alleviate the strain on the lake's resources.

Table 1. *Trends of fish catch from the Pulicat Lake*

States	1980s	2007-08	2008-09
Andhra Pradesh	6500 t	2345 t	1747 t
Tamil Nadu	2835 t	2200 t	2145 t
Total	9335 t	4545 t	3892 t

CONCLUSION

Pulicat Lake, an essential brackish water ecosystem, is encountering serious challenges stemming from habitat degradation, overfishing, and the intensifying effects of climate change. The reduction in fish populations and the disturbance of ecological equilibrium pose significant risks to biodiversity and the well-being of communities that rely on these resources. A comprehensive approach is essential for ensuring the sustainability of Pulicat Lake fisheries. Restoring habitats, implementing sustainable fishing methods, engaging communities, and developing adaptive strategies to address climate impacts are essential routes to building resilience. By addressing these challenges comprehensively, we can safeguard Pulicat Lake as an essential resource, providing ecological and socioeconomic advantages for future generations.

ACKNOWLEDGEMENTS

We extend our heartfelt appreciation to the local fishing communities of Pulicat Lake for generously sharing their invaluable knowledge and insights. We extend our gratitude to the Director, ICAR-CIFRI for his invaluable guidance throughout this study.

REFERENCES

Akila, M., Anbalagan, S., Lakshmisri, N.M., Janaki, V., Ramesh, T., Merlin, R.J. and Kamala-Kannan, S. (2022). Heavy metal accumulation in selected fish species from Pulicat Lake, India, and health risk assessment. *Environmental Technology & Innovation*, 27: 102744.

Jesintha, N., Jayakumar, N., Karuppasamy, K., Ahilan, B., Manikandavelu, D., Uma, A. and Madhavi, K. (2022). An Annotated Checklist of Finfish and Shellfish Diversity of Pulicat Lake, Southeast Coast of India. *Indian Journal of Animal Research*, 56(4): 468-475.

Nair, N.V. and Nayak, P.K. (2023). Uncovering water quality and evaluating vulnerabilities of small-scale fisheries in Chilika Lagoon, India. *Frontiers in Marine Science*, 10: 1087296. DOI:10.3389/fmars.2023.1087296.

Thirunavukkarasu, N. and Sumithraa, R. (2022). Socio-Economics Profile, Environmental and Climate Change Impacts of Fishermen Community at Pulicat Lake. In Impact of Climate Change on Hydrological Cycle, Ecosystem, Fisheries and Food Security (pp. 547-556). CRC Press.

Poster T5P2

Estimation of different fractions of carbon stored in the Sundarbans mangrove sediment of India and its implication in climate change mitigation

A. SAHA*, P. GOGOI, B. K. DAS, and P. MAJHI

ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata - 700 120, India

E-mail: ajoysahacob@gmail.com

Key Words*: Carbon Sequestration; Climate Change; Sundarbans Mangrove; Soil Depth; Total Organic Carbon*

INTRODUCTION

Sundarbans mangroves system is currently experiencing the highest degradation rate as compared to any other forest ecosystems. The causes of this degradation are both natural (cyclone, lighting, storm surge etc.) and anthropogenic (pollution, expansion of aquaculture, urban development, agriculture etc.). In addition to loss of above ground carbon due to mangrove disturbance, a large amount of CO_2 is also released into the atmosphere due to decomposition of soil organic carbon (SOC). Investigation on soil organic carbon stock has been considered as an essential study in aquatic and environmental sciences. However, mere estimation of total SOC may not give the sufficient knowledge about storage, stability and dynamics of SOC. Several fractions of C polls contribute to the total SOC which comprises labile and recalcitrant fractions (Taran et al., 2022). These various pools of SOC are very dynamic and influenced by small changes in the environment and could cause a significant impact on greenhouse gas emission. Hence it is important to measure the various pools of SOC *viz*., very labile (VLc), labile (Lc), less labile (LLc), non-labile (NLc) carbon to determine the role of Indian Sundarbans in mitigating climate change impact. The objectives of the present study are 1) to estimate the C stock in the sediments of Sundarbans mangroves, 2) to identify the patterns of C fractions along with the soil depth.

MATERIALS AND METHODS

Study area:

Sundarbans mangroves is the world's largest “mangrove chunk” (Mitra et al., 2022) and recognized as “Ramsar site” i.e. wetland of international importance. The area traverses both India and Bangladesh. In this study, Jharkhali, Dhamakhali and Patharpratima station of Indian Sundarbans ecoregion (Fig. 1) were selected which belong to differential tidal environments, having different energy fluxes and have different distances from the sea (Bay of Bengal). Samples were collected in three distinct season i.e. pre-monsoon, monsoon and post-monsoon season of the year 2022-2023.

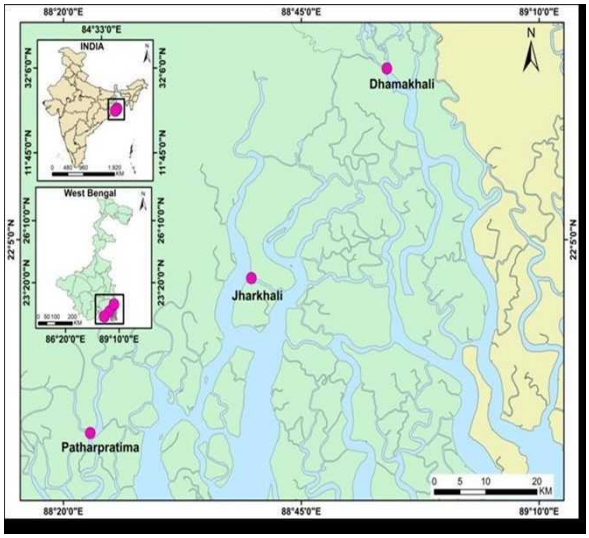

Fig. 1. *Map of Indian Sundarbans along with the sampling locations*

Sediment profile of various depths (0-10 cm, 10-20 cm, 20-30 cm and 30-45 cm) was collected from different stations for sediment physicochemical properties and carbon fractionation studies. pH-EC meter (Eutech Instruments, India) was used to measure the pH and electrical conductivity (EC) of the sediment. Sediment organic carbon (SOC) fractions were determined under an increasing grade of the oxidizing condition by employing three different aqueous sulfuric acid concentration solutions **(**Chan et al. 2001).

- Very Labile Fraction (VLc): Organic carbon oxidizable under 0.5:1 H_2SO_4:$K_2Cr_2O_7$
- Labile Fraction (Lc): The difference in carbon oxidizable under 1:1 and 0.5:1 H_2SO_4:$K_2Cr_2O_7$
- Less Labile Fraction (LLc): The difference in carbon oxidizable under 2:1 and 1:1 H_2SO_4:$K_2Cr_2O_7$
- Non-labile Fraction (NLc): The difference between TOC and carbon oxidizable under 2:1 H_2SO_4:$K_2Cr_2O_7$

RESULTS AND DISCUSSION

The lower pH with increasing sediment depth is attributed to release of low molecular weight organic acids through decomposition of root material and/or oxidation of sulfide minerals. Comparatively lower pH value in Jharkhali sediment attributing to the more dense mangroves. EC values were decreasing with increasing sediment depth in non-monsoon season while (EC) in the surface sediment was lower during monsoon season due to freshwater influence. Sediment was dominated by silt followed by clay and sand.

Investigation on composition of SOC of mangroves soil and sediment provides important information about the C cycles, plant productivity and microbial activity. Hence, SOC fractionation study is important to determine the role of mangroves wetland in C storage and cycling. SOC values varied with sampling station and depth of sediment profile. Results revealed that mean SOC content decreases irrespective stations and sampling seasons.

Average SOC stock was estimated at 17.3 ± 2.07 Mg C ha^{-1} (Table 1). Temporal patterns indicate that mean SOC content was higher in pre-monsoon and post-monsoon period as compared to monsoon season. SOC stock was highest at Dhamakhali station which is under constant anthropogenic stress. The average contribution of NLc (upto 56.6%) to total SOC was highest while VLc contributed only up to 22.5% of total SOC. In general, labile pools are more sensitive to climate change as compared to other pools and it has the highest turnover rate. A substantial amount of sediment SOC stock is contributed by a non-labile fraction which is considered a resistant pool of mangrove sediment organic pool. Thus this resistant pool of carbon fraction is sequestered into the mangrove sediment of Indian Sundarbans. Thus this indicates that Indian Sundarban mangroves act as a sink of natural carbon (Zinke, 2020), however it can be a source of greenhouse gases if the mangrove vegetation is not protected.

Table 1: *Variation in soil organic carbon fractions (Mean ± SD; Mg C ha^{-1}) among the different stations of Indian Sundarbans*

Depth (cm)	VLc	Lc	LLc	NLc	TOC
		Jharkhali			
0-10	3.53±0.32	1.16±0.34	1.88±0.34	9.91±2.87	16.44±2.41
10-20	2.79±0.39	1.17±0.42	2.17±0.38	10.81±2.99	16.90±2.86
20-30	2.59±0.08	0.75±0.72	2.27±0.42	10.67±2.62	16.26±2.50
30-45	2.14±0.29	0.95±0.48	2.36±0.33	8.28±3.35	13.74±3.71
Depth (cm)	VLc	Lc	LLc	NLc	TOC
		Dhamakhali			
0-10	7.16±1.12	1.94±0.93	2.96±1.19	8.58±2.03	20.64±3.78
10-20	6.28±0.41	1.50±0.67	3.03±1.24	9.46±2.61	20.28±4.72
20-30	4.81±0.73	1.79±0.75	2.91±0.32	9.75±2.54	19.26±4.08
30-45	3.77±0.36	2.04±0.44	2.97±0.58	9.85±2.30	18.63±3.16
Depth (cm)	VLc	Lc	LLc	NLc	TOC
		Patharpratima			
0-10	5.02±0.36	1.06±0.35	1.89±0.20	8.64±3.66	16.62±3.42
10-20	4.36±0.81	0.70±0.07	2.49±0.67	10.81±2.57	18.34±2.73
20-30	3.35±0.99	0.44±0.13	2.77±0.64	10.18±2.88	16.75±3.76
30-45	2.08±0.19	0.34±0.32	2.39±0.69	9.14±3.33	13.92±3.70

VLc-very labile carbon, Lc-labile carbon, LLc- less labile carbon, NLc-non-labile carbon

Our study also indicates the association of SOC pools with two or more other carbon fractions and thus changes in one pool can cause carbon dynamics in the Sundarbans ecosystems. Present study showed that non-labile pools are the major fractions of SOC, indicating that suitable mangrove management can increase the sediment organic carbon content in the Sundarban wetland and thus can help in climate change mitigation. Moreover, with protection of mangrove wetland we can achieve UN Sustainable Development Goals (SDG 1, SDG 2, SDG 6, SDG 13, SDG 14, and SDG 15).

CONCLUSIONS

Though the present study only investigated the spatio-temporal variation of SOC stock, the changes in SOC stock should also be correlated with the changes in atmospheric conditions like changes in temperature and rainfall pattern. It is well established that mangrove wetlands are a major sink of sediment carbon. Mangrove deforestation and increases in human settlement has led to a loss of C and other ecosystem services provided by the mangrove ecosystem. Hence it is important to conserve mangrove wetland which not only protects the natural C sinks but also provides ecosystem services.

REFERENCES

Chan, K.Y., Bowman, A. and Oates, A. (2001). Oxidizable organic carbon fractions and soil quality changes in an Oxic Paleustalf under different pasture leys. *Soil Science* 166: 61–67.

Mitra, A., Zaman, S. and Pramanick, P. (2022). Blue economy in context to the mangrove dominated Indian Sundarbans. In Blue Economy in Indian Sundarbans: Exploring Livelihood Opportunities (pp. 85-174). Cham: Springer International Publishing.

Taran, M., Ahirwal, J., Deb, S. and Sahoo, U.K. (2023). Variability of carbon stored in inland freshwater wetland in Northeast India. *Science of The Total Environment*, 859:160384.
Zinke, L. (2020). The colours of carbon. *Nature Reviews Earth & Environment*, 1(3):141-141.

Poster T5P3

Land use impacts on carbon pools in the *Pokkali* ecosystem

P. P. ATHUL[1*] and A. K. SREELATHA[2]
[1]College of Agriculture, Kerala Agricultural University, 680 656, Thrissur, Kerala, India
[2]Rice Research Station, Kerala Agricultural University, 682 019, Vyttila, Kerala, India
E-mail: athulp.puthanpurayil@gmail.com

Key Words: *Carbon Mineralization, Land Uses, Mangroves, Pokkali, And Prawn*

INTRODUCTION

The *Pokkali* lands of Kerala, India, have long been recognized for their unique ecological and agricultural significance, particularly in the context of carbon mineralization, a crucial process that plays a vital role in the global carbon cycle. These coastal wetlands characterized by their saline-tolerant agricultural practices, have garnered attention from researchers as they present challenges and opportunities in the face of climate change and environmental degradation. The *Pokali* lands encompass a range of land uses, including rice, rice-prawn, prawn, fallow and mangroves, which can profoundly influence the carbon dynamics in the region. The traditional system of organic rice cultivation (low-saline monsoon) followed by saline aquaculture is being replaced by an unsustainable year-round prawn monoculture, which in the long run is found to be unsustainable both in the ecological and the social context. This paper explores the impact of different land uses on different carbon pools within these lands.

MATERIAL AND METHODS

This study selected five land uses (rice alone, prawn alone, rice-prawn, fallow, and mangroves). Four upland and lowland samples were collected from each land use and analyzed for Total Organic Carbon (TOC), Resistant Organic Carbon (ROC), and Active and Slow Carbon (ASC) pools.

1. Total Organic Carbon (TOC): Analyzed using a CHNS analyzer.
2. Resistant Organic Carbon pool (ROC): Resistant organic C in soil samples is determined using the method suggested by Rovira and Vallejo (2002). One gram of oven-dry sieved (<0.2mm) soil sample is hydrolyzed with 25 mL of 6 M HCl at 110°C for 18 h with occasional shaking. After cooling, the unhydrolyzed residue is recovered by centrifuging. The process of centrifugation (at 20°C) and decantation is repeated several times with deionized water until
3. samples are free from chloride. Residues are then transferred to pre-weighed vials and dried at 60°C to constant weight, and total C is measured using a CHNS analyzer.
4. Active and Slow Carbon pool (ASC):

$$\text{ASC pool} = \text{TOC} - \text{ROC}$$

RESULTS AND DISCUSSION

Prawn and fallow lands recorded the highest TOC levels, with lowland prawn farms registering 325 mg/kg and lowland fallow land 318.50 mg/kg. Resistant carbon followed a similar trend, with prawn and fallow land showing the highest values. In contrast, mangroves and upland rice-prawn systems observed the lowest TOC levels. The ASC fraction was generally lower in upland samples across all land-use types, with the sharpest decline observed in upland rice fields (26.95 mg/kg). These findings highlight the influence of land use and topography on soil carbon dynamics, emphasizing the role of wetland and aquaculture systems in carbon sequestration. Table 1 presents data on soil organic carbon fractions of lowland and upland soils under different land-use systems.

Table 1: *Carbon pools of different land uses of Pokkali lands*

Land Use	Sample	Total Organic Carbon (mg/kg)	Resistant Carbon (mg/kg)	Active+ Slow carbon (mg/kg)
Rice	Lowland	244.75	161.33	83.42
	Upland	146.25	119.30	26.95
Prawn	Lowland	325.00	257.33	67.67
	Upland	207.75	128.00	79.75
Rice-Prawn	Lowland	182.00	140.33	41.67
	Upland	82.50	62.67	19.83

Fallow	Lowland	318.50	249.50	69.00
	Upland	133.50	78.00	55.50
Mangroves	Lowland	92.75	63.67	29.08
	Upland	227.75	180.33	47.42

CONCLUSION

The data suggest that land-use type and topographical position strongly influence soil carbon content. Lowland conditions favour higher carbon storage, while upland soils show lower organic carbon levels. Prawn and fallow lands contribute significantly to soil carbon sequestration, whereas upland rice-prawn systems have the lowest carbon retention. These findings highlight the need for sustainable land management strategies to maintain soil carbon stocks and enhance soil fertility.

ACKNOWLEDGEMENT

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REFERENCE

Dawson, J. J. C. and Smith, P. (2007). Carbon losses from soil and its consequences for land-use management. *Sci. Total Environ*. 382: 165-190

Rovira, P., Vallejo, V.R. (2002). Labile and recalcitrant pools of carbon and nitrogen in organic matter decomposing at different depths in soil: An acid hydrolysis approach. *Geoderma* 107, 109–141.

Poster T5P4

Assessing the relationship between climate extremes and crop diversification in coastal plain of West Bengal

CHANDRIMA BANDYOPADHYAY[1]*, GUPINATH BHANDARI[2]

[1]Research Scholar, School of Water Resources Engineering, Jadavpur University

[2]Professor, Civil Engineering, Jadavpur University

E-mail: chandrimab.swre.rs@jadavpuruniversity.in

Key Words: *Simpson's Index of Diversity, Standardised Precipitation Index, Pearson's Correlation Coefficient.*

INTRODUCTION

Climate extremes pose significant challenges to agricultural sustainability, particularly in regions reliant on farming for subsistence. Cyclones and associated floods severely impact crops, soil health, and overall agricultural productivity, especially in coastal areas. High winds, storm surges, and prolonged flooding lead to soil degradation, delayed crop cycles, and increased pest infestations, making farming more difficult. Climate change-driven increases in cyclone frequency further threaten agricultural planning and crop diversification. To analyze these impacts, the present study explores the relationship between climate extremes and crop diversification using the Standardized Precipitation Index (SPI) and the Simpson Index (SI). SPI.

MATERIALS AND METHOD

The study area consists of six coastal Community Development (CD) Blocks namely Ramnagar I, Ramnagar II, Contai I, Deshapran, Khejuri II and Nandigram of Purba Medinipur District of West Bengal (Figure 1). The latitudinal and longitudinal stretch of the study area is about 21°36'N to 21°40'N and 87°28'E to 87°37'E respectively having almost 55 km long coastline. The study focusses mainly on monthly average precipitation and total cropped area under different types of crops. Firstly, daily rainfall data sets for the years of 1991-2023 were obtained from IMD grided daily rainfall data (0.25x0.25 degree) and CD Block-wise gross cropped area are collected from District Statistical Handbook of Purba Medinipur for the last 15 years (2009 - 2023). After

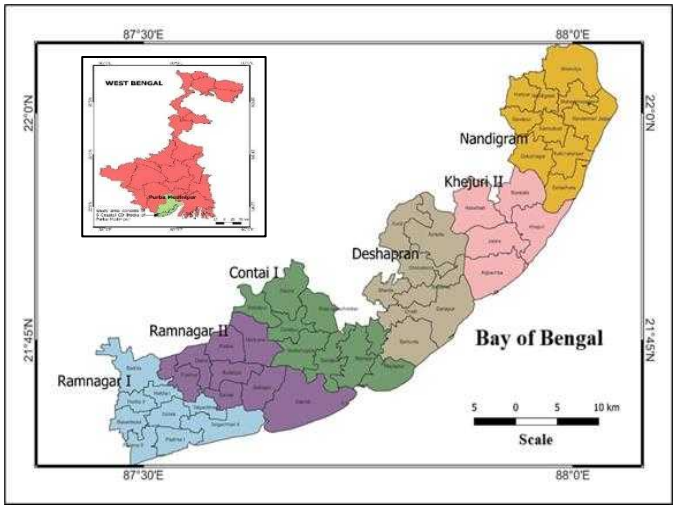

Fig 1*. Study Area*

collection of data SPI and SI are calculated. At the last stage Pearson's correlation coefficients (r) are calculated for each CD Block for the assessment of the relationships between SPI and SI values.

RESULTS AND DISCUSSION

The wetness pattern from 1991 to 2023 alternates between wet and dry years, with peak flows occurring during monsoon months (July–September) as shown by SPI3, SPI6, and SPI12. Since 2005, drier years have declined while pluvial years have increased, raising soil moisture and flood risks. All SPI indices show positive trends, with SPI12 exhibiting the most significant increase ($R^2 = 0.016$), confirming the intensification of wet spells and wetter years in the region. Over the past 15 years, Ramnagar I and Nandigram have shown the highest crop diversity, while Khejuri II and Deshapran have the lowest SI values, indicating poor diversity. The average crop diversity remains low (<0.5), but since 2015, more CD blocks have adopted diversified cropping, reducing reliance on monoculture. In the short-term, only Contai I shows a positive correlation between SPI3 or SPI6 and SI, while all other blocks exhibit a significant negative association. Over 12 months, no block demonstrates a positive relationship (.

Table 1. *Spatio-temporal Relationships between SPI and SI*

CD Block Name	r (SPI_3 and SI)	r (SPI_6 and SI)	r (SPI_{12} and SI)
Ramnagar I	-0.03524	0.037638	-0.23655
Ramnagar II	-0.25423	-0.30817	-0.31257
Contai I	0.192048	0.221794	-0.07513
Deshapran	-0.22465	-0.30217	-0.27948
Khejuri II	-0.0895	-0.05463	-0.17416
Nandigram	-0.18633	-0.05829	-0.18797

CONCLUSION

In conclusion it can be stated that dry spells are decreasing, while wet periods and flood risks are rising in coastal West Bengal. But crop diversity remains low, possibly due to waterlogging and possible direct economic loss. However, diversification is crucial for mitigating climate risks in long run, enhancing livelihoods, and ensuring food security in the region. For this reason, it is necessary to implement appropriate measures in order to increase agricultural variety on the coastal plain of West Bengal.

REFERENCES

McKee, TB,; Doesken, NJ,; Kleist, J. 1993. "The Relationship of Drought Frequency and Duration to Time Scales." In *Proceedings of the 8th Conference on Applied Climatology*, 179–84. Boston: American Meteorological Society.

Report. 2022. "DISTRICT SURVEY REPORT OF PURBA MEDINIPUR DISTRICT (For Mining of Minor Minerals) Meeting of SEIAA under Miscellaneous Section, Point No.1)." *Govt of West Bengal* 141 (1).

S.C. Nagpure,; R.G. Deshmukh, Pawan Kumar Sharma and D. N. Ingole. 2017. "Pattern of Crop Concentration and Crop Diversification-An Economic Analysis." *Maharashtra Jn. of Agril. Economics*. 20 (2): 128–32. www.indiastat.com.

Poster T5P5

Assessment of jute cultivated area affected by waterlogging during Amphan and Yaas cyclones using GIS and remote sensing techniques

M. Islam, A.K. Singh, B. Majumdar, G. Kar and D. Datta
ICAR-Central Research Institute for Jute and Allied Fibres
Barrackpore, 700121, West Bengal
E-mail: Islam.mafijul001@gmail.com

Key Words: *Cyclone Amphan and Yaas, GIS and Remote Sensing, Jute, LULC, Waterlogging*

INTRODUCTION

Jute cultivation plays a crucial role in the agricultural economy of West Bengal, particularly in Nadia and North 24 Parganas districts (Fig-1)**,** where it is grown over 1,62,926 hectares. However, extreme weather events, such as cyclones, pose a significant threat to its productivity. Cyclones Amphan (May 2020) and Yaas (May 2021) led to severe flooding and prolonged waterlogging in these regions, causing extensive damage to jute crops. Water stagnation for extended periods adversely impacts plant growth, fibre quality, and overall yield, resulting in economic distress for farmers. This study employs Remote Sensing (RS) and Geographic Information System (GIS) techniques to assess

flood-inundated areas using Sentinel-2 satellite imagery. By analysing NDWI and NDVI indices, the extent of waterlogging and its impact on crop health was evaluated. The findings help identify vulnerable zones, aiding policymakers and stakeholders in developing climate-resilient strategies to mitigate future cyclone-induced agricultural losses.

MATERIALS AND METHODS

This study assessed the impact of Cyclones Amphan (2020) and Yaas (2021) on jute cultivation in West Bengal's Nadia and North 24 Parganas districts using Remote Sensing (RS) and GIS techniques. Sentinel-2 imagery and indices like NDWI and NDVI were used to analyze flood inundation and crop health (Fig-1). The study provided insights into cyclone-induced crop loss and helped estimate economic damages, supporting climate-resilient agricultural strategies for jute farming.

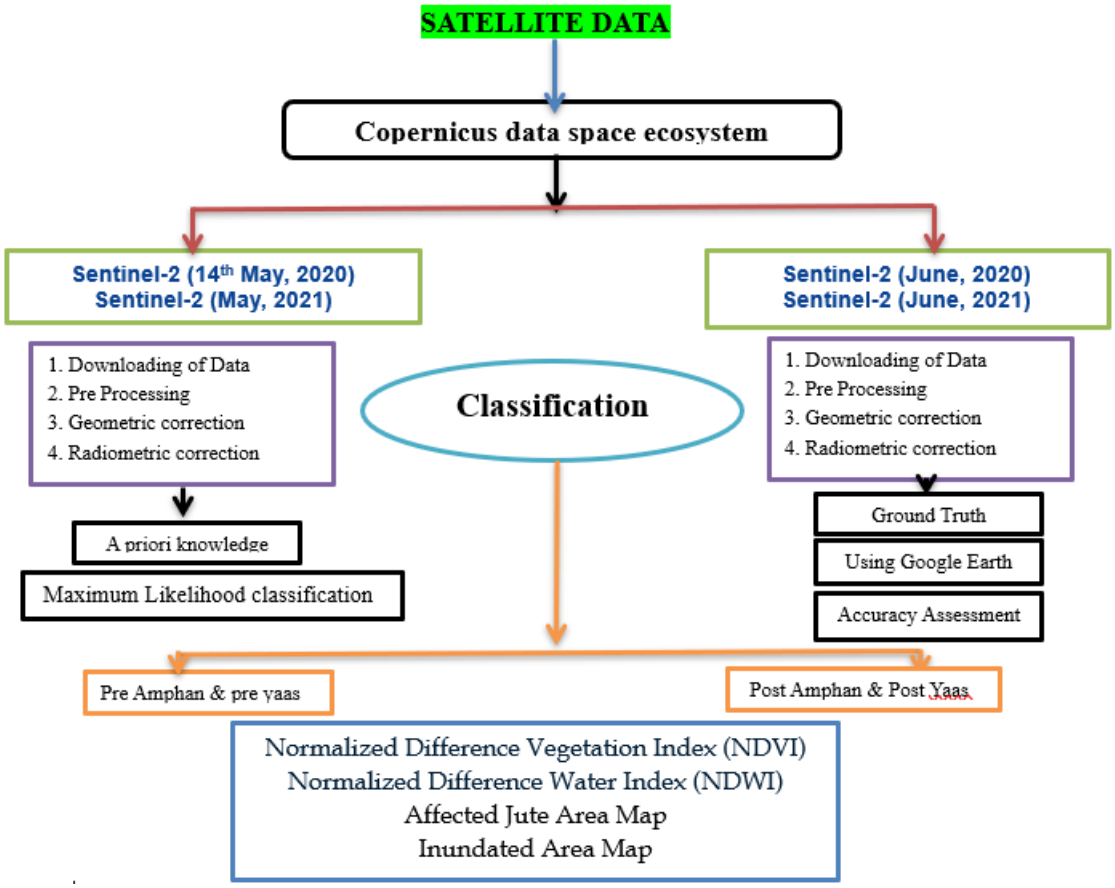

***Fig-1**: Flow chart of Data Processing*

RESULT AND DISCUSSION

In 2020, the jute cultivation area in Nadia and North 24 Parganas was 172,904 hectares. Cyclone Amphan impacted 52,902 hectares, while Cyclone Yaas affected 32,902 hectares. During Amphan, permanent water spanned 36,637 hectares, and the inundated area reached 96,773 hectares. For Yaas, permanent water covered 32,637 hectares, and the inundated area was 71,904 hectares.

CONCLUSION

The study demonstrates the effective use of GIS and Remote Sensing techniques in assessing the impact of Cyclones Amphan and Yaas on jute cultivation in West Bengal. The findings reveal significant waterlogging and crop damage, particularly in North 24 Parganas, where 70% of jute fields were submerged during Amphan. With 35% of jute fields affected across the region, the study provides valuable insights for policymakers and farmers, offering critical data to support the development of climate-resilient agricultural strategies and targeted interventions in cyclone-prone areas.

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Technical session 6: Impact of technological advancements, gender issues, market dynamics and new opportunities

Lead Lect-1T6D2

Climate smart socio-technical innovations bundling for sustainable agri-food systems and farm livelihoods in coastal agro-ecosystem

SOUVIK GHOSH
Professor, Dept. of Agricultural Extension, Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati University, Sriniketan, Birbhum, West Bengal
E-mail: souvik.ghosh@visva-bharati.ac.in

The agricultural sector, particularly in developing countries, faces increasing challenges due to climate change, necessitating innovative solutions to ensure sustainability, resilience, and improved farm livelihoods. Coastal agro-ecosystems are highly vulnerable to climate change, posing significant challenges to agricultural productivity, food security, and farm livelihoods. Climate change has exacerbated vulnerabilities in the agricultural sector, particularly in coastal regions of India, where small and marginal farmers dominate. The increasing frequency of extreme weather events, unpredictable monsoons, and rising temperatures pose significant threats to crop yields, income stability, and food security. These challenges are further compounded by inadequate infrastructure, limited access to resources, and low levels of climate awareness among farmers. To address these issues, Climate-Smart Agriculture (CSA) emerges as a critical framework. CSA aims to increase productivity, build resilience, and reduce greenhouse gas emissions. It incorporates advanced technologies such as precision farming, climate-resilient crop varieties, and renewable energy systems to create sustainable agricultural practices.

A key component of CSA is climate-smart socio-technical innovation bundling, which combines technological advancements with social innovations. Climate-smart socio-technical innovation bundling (CSTIB) presents an integrated approach to enhancing resilience and sustainability in the fragile coastal regions. This synergistic approach recognizes that technology alone cannot address the multifaceted challenges of climate change. Social innovations, such as farmers aggregation, knowledge-sharing platforms, and capacity-building programs, play a vital role in fostering community resilience and encouraging the adoption of sustainable practices. For example, integrating satellite-based weather information with precision agriculture can optimize irrigation and fertilizer application, reducing resource use while maintaining productivity.

The role of Extension and Advisory Services (EAS) is crucial in facilitating the adoption of these innovations. EAS must transition into climate-smart services that effectively disseminate climate-related knowledge and technologies. Their responsibilities include capacity building, participatory research, and policy advocacy to ensure that climate-smart practices are scalable and inclusive. Engaging farmers in the decision-making process is also essential, as their insights and preferences ensure the alignment of interventions with local needs.

In conclusion, CSTIB integrates climate-smart agricultural practices, digital technologies, institutional frameworks, and community-driven solutions to optimize resource use, mitigate climate risks, and promote economic stability for farming communities. Scaling up climate-smart socio-technical innovations is vital for building resilient and sustainable farming systems. This requires strengthened partnerships among stakeholders, robust institutional support, and a focus on empowering farmers through education and capacity building. By embracing this integrated approach, the agricultural sector can better adapt to climate challenges, secure farm livelihoods, and contribute to global food security. Such efforts underscore the transformative potential of climate-smart agriculture in creating a sustainable and equitable future.

Lead Lect-2T6D2

Zero tillage potato production in salt affected delta regions: socio-economic and gender perspectives

N. KAWARAZUKA[1*], D. BURMAN[2], T.D. LAMA[2], U.K. MANDAL[2], R.N. BHUTIA[2], P. BHARTI[3], S. CHAUDHARI[1], M.M. HOSSAIN[4] and E.H.M.S. RAHAMAN[4]
[1]International Potato Center, Hanoi, Vietnam
[2]ICAR-CSSRI, RRS, Canning Town- 743329, West Bengal, India
[3]International Rice Research Institute, Bhubaneswar - 751007, Odisha, India
[4]International Potato Center, Dhaka, Bangladesh
E-mail: N.Kawarazuka@cgiar.org

Key Words: *Conservation Agriculture, Potato Cultivation, Technology Adoption, Farmers' Perception, Gender*

INTRODUCTION

Climate change significantly affects the delta region with increasing salinity in the soil and water during the rabi season, making it difficult to grow crops. Zero-tillage potato cultivation with rice straw mulch has a great potential to utilize the fallow fields after harvest of kharif rice, as potato is relatively tolerant to soil salinity while rice straws can preserve soil moisture and reduce salinity build up in soil. While agronomic and soil research in demonstration plots show promising results (Sarangi et al., 2018; 2021; 2024, Ramirez et al., 2022:2024), farmers' perceptions on this new practice, their willingness, and gender implications are not fully documented. To address this knowledge gap, following three objectives were set in this study: 1) understanding men and women farmers' perceptions on zero-tillage potato production; 2) identifying the reasons for not adopting; and 3) understanding the role of women in zero tillage potato production. Insights from this study will help address socio-technical constraints farmers face and develop gender-responsive scaling approaches.

MATERIALS AND METHODS

Data was collected in 2023 and 2024 from total 628 households who participated in zero tillage potato production trials (528 households in Khulna, Bangladesh and 100 households in South-24 Parganas, West Bengal, India). The survey was based on structured interviews with 4-8 short questions related to their willingness to adopt, the size of cultivation area, the reasons for not adopting, their neighbours who adopted this new practice, and women's roles. Youth or women within the studied communities were trained as enumerators for conducting the survey using their own smartphones as part of facilitating women/youth empowerment and community participation in the research process. In addition, the post-experiment gender-disaggregated focus group discussions were conducted in Ramgopalpur village in South 24 Parganas with 18 men and 25 women. A total of 30 semi-structured questions were used on five themes: 1) the zero-tillage method experience; 2) potato late blight management; 3) seed quality and variety preference; 4) irrigation; and 5) rice straw availability and recycling. Thematic analysis was conducted for qualitative data from focus group discussions. Results were shared with farmers in the study communities for a validation purpose and further feedback was documented.

RESULTS AND DISCUSSION

Both men and women farmers were optimistic about the zero-tillage method, as it can reduce labor, time, irrigation water, and input costs without compromising yield compared to conventional tillage. In Ramgopalpur, South 24 Parganas, there is a shortage of male labor due to migration. Women in male-absent households particularly acknowledged the labor-saving aspect of zero tillage. Farmers also liked that they could sow potatoes immediately after harvesting rice in wet fields without land preparation, which allowed their harvesting two weeks earlier or growing two weeks longer than that with conventional tillage. Both men and women recognized that rice straws effectively preserve soil moisture, reducing both the amount and frequency of irrigation.

Farmers' willingness to adopt zero tillage potato production was very high. 88% and 90% of respondents in South 24 Parganas and Khulna respectively were willing to adopt it in the following season with an average of seed investment of 64kg and 46kg respectively. In Khulna, we conducted follow-up studies and actual adoption rates were 56% in 2023 and 87% in 2024. The adoption rate in 2023 was lower relative to their willingness due to the high price of potato seed. In 2024, the high price of both seed and table potato continued, but the demand for potato appears to be increased.

The reasons for not adopting vary with the contexts. In South 24 Parganas where farmers traditionally grow potato with conventional tillage, the major reason for not adopting was their belief in conventional tillage (they do not see a great benefit of changing methods) (11 respondents), rodent

infestation which affects more seriously in zero tillage than conventional one (9 respondents), lack of plots suitable for zero tillage (e.g., appropriate drainage) (5 respondents). In Khulna where potato production was new for farmers, unavailability of seed and lack of capital to purchase seed were two major reasons for not adopting.

Farmers also contributed to promoting zero tillage potato production to neighbors, friends and relatives. An average number of other households who are willing to adopt zero tillage in their own plots was 3.4 households per respondent. This indicates that the on-farm demonstration in farmers' plots is a powerful means for scaling to neighborhoods.

Women play significant roles in various activities of potato production from seed preparation to harvesting (Figure 1). Some women even perform pest and disease management, indicating the importance of involving women in training to gain knowledge and information on potato production and crop protection. In conventional agricultural production in South Asia in general, land preparation is exclusively performed by men, and this makes it difficult for households with shortage of male labor to engage in crop production during the fallow season when men migrate. Zero tillage has a great advantage in this respect. Women's involvement in decision-making and management was low. In a short term, convincing men is important to disseminate zero tillage potato production. In a long term, it is important to facilitate women's involvement in decision making by providing knowledge and skills to women, as their involvement is likely to contribute to household decisions towards more sustainable agriculture.

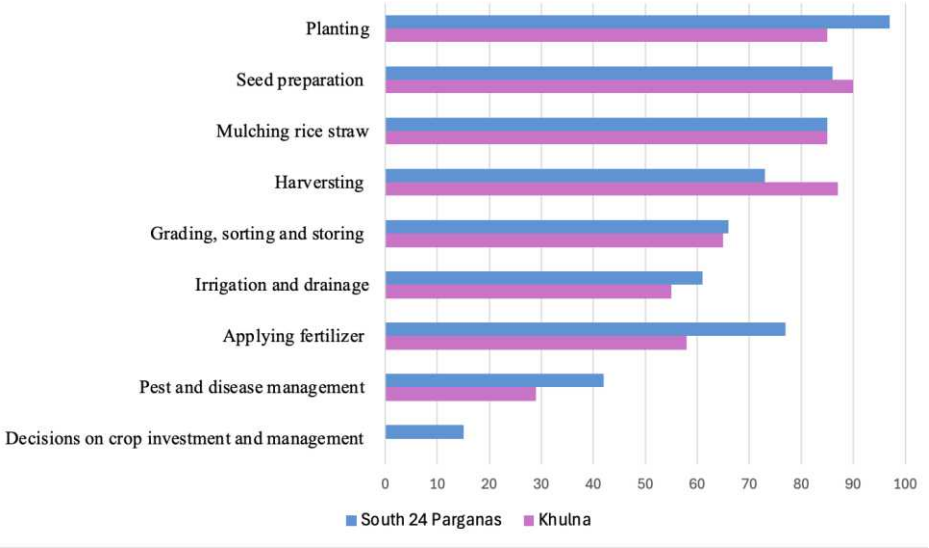

Fig. 1. *Women's participation in zero tillage potato production by activity (%)*

CONCLUSIONS

The results confirm that farmers strongly support the zero-tillage method as a way to utilize the fallow plots for food production during the rabi season. This labour-saving method also enables women to handle by themselves, making women's contribution more visible and recognizable. Ensuring sustainable access to quality seed remains a big challenge in the area where there is no seed market. Cross-sectoral efforts for establishing sustainable seed systems are required by collaborating with policy makers and the private sector. Organizing demonstration plots in farmers' fields appears to be an important means for scaling this new technology.

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REFERENCES

Sarangi, S. K., Maji, B., Digar, S., Mahanta, K. K., Sharma, P. C., &Mainuddin, M. (2018). Zero tillage potato cultivation. *Indian Farming*, 68(04): 23-26.

Sarangi, S. K., Maji, B., Sharma, P. C., Digar, S., Mahanta, K. K., Burman, D., ... &Mainuddin, M. (2021). Potato (Solanum tuberosum L.) cultivation by zero tillage and paddy straw mulching in the saline soils of the Ganges Delta. *Potato Research*, 64: 277-305.

Sarangi, S. K., Mainuddin, M., Bell, R. W., & Digar, S. (2024). Rice-zero tillage potato-green gram and conservation agriculture enable sustainable intensification in the Coastal Region. *Journal of the Indian Society of the Coastal Agricultural Research*, 42(1): 147322.

Ramírez, D.A., Silva-Díaz, C., Ninanya, J., Carbajal, M., Rinza, J., Kakraliya, S.K., Gatto, M. and Kreuze, J. (2022). Potato Zero-Tillage and Mulching Is Promising in Achieving Agronomic Gain in Asia. *Agronomy*, 12(7): 1494

Ramírez, D. A., Hossain, M. M., Rahaman, E. S., Mestanza, C., Rinza, J., Ninanya, J., ... &Kreuze, J. F. (2024). Potato production under zero tillage with rice straw mulching as a promissory technology to diversify rice-based systems in Southwest Coastal Bangladesh. *Journal of Agriculture and Food Research*, 101603.

Lead Lect-3T6D2

Decision support system: Intelligent monitoring of coastal ecosystem for resilient livelihood and ecology

SANKAR KR. ACHARYA
Professor in Agricultural Extension &Former Dean, Post Graduate Agriculture,
Bidhan Chandra Krishi Viswavidyalaya, Mohanpur- 741252, Nadia, West Bengal, India
E-mail: acharya09sankar@gmail.com, acharjee.sankar.kr@bckv.edu.in

Key Words: *Decision Support Systems, Knowledge-Based Systems, Online Analytical Processing, Executive Information Systems*

INTRODUCTION

The farmers and farming on coastal lines in India are becoming increasingly vulnerable to huge pool of uncertainty factors consisting of weather, market, technology, input delivery, quality management and skill availability. The marginalization of land resources and its fragmentations, increasing intensity and veracity of cyclonic storms, sea level rising at an ever-increasing scale, erosion of mangroves, fragile and uncertain economy of more than 80 person of rural people are making life of coastal agro ecosystem of West Bengal more uncertain, complex and difficult. They need a strong decision support system which would help them extract the best choice out of a basket of choices. That can encompass the diverse entrepreneurial options amidst crop-fish-livestock, forest resource towards attaining a sustainable ecofriendly livelihood.

Unlike other part of the globe, small and marginal farmers in India have to confront with uncertainty and chaos. These uncertainties are relating weather, market, livelihood, productivity and functional knowledge in agriculture. These are more conspicuous for a coastal ecosystem of Bengal. The brunt of climate change, sea level rise, ingress of salinity, punitive poverty, migration and up scaling conflict between wild life and human interest have made the entire scenario more complex and polymorphic in nature. So, making and taking decisions are so complex here. When crop yield is better, market price is poor, when everything sets to big success, cyclonic storms wash away everything. For this zone, we need application of decision support system, both in participatory and non-participatory manners. The proposed DSS comprises not only of ephemeral decision making for farmers, it would empower them in predicting and projecting for a mid to long term perspectives. The community-based knowledge management, micro level brain storming, application of DSS, knowledge kiosk, local level market informant are of innovative interventions for dealing with uncertainty and unpredictability character of coastal agro-ecosystem. The objective of the study were (i) To elucidate the evolving nature of ecological and meteorological risks and hazards in coastal lines, (ii) To highlight the aspects of vulnerability and shocks in terms of climate change , mangrove depletion , biodiversity erosion , livelihood and in migration as well as outmigration, (iii) to illustrate DSS as tools and strategy for clandestine monitoring of coastal ecosystem and (iv) to elucidate different DSS tools as applicable to micro sociological holons in coastal agro-ecosystems.

MATERIALS AND METHODS

The concept of Decision Support System (DSS) involves sensitizing stakeholders to its role in enhancing decision-making through data-driven insights and analytical tools. The methodology of DSS includes data collection, processing, modeling, and result interpretation to facilitate informed decisions. Identifying suitable application areas is crucial, ranging from agriculture to environmental management, ensuring sector-specific benefits. However, DSS faces challenges such as data availability, integration complexity, user adaptability, and technological constraints. In agriculture and allied sectors, DSS has been increasingly applied for precision farming, resource management, and climate adaptation. Particularly in coastal agro-ecosystems, DSS plays a vital role in addressing salinity intrusion, water resource management, and sustainable land-use planning, thereby supporting resilience and productivity in these vulnerable regions.

RESULTS AND DISCUSSION

The Cropping System Model (CSM) released with DSSAT Version 4 represents a major departure from previously released crop models in DSSAT, not in function, but in design. The computer source code for the model was restructured into a modular format in which components separate along lines of scientific discipline and are structured to allow easy replacement or addition of modules. CSM

now incorporates all crops as modules using a single soil module and a single weather module. The new cropping system model now contains models of 17 crops derived from the old DSSAT CROPGRO and CERES models. The major modules are: i) land module, ii) management module, iii) soil module -a soil water balance sub-module and two soil nitrogen / organic matter modules, iv) weather module - reads or generates daily weather data, v) soil-plant-atmosphere module - deals with competition for light and water among the soil, plants, and atmosphere, vi) CROPGRO plant growth module: a. grain legumes - soybean, peanut, dry bean, chickpea, cowpea, velvet bean, and faba bean, b. vegetables - pepper, cabbage, tomato, c. grasses - bahia, brachiaria.

If one wants to apply this DSS in the situations of coastal eco-system, first, the marine, wetland, estuarine, and coastal systems are to be studied (Sorensen and McCreary 1990; Clark 1992). Coastal ecosystems are characterized by some vulnerable ecosystems like mangroves, sea grass beds, and coral reefs, human system interacts with the ecosystems by the means of fishing, tourism, recreation, residential, or industrial activities. As a result of these activities, decision makers have to face the issues of rapid population growth, increasing pressure on tourism, depletion of the fish stocks because of overexploitation, and fragile personnel and financial capacity to manage natural resources (Wilkinson 1993; IUCN 1993; Bryant et al. 1998; Cicin-Sain and Knecht 1998). Hence, for effective decision-making for the coastal agro-ecosystem multiple decision-makers from different disciplines must be involved to understand and cope with the complexity arisen from the issues (Sorensen and McCreary 1990; Bijlsma et al. 1993; Bower et al. 1994; Cicin-Sain and Knecht 1998). Besides, in a decision-making environment, decision makers ought to make their view broaden and add the impacts of the decisions made, on other stakeholder groups and socio-economic sectors. And DSS are developed with the belief that they are capable to improve inter-relationships between ecological and socio-economic factors (Grêt-Regamey A, Sirén E, Brunner S H,2017); Fabbri 1998).

REFERENCES

Bijlsma L, Crawford M, Ehler C et al (1993) World coast conference report. World coast conference, Ministry of Transport, Public Works and Water Management, Noordwijk, the Netherlands and National Institute for Coastal and Marine Management, Coastal Zone Management Centre, 1993, p 115

Bower B T, Ehler CN, Basta D J (1994) A framework for planning for integrated coastal zone management. National Oceanographic and Atmospheric Administration (NOAA), Washington DC

Bryant D, Burke L, McManus J et al (1998). Reefs at risk. a map-based indicator of threats to the world's coral reefs. World Resources Institute, Washington

Cicin-Sain B, Knetch R W (1998) Integrated coastal and ocean management: concepts and practices. Island Press, Washington DC and Covelo CA

Clark J R (1992) Integrated management of coastal zones. Technical report 327. FAO, Rome, Italy

Grêt-Regamey A, Sirén E, Brunner S H (2017) Review of decision support tools to operationalize the ecosystem services concept. Ecosyst Serv 26:306-315. doi:10.1016/j.ecoser.2016.10.012

IUCN (1993) Reefs at Risk. IUCN Marine Coastal Areas Programme

Sorensen J C, McCreary S T (1990) Institutional arrangements for managing coastal resources and environments. National Parks Service, US Department of Interior, Washington DC

Wilkinson C R (1993) Coral reefs of the world are facing widespread devastation: can we prevent this through sustainable management practices. In Richmond RH (ed) Proceedings of the 7th international coral reef symposium, vol. 1., University of Guam Press, UOG Station, Guam, p 11-21

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Comparing the impact of in-person and virtual agro-advisory services on farmer adoption rates-a case study on rice crop manager (RCM) in Odisha

P. BHARTI* and S. GAKHAR
International Rice Research Institute
E-mail: p.bharti@irri.org

Key Words: *Adoption, Digital Agriculture, Digital Extension*

INTRODUCTION

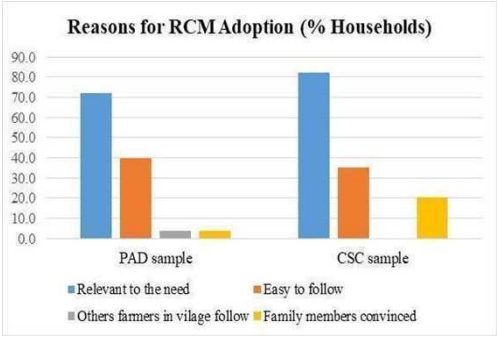
Rice is the staple crop in Odisha covering 38.59 lakh ha area annually; of that, 35.85 lakh ha are cultivated during Kharif season and 2.74 lakh ha during Rabi season (Odisha Agriculture Statistics 2018-19, DA&FE, Odisha). This amounts to 69% of the cultivated area in the state with around 70% of the population dependent on it for livelihood. However, the productivity of rice is not at par with the national average which is 2.7 t/ha compared to 1.7 t/ha of Odisha. Nutrient management plays an important role in increasing the rice yield (Sapkota, T.B., Jat, M.L., Rana, D.S. et al 2021) but farmers generally follow a blanket approach which does not contribute to potential yield gain. International Rice Research Institute (IRRI) in 2013 developed a digital tool called Rice Crop Manager (RCM) based on Site-Specific Nutrient Management (SSNM) principles to provide plot-specific advisory to farmers. SSNM has proven to increase the farmers income compared to the farmers' traditional practice of blanket fertilizer application (Sharma et al, 2019). To scale this tool, two different dissemination modes were tested: in-person dissemination using face-to-face interview and virtual using telephonic advisory. The study was done to compare if adoption of advisories by farmers varies depending on the modes of dissemination.

MATERIALS AND METHODS

RCM tool has a set of questions on rice crop management which are asked to a particular farmer for his specific rice plot. Based on his/her responses, on submitting the questionnaire, a recommendation is generated for the rice plot with the details on the timing, amount and type of fertilizer to be applied. Advisory on nursery and weed management is also included in the recommendation page. The advisories were disseminated to farmers using two modes. One was done through Common Service Centers (CSCs) CSCs are established all over India under the National e-governance plan to provide Government-to-Citizen (G2C) e-services to the citizens. The CSC is a physical ICT service delivery infrastructure run by Village Level Entrepreneur (VLE). The VLEs were trained by IRRI to provide RCM recommendations to the farmers visiting CSCs. VLEs conducted interview of the farmers using RCM, provided a printed copy of the RCM recommendations after the interview and advised farmers to use the recommendation in the coming season to manage their rice crop. Another mode was through PAD which is a non-profit organization focused on providing agro-advisories to the farmers. Under this project, staff of PAD were trained to use RCM. Using this tool, staff members conducted telephonic interviews with farmers, gathering information through the RCM questionnaire. The collected data was used to generate recommendations, which were subsequently transformed into personalized voice advisories. These advisories were delivered to the farmers via mobile phone, ensuring they received timely guidance ahead of the recommended fertilizer application dates. All 30 districts were selected for the study. 325 farmers were selected randomly for the study. A semi-structured questionnaire with both open-ended and closed-ended questions was used to interview farmers who had received RCM recommendations from either CSC or PAD.

RESULTS AND DISCUSSION

The findings of the study suggest that the mode of dissemination was not found to affect the adoption of technologies by the farmers as the percentage of farmers who followed the advisories from both the groups were similar. Majority of the farmers belonged to the middle age group indicating less involvement of younger and elderly aged farmers in receiving agro-advisories. Majority of the farmers (80%) were from marginal and small farmers' category. 64 % of adopters on an average reported an increase in yield after following RCM recommendation. 80% of the farmers were willing to pay for RCM recommendations. Two of the major reasons selected by the farmers for following RCM adoption was they found it relevant to their need and easy to follow the advisories (Fig. 1).



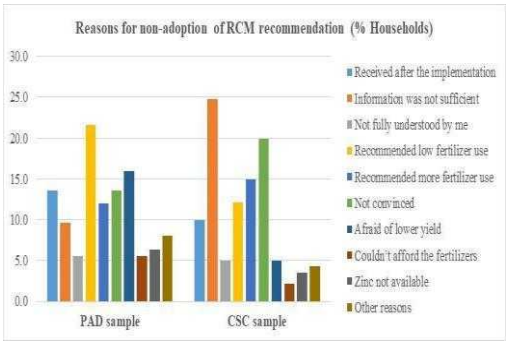


Fig. 1 *Reasons for RCM adoption* ***Fig.2*** *Reasons for RCM non-adoption*

The following are the top five reasons for the non-adoption of the RCM recommendation by the PAD sample: (i) The recommended fertilizer doses by RCM are lower compared to the farmer's dose (21.6%), (ii) farmers are afraid of getting lower yield (16.0%), (iii) the recommendation was received late (13.6%), (iv) farmers are not convinced about the recommendation (13.6%), and (v) RCM recommended fertilizer dose is more compared to the farmers' doses (12.0%).

The respondents in the CSC sample stated the following reasons for non-adoption: (i) The RCM information provided is insufficient (24.8%), (ii) farmers are not convinced about the recommendation (19.9%), (iii) RCM recommended fertilizer doses are more compared to farmers' doses (14.9%), (iv) the RCM recommended fertilizer doses are less compared to farmers' doses (12.1%), and (v) the recommendation was received late (9.9%). (Fig.2)

CONCLUSIONS

This study analysed the various factors which affect the adoption decision of a new technology by the farmers following its introduction (RCM) for one season. The findings suggest that mode of dissemination of information whether face-to-face or telephonic did not affect the adoption decision. The adoption was more associated with willingness to try new technology in anticipation of increase in production. Farmers are willing to change their traditional practices more when shown evidence in form of demonstrations and if the given advisories come from trusted sources like the government officials.

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REFERENCES

Sapkota, T.B., Jat, M.L., Rana, D.S. et al. Crop nutrient management using Nutrient Expert improves yield, increases farmers' income and reduces greenhouse gas emissions. *Sci Rep* 11, 1564 (2021).

Sheetal Sharma, K.K. Rout, C.M. Khanda, Rahul Tripathi, Mohammad Shahid, Amarash Nayak, Swetapadma Satpathy, Narayan Chandra Banik, Wasim Iftikar, Nabakishore Parida, Vivek Kumar, Amit Mishra, Rowena L. Castillo, Theresa Velasco, Roland J. Buresh,
Field-specific nutrient management using Rice Crop Manager decision support tool in Odisha, India, Field Crops Research, Volume 241, 2019, 107578, ISSN 0378-4290,

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Women in small-scale fisheries in the coastal Sundarbans: Navigating challenges and advancing sustainability

A. ROY* and B.K. DAS

ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata-700120, West Bengal

E-mail: aparnaroycifri@gmail.com

INTRODUCTION

The Sundarbans are the world's largest mangrove ecosystem and are rich in biodiversity. Small-scale fisheries support the livelihoods of millions in Indian Sundarbans. Women play a crucial yet often unrecognized role in these fisheries, engaging in various activities such as fish drying, net mending, fish harvesting and shrimp seed collection etc. Despite their contributions, women face numerous socio-economic and environmental challenges that hinder their participation and well-being in the sector. Addressing these challenges through strategic interventions can lead to a more sustainable and inclusive fisheries system in the coastal Sundarbans. Women in the Sundarbans are involved in multiple aspects of small-scale fisheries, from pre-harvest to post-harvest activities. They engage in fish harvesting, seed

collection, fish sorting, processing, and marketing while also participating in aquaculture, particularly in prawn and crab farming. Many women work as informal laborers in seafood processing industries, ensuring a steady supply of fish and shellfish to local and national markets. Their efforts contribute significantly to household incomes and food security, yet their roles remain largely unacknowledged in policy frameworks. Keeping this in view, a study was conducted to identify the present status of women in small-scale fisheries and also to pave a pathway towards sustainability.

MATERIAL AND METHODS

The study was conducted in the coastal regions of the Sundarbans. The data collection was focused on key fishing villages where women play an active role in fisheries-related activities, including catching, processing, and selling fish and other aquatic products. A mixed-methods approach was employed, incorporating both qualitative and quantitative data collection techniques. Structured questionnaires were administered to 600 women engaged in small-scale fisheries to assess their socioeconomic conditions, fishing practices, challenges, and adaptation strategies. In-depth interviews with 30 key informants, including fisherwomen, community leaders, policymakers, and fisheries experts, were conducted to gain insights into gender dynamics and sustainability. Five FGDs were organized with women's fishing cooperatives and self-help groups to understand collective strategies for resilience and sustainability. Survey responses were analyzed using descriptive statistics (mean, percentage, standard deviation) and inferential statistics (chi-square tests) to identify patterns and correlations.

RESULT AND DISCUSSION

It was fund that, In the five islands of Sundarbans, the gender ratio was 965 females per 1000 males. Most (68%) of the fisher community belonged to Scheduled Caste. women in small-scale fisheries often work in informal and low-paying jobs without financial security. Limited access to credit, lack of ownership of fishing assets, and gender-based wage gaps (Roy et al.,2017) further marginalize their economic prospects. The physically demanding nature of fishery-related activities exposes women to significant health hazards (Roy et al,2023). Prolonged exposure to water while collecting shrimp seeds leads to skin infections, while unsafe working conditions in processing units contribute to respiratory and musculoskeletal issues. Rising sea levels, cyclones, and increasing salinity levels due to climate change threaten the livelihoods of coastal fishers. Women, who are already economically vulnerable, bear the brunt of these environmental changes, often facing displacement and loss of income. Traditional gender norms restrict women's access to education, training, and leadership opportunities in the fisheries sector. Male-dominated fishery cooperatives and decision-making bodies often exclude women, limiting their ability to advocate for better working conditions and policies.

A sustainable and equitable fisheries sector in the coastal Sundarbans requires a multi-stakeholder approach that integrates gender-sensitive policies, financial inclusion, and environmental conservation. Recognizing and addressing the unique challenges faced by women in small-scale fisheries will not only improve their socio-economic status but also contribute to the overall sustainability of the region's fisheries

CONCLUSION

Women are indispensable to small-scale fisheries in the coastal Sundarbans, yet they continue to face structural and socio-economic barriers. By implementing targeted strategies that enhance financial empowerment, capacity building, and climate resilience, stakeholders can create a more inclusive and sustainable fisheries sector. A gender-responsive approach will ensure that women's contributions are acknowledged and that they can thrive as key players in the fisheries economy, leading to long-term socio-economic and environmental benefits.

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REFERENCE

Roy, A., Manna, R. K., Ghosh, S., Sahu, S. K., & Das, B. K. (2023). Assessment of women's contribution in small-scale fisheries in Indian Sundarbans: Issues, strategies, and way forward for sustainability. *Fisheries Management and Ecology*, 30(4), 378-391

Roy, A., Sharma, A. P., Bhaumik, U., Pandit, A., Singh, S. R., Saha, S., & Mitra, A. (2017). Socio-economic features of womenfolk of Indian Sunderbans involved in fish drying. *Indian Journal of Extension Education*, 53(2), 142-146.

Oral V1T6D2

Economic potential for women entrepreneurs in fish processing and value addition in the Indian Sundarbans

S. GHOSH*, A. PULAPPARAMBIL and R. PATTANAYAK
Sasya Shyamala Krishi Vigyan Kendra, RKMVERI, Kolkata – 700150, West Bengal, India
E-mail: swagotor@gmail.com

Key Words: *Economic Opportunities, Fish Processing, Sundarbans, Value Addition, Women Entrepreneurs*

INTRODUCTION

Aquaculture is a vital component of West Bengal's economy, particularly within wetland ecosystems like the Sundarbans and the East Kolkata Wetlands (Ghosh et al., 2024; Ghosh & Goswami, 2022). These regions support fisheries and allied industries, yet the potential for value-added fish products remains underutilized. The Sundarbans known for its rich aquatic biodiversity, offers significant opportunities for women entrepreneurs in fish processing and value addition (Roy et al., 2017). However, several challenges hinder their participation, including inadequate training, financial constraints, and limited market access. Overcoming these barriers through targeted skill development, improved infrastructure, and financial inclusion can enhance women's economic empowerment while promoting sustainable aquaculture practices. By integrating women into the fish processing value chain, economic benefits can be maximized, contributing to livelihood security and biodiversity conservation. This study assesses the current status of women's involvement in fish processing and explores strategies to strengthen their role in the aquaculture sector, fostering long-term economic and environmental sustainability.

MATERIALS AND METHODS

The study covered four blocks Canning I, Canning II, Gosaba, and Basanti surveying 180 women from diverse socio-economic backgrounds. Ethical considerations included informed consent, confidentiality, and voluntary participation. The study highlights the socio-economic potential of women in fish processing, emphasizing the need for targeted interventions to enhance entrepreneurship, infrastructure, and market linkages. Farmers were interviewed on-site using a pre-tested, semi-structured interview schedule. These interviews were complemented by participatory appraisal techniques and a series of focus group discussions. Research suggests that combining small-scale surveys with diverse methodological tools provides cost-effective and comprehensive data on rural livelihoods. This study employed structured questionnaires, PRA techniques, ranking, semi-structured interviews, and document reviews (Ghosh et al., 2017). Quantitative data were analyzed using Microsoft Excel and SPSS, applying descriptive statistics and cross-tabulation to examine respondent distributions. Thematic analysis identified key barriers, such as technological gaps and financial constraints.

RESULTS AND DISCUSSION

The study revealed a strong interest among women in learning fish processing techniques, with 90% of respondents expressing a willingness to acquire new skills. Additionally, 80% were keen on adopting innovative value-addition methods, indicating a significant potential for entrepreneurship in fish processing. However, key barriers such as inadequate infrastructure (50%), limited training access (30%), lack of market linkages (9%), and financial constraints (6%) hindered their participation. Basanti had the highest proportion of graduates (30.3%) and higher secondary-educated individuals (34.3%), suggesting better access to educational resources. In contrast, Gosaba had the highest percentage (40%) of respondents with no formal education, highlighting the need for targeted training programs in this region. The 180 respondents comprised of housewives (30%), aquaculture workers (20%), self-employed individuals (24%), and small-scale fish sellers (26%), represent an untapped workforce that could benefit from training in hygienic fish drying, processing, smoking, salting, and fermentation. The study revealed a significant skill gap, with 90% of women lacking training in fish processing and value addition. However, 92.9% showed varying levels of interest in pursuing value-added production as a profession, indicating strong entrepreneurial potential. Enhancing economic sustainability through value addition such as packaging, branding, and preservation can improve product quality, expand markets, and generate new economic opportunities (Gonçalves & Kaiser, 2011). Thus, targeted interventions in skill development, infrastructure, and financial support are essential to unlocking the economic potential of women entrepreneurs in fish processing in the Sundarbans. Out of the 180 respondents, 50.3% of women fish farmers identified limited access to training as the primary challenge in adopting value addition as an aquaculture profession. Financial constraints were cited by 48% as a major barrier, while 47% pointed to inadequate infrastructure. Additionally, 46% of fish farmers highlighted a lack of market

linkages as a key challenge in adapting to climate change. Furthermore, 37% identified a lack of technology as a significant constraint, while 28% emphasized household responsibilities as a major obstacle for women entrepreneurs in fish processing and value addition in the Sundarbans (Fig.1). Empowering women through training, financial aid, cooperatives, and infrastructure can enhance fish processing and boost economic independence (Table 1).

Table 1: *Factors Helping Women Fish Farmers Take Up Value Addition as a Profession*

Factors	Mean Garret Score (%)	Rank
Technology Training	52.6875	1
Provides Market Linkages and Certification Assistance	50.5	2
Women Cooperatives	50	3
Government Subsidies	49.5	4
Input Distribution and Infrastructure Development	47.25	5

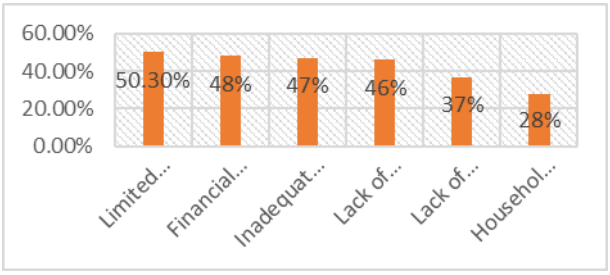

Fig. 1. *Major obstacle for women entrepreneurs in fish processing and value addition in the Sundarbans*

CONCLUSION

Empowering women fish farmers in the Sundarbans through skill development, financial support, infrastructure improvement, and market linkages can significantly enhance their participation in value-added fish processing. Establishing cooperatives and leveraging government schemes like PMMSY and NABARD can provide the necessary financial and structural support. By integrating digital marketing and modern processing techniques, women can achieve economic independence and sustainability.

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REFERENCES

Ghosh S, Goswami B. (2022). Present Status of Pond-Based Integrated Farming on Selected Blocks of South 24Parganas, India. *Int J Sci Res* (IJSR).;11(5):1288-1293.

Ghosh, S. Anju, P.; Pattanayak, R., and Sahu, N.C. (2024). Fisheries and aquaculture in wetland ecosystems: A reviewof benefits, risks, and future prospects in India. *Journal of Coastal Research*, 40(3), 598–612.

Ghosh, S., Manna, S., Sahu, N. C., Dutta, A., & Goswami, R. (2017). Social, economic, and production characteristics of freshwater prawn, *Macrobrachium rosenbergii* (De Man, 1879) culture in West Bengal, India. *Aquaculture International*, 25(1), 10.

Gonçalves AA, Kaiser C (2011) Value-added Products from Aquaculture: A Global Trend. World Aquaculture.;43(4):48-67

Roy, A., Sharma, A. P., Bhaumik, U., Pandit, A., Singh, S. R. K., Saha, S., & Mitra, A. (2017). Socio-economic features of womenfolk of Indian Sunderbans involved in fish drying. *Indian Journal of Extension Education*, 53(2), 142–146.

Oral V2T6D2

Factors affecting extent of market participation among smallholder farmers in the Indian Ganges delta

S. MALLICK[1]*, D. BURMAN[1], U. K. MANDAL[1], S. KUMAR[2], K. K. MAHANTA[1], T. D. LAMA[1], S. DIGAR[1], R. N. BHUTIA[1], S. DEVIKA[1], M. MONJARDINO[3], M. MAINUDDIN[4]
[1]ICAR-Central Soil Salinity Research Institute, RRS, Canning Town - 743 329, West Bengal, India
[2]ICAR-Central Soil Salinity Research Institute, Karnal-132001, Haryana, India
[3]CSIRO Agriculture and Food, Waite, Adelaide, SA - 5064, Australia
[4]CSIRO Environment, Canberra, ACT - 2601, Australia
E-mail: sonalimallickiari@gmail.com

***Key Words**: Crop Diversification, Market Participation, Smallholder Farmers, Salinity, Simpson Index*

INTRODUCTION

Market participation plays a pivotal role in enhancing the livelihoods of rural households. Many smallholder farmers face challenges in marketing their produce (Mandal, 2019). While existing studies have addressed factors influencing the extent of sale (Omiti et al., 2009), limited research explores how crop diversification impacts the extent of sale among smallholders. This study seeks to fill this gap by assessing the role of crop diversification in influencing market participation and sales among smallholder households in the Indian Ganges delta, aiming to provide insights for better policy formulation.

MATERIALS AND METHODS

The study used a sample size of 199 households (57 from Sonagaon, 41 from Chandipur, 101 from Bijaynagar). Further, the Simpson Crop Diversification Index (SI) was calculated to measure the diversity of crops grown using the formula:

$$SI = 1 - \sum_{i=1}^{n} P_i^2$$

where P_i represents the proportion of the total area dedicated to the i^{th} crop.

Additionally, the extent of sale was calculated for each household using the formula:

Extent of sale = (Marketed Surplus / Total produce) *100

which represents the percentage of total produce sold in the market. A truncated regression model was applied to analyze the factors influencing the extent of sale, accounting for censored data (households with zero sales).

RESULTS AND DISCUSSION

The mean Simpson Index for crop diversification was 0.382, indicating moderate crop diversification. On average, 63.18% of the produce was sold, suggesting a moderate level of market engagement among farmers. Local polynomial regression analysis showed that crop diversification decreased with landholding size, while the extent of sale increased with landholding size (Figure 1). This implies that smaller farmers may diversify crops for household consumption, limiting their marketed surplus. The truncated regression model revealed that operational landholding was the most significant factor influencing the extent of sale ($p < 0.001$). Larger landholdings enable farmers to produce more and sell a larger share of their output. Education also had a positive effect on market participation, as educated farmers were better equipped to access resources and markets. Additionally, the Simpson Index of crop diversification was positively and significantly associated with the extent of sale ($p = 0.004$), suggesting that diversified farms are more likely to sell higher proportions of their produce. Conversely, the distance to markets negatively affected the extent of sale ($p = 0.019$), as farmers farther from markets faced greater logistical challenges. Non-farm income was found to negatively influence market sales ($p = 0.015$), with farmers relying more on non-farm income being less inclined to sell agricultural produce

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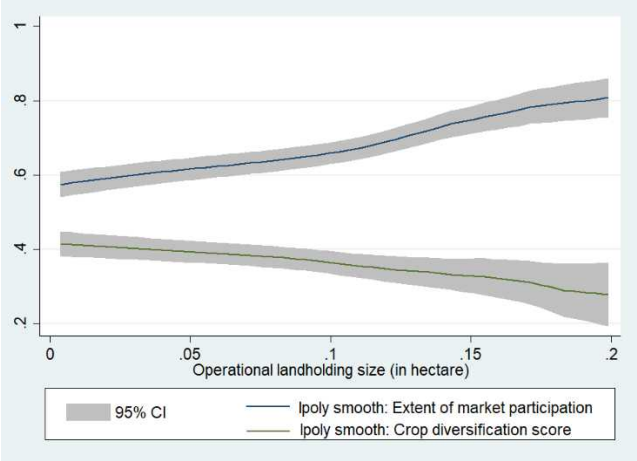

Fig. 1*. Local polynomial regression showing relation between Operation landholding sizes vs Extent of market participation and Operation landholding sizes vs Crop diversification (Source: Authors' Calculation)*

CONCLUSIONS

Crop diversification, larger landholdings, and education positively influence market participation among smallholders in the Indian Ganges delta. To boost agricultural sales, policies should focus on promoting diversification, improving market access, and addressing logistical barriers.

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REFERENCES

Mandal, S. (2019). Risks and profitability challenges of agriculture in Indian Ganges delta, India. In: Sen, H. (eds) The Indian Ganges delta: A Disaster-Prone Eco-Region. Coastal Research Library, vol 30. Springer, Cham. https://doi.org/10.1007/978-3-030-00680-8_12

Omiti, J. M., Otieno, D. J., Nyanamba, T. O., & McCullough, E. B. (2009). Factors influencing the intensity of market participation by smallholder farmers: A case study of rural and peri-urban areas of Kenya. African Journal of Agricultural and *Resource Economics*, 3(1), 57-82.

Oral V3T6D2

Value chain in jute in technological and economic empowerment of farm families

S. ABOO, S.K JHA, S.P MAZUMDAR, R.K NAIK, N.M ALAM and G.KAR
ICAR-Central Research Institute for Jute and Allied Fibres, Kolkata 700121, West Bengal, India
E-mail: shamnaicar@gmail.com

Key Words*: Value Chain, Empowerment, Farmers Interest Groups, Self Help Groups, Livelihood*

INTRODUCTION

Value chains are interactive systems, with products, money and information flowing through them, all reliant on relationships (Fearne and Hughes, 1999). For sustaining jute cultivation and making it more profitable for farmers, Jute value chain can play an important role. Various ways are to be thought for bringing a part of economic rent from the jute value chain to farm house holds so that farmers receive an increased income from jute. Diversified jute products produced by small and micro enterprises and rural area women are getting wider acceptance in the national and international market. Banik and Shil (2014) stated that commercialisation of these diversified jute products is expected to open up new possibilities of reviving jute economy and helps to improve the economic conditions of the farmers including women worker. More than seventy percent of total jute production in India is from West Bengal state where 96 per cent of farmers belong to small and marginal farmers' category. If these farmers can be organised to producer groups, profitability from jute cultivation can be enhanced to some extent by involving the groups in jute value chain. Under the DST Sponsored project on technological and economic empowerment of farm families through jute cultivation, value addition and value chain

management, a value chain in jute was formed where ICAR-CRIJAF, farmers, FPO, SHGs were the integral part of the chain with an objective to analyse the performance of the value chain and farmers perception towards it.

MATERIALS AND METHODS

Both experimental and expost facto research method was used**.** The project was implemented in Barracpore -1 and Amdanga blocks of North 24 parganas. A model value chain was developed for jute fibre and diversified products. All the farmers from the project area were grouped into different FIGs under the Sabka Apna Farmers Producer Company Limited. Farm women were also trained in value addition of jute and grouped in to different women SHGs. The highlight of this model is the involvement of women SHGs in value addition and establishment of value chain through FPO that would help the farm house holds to bring home a greater percentage of profit from agriculture. After implementing the model by linking various actors in the value chain, data was collected from the participants (n=140) using a structured interview schedule and focussed group discussion. The data was analysed using SPSS.

RESULTS AND DISCUSSION

This paper is specifically on the perception of farmers on the role of value chain in technological and economic empowerment in the project area. The farmers reported that the value chain model in jute was very helpful for small holder farmers (98%), FIGs formed under FPO had helped to act collectively (94%) and SHGs formed and trained under FPO helped to augment the farm income (78%). With respect to use of inputs, the farmers have reported that the model helped them to reduce cost of inputs, could get inputs timely, common resource use helped to cut down the cost of production. Linkages with government departments have helped the farmers to get crop related credible information, trainings to improve knowledge, early adoption of technologies and development of self confidence in farming. With respect to market access, majority of the farmers reported that the Value Chain Model in jute helped to have better access to market. FIGs formed and trained under FPO by ICAR-CRIJAF had helped them to have better understanding of fibre grades. In terms of livelihood assets, the value chain contributed to enhance their human capital in terms of skill, knowledge, good health and reduction in drudgery, social capital in terms of social network and trusting relationships between fellow farmers and other stake holders and finally financial capital in terms of credit access, financial gain through improved production and reduced cost of cultivation in jute. Value chain in jute had helped the jute growers to obtain all jute related information and support under one umbrella of FIGs under the FPO. The women SHGs involved in the value chain had kick started their jute micro enterprise and this had helped them to obtain an additional income to their households. The growth of Jute diversified Products will induce the farmers for producing better quality fiber and it will lead towards better income(Jyoti and Anjan 2021).

CONCLUSION

In order to meet the increasing demand of market, jute production and profitability for the farmers is to be increased and for this value chain development in jute and jute diversified products can play a key role. Involvement of farmers and farm women in the value chain in jute and jute diversified products can bring a huge transformation in the aspects like poverty reduction, economic empowerment, gender equality and standard of living in the rural areas of India.

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REFERENCES

Banik, S. & Shill, P. (2014) Indian Jute diversified products in the export market 2000-01 to 2012-13. *International Journal of Economic and Business Review*. 2(11).

Fearne A and Hughes D. (1999). Success factors in the fresh produce supply chain: insights from the UK. *Supply Chain Management*. 4 (3), 120-131.

Jyoti,K.B and Anjan, B. (2021). Feasibility of Diversification Strategy for Sustainable Jute Cultivation: A Study in Assam . *Journal of Entrepreneurship & Innovation*.**7**(2):13-25

Poster T6P1

Sustainable intensification in rice-potato systems can improve the food security of women farmers and reduce their dependence on remittance: a case study in Indian Sundarbans

K. ROY[1*], R. ROY[1], P. SEN[1], K. MALLICK[1], S. SARKAR[1], K. RAY[2], S. MISRA[1], R. GOSWAMI[1], M. MONJARDINO[4] and M. MAINUDDIN[5]

[1] School of Agriculture and Rural Development, Ramakrishna Mission Vivekananda Educational and Research Institute, Kolkata 700103, West Bengal, India

[2] Sasya Shyamala Krishi Vigyan Kendra, Ramakrishna Mission Vivekananda Educational and Research Institute, Kolkata 700103, West Bengal, India

[4] CSIRO Agriculture and Food, 4 Waite Rd, Urrbrae, South Australia 5064

[5] CSIRO Land and Water, Black Mountain Laboratories, GPO Box 1700, Canberra ACT 2601, Australia

E-mail: kalyan.roy003@gmail.com

Key Words: *Dietary Energy, Food Security, Indian Sundarbans, Sustainable Intensification, Women Farmers*

INTRODUCTION

Smallholder farmers in climatically challenged low and middle-income countries are at risk of food insecurity due to constrained resource endowment, uncertain crop productivity and farm income, and inadequate support of public food distribution programmes. These factors, coupled with population growth, climate change, and political instability can lead to food insecurity for marginal farmers. Women in these family farms invest substantial time and effort into producing, collecting and processing food since their male counterparts often migrate to non-farm sectors (Caroli et al., 2022). However, in many cultures intra-household food distribution discriminates against women, making them prone to dietary energy deficit (Agarwal, 2018). We examined the food security of women rice growers, as an outcome of a sustainable intensification project, in a climatically challenged fragile agri-food system in the Indian Sundarbans.

MATERIALS AND METHODS -

We took the case of a donor aided project aimed to sustainably intensify the cropping systems of coastal saline regions of India and Bangladesh. The study area encompasses two islands, Gosaba and Satjelia from Gosaba block, South 24 Parganas district. The project promoted medium-duration Salinity-resistant Paddy Varieties (SPV) followed by Zero Tillage Potato (ZTP) under straw-mulch conditions to utilize residual soil moisture. By using a farm typology approach based on resource endowments, we selected representative women farmers from each of the six farm types, ranging from landless to resourceful. A brief survey recorded the farms' rice yields before and after project interventions, their daily rice consumption, ZTP yields and their expansion potential, and the amount of government food assistance (rice) received by the farm families. We considered the ideal per capita per day cereal requirement as per the Government recommendation (food security threshold) (National Institute of Nutrition, 2011) and compared them with the baseline rice production and public food assistance initiatives. Also, we compared the cash income from surplus SPV (above the threshold) and ZTP with the remittances received from a migrated family member(s).

RESULTS AND DISCUSSION –

The farm typology approach for categorizing heterogenous farms in study area based on resource endowments, is based on five key farm parameters, i.e. land ownership, irrigation coverage, livestock diversity, cropping systems and farm-off farm income ratio. All these parameters have different values and range, based on which the farm types have been proven significantly different from one another. Farm type 1 and 5 represents farms who do not possess any ruminants, have very less irrigated area, with only difference being FT-1 cultivating SPV-ZTP system on the field, while FT-5 cultivating only SPV in their field. Farm type-2, 3 and 4 represents the ones who own ruminants and cultivating multiple crops along SPV-ZTP system, with FT-3 and 4 have nearly equal share of farm and off farm income in household, but FT-3 irrigating substantially lesser land (<33% of gross cropped area) than FT-4. FT-2 heavily relies on off farm income as its primary livelihood, while irrigating small proportion of land (<33% of gross cropped area). Farm type 6 denotes the landless farmers. Figure 1 exhibits that 50% of women farmers, including most resource constrained (FT – 5) households have overcome food insecurity through paddy production only irrespective of government assistances, due to project interventions. Noticeably, none of the interviewed household members, including women,

consumed the recommended amount of cereal per day to secure the calorie need of an active rural person. This inadequate cereal consumption might be due to changing food preferences, increased production and affordability of milk, meat and fruit-based food items, thus increasing dietary diversity. However, the insufficiency might negatively influence pricing supports for such crops and affect health factors such as micronutrient intake (Kapoor et al., 2024).

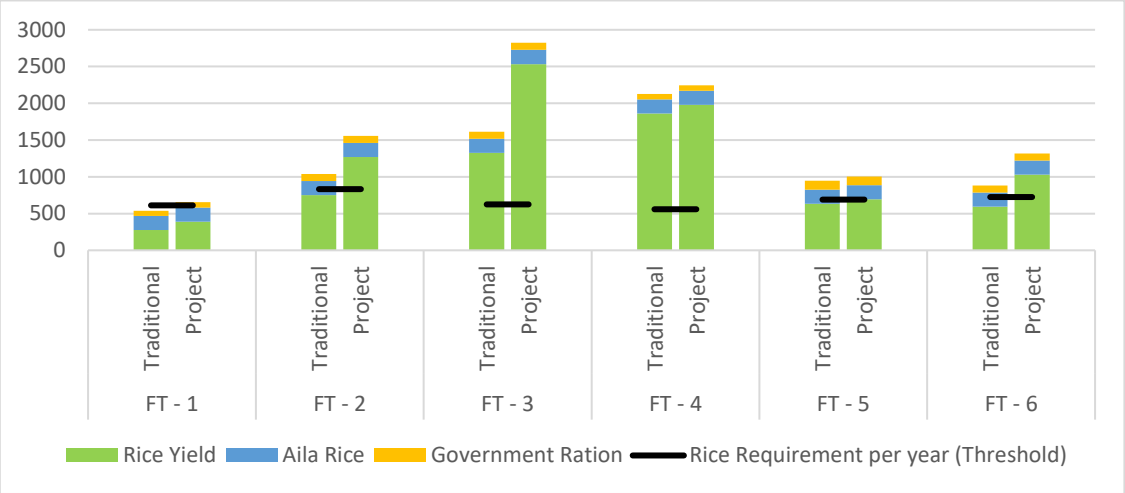

Fig 1: *Improvement in Food Security due to SPV Introduction in different farm types*

Table 1 shows the additional cash flow generated from the scenario where surplus rice (difference between the marketable surplus of traditional and SPV after meeting the recommended dietary requirements) was sold at Minimum Support Price (MSP), and ZTP were to be expanded by an average of 300%, would be enough to reduce the dependency on remittances at least by 15-30%. This additional farm income, along with the remittances, might be utilized to build household assets and community resources and economic wellbeing, leading to a resilient community in the climate sensitive area (Jha et al., 2018).

Table 1: *Changes in Remittances of families due to surplus income from SPV and ZTP*

Farm Types*	Increase Income from Paddy (Assuming MSP Rs. 20.6/kg)	Potato (Selling Price - Rs. 14/kg)	Total increased income (INR)	Total Remittance (INR)	Reduced share of Remittance (%)
FT – 4	3708	8400	12108	84000	14.41
FT – 5	1854	5460	7314	30000	24.38
FT – 2	16068	8820	24888	144000	17.28
FT – 6	13596	4200	17796	60000	29.66

* Only for farm types who have migrants in their household

CONCLUSION

The farm typology approach in the study highlights the diverse resource endowments and livelihood strategies among farm households, with significant implications for food security and income stability. While project interventions have improved paddy production, dietary insufficiencies remain a concern. The SPV-ZTP systems with extended acreage and appropriate pricing might therefore create a sustainable, equitable and resilient food system in climatically challenged ecosystems, reducing needs to migrate. With women managing both household and agricultural responsibilities in these regions, ensuring adequate food along with additional farm income will generate gender sensitive benefits, leading to a better and just society.

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REFERENCES:

Caroli, G., Tavenner, K., Huyer, S., Sarzana, C., Belli, A., Elias, M., Pacillo, G., Läderach, P. (2022). The Gender-Climate-Security Nexus: Conceptual Framework, CGIAR Portfolio Review, and Recommendations towards an Agenda for One CGIAR. Position Paper No. 2022/1. CGIAR FOCUS Climate Security.

National Institute of Nutrition. (2011). Dietary Guidelines for Indians – A Manual.

Kapoor, M., Ravi, S., Rajan, S., Dhamija, G., Sareen, N. (2024, September). Changes in India's Food Consumption and Policy Implications: A Comprehensive Analysis of Household Consumption Expenditure Survey 2022-23 and 2011-12. (EAC-PM Working Paper No. - EAC-PM/WP/30/2024).https://eacpm.gov.in/wp-content/uploads/2024/09/Comprehensive-Nutrition-Report-Final-1.pdf

Agarwal, B. (2018). Gender equality, food security and the sustainable development goals. *Current Opinion in Environmental Sustainability*, 34, 26-32.

Jha, C. K., Gupta, V., Chattopadhyay, U., & Amarayil Sreeraman, B. (2018). Migration as adaptation strategy to cope with climate change: A study of farmers' migration in rural India. *International Journal of Climate Change Strategies and Management,* 10(1), 121-141.

Poster T6P2

JuteClimet and Climate Expert on Jute - ICT based decision support system for weather-based agroadvisory on jute production

D. BARMAN, R. SAHA, D. BANIK and G.KAR

ICAR-Central Research Institute for Jute & Allied Fibres, Barrackpore, Kollkata-700121

E-mail: dbarman.icar@gmail.com

Key Words: *Decision-Making Process, Decision Support Systems, Expert Systems, Jute*

INTRODUCTION

Jute, the most important 'cash crop' of the eastern India plays an important role in carbon sequestration by removing carbon from the atmosphere as well as by longer residency in the ecosystem as fibre products (Barman et al., 2022) and is mostly climate dependent and its success therefore is governed by availability of real-time correct information about the climate in hand of the farming community. Many researchers have developed information and communication technology (ICT)-based tools for agro-advisory services (Singh & Gupta, 2016; Marwaha S., 2012; Bachu et al. 2006; Krishna Reddy and Ankaiah, 2005) for various crops but such ICT-based tools are very limited for jute crop. Therefore, for addressing jute production related issues a web-based dashboard, Climate Expert on Jute and an android mobile app, JuteClimet have been designed using ICT for farmers and other stakeholders. This expert mobile app will allow the farmers to get updated information and weather-based agro-advisories for improved and sustainable jute production.

MATERIALS AND METHODS

The mobile app will be linked with web-dashboard, Climate Expert on Jute, which is designed using PHP and MySQL for database management. The database will be used to store knowledge for the solution of questions asked by the user (farmer) through IF-THEN-ELSE condition. Thus, an interaction between user and Expert System will be made based on GUI (Graphical User Interface). The dashboard contains different modules which deal with the information related to jute cultivation. The android mobile app, JuteClimet is designed as a farmers' friendly ICT tool for addressing their site-specific need. It is based on a set of rules and logic.

RESULTS AND DISCUSSION

A series of modules has been developed that compile essential information on jute production such as brief history about origin of jute and its suitable climatic requirement, agro-climatic zones and agronomy, jute production vulnerability zones and climate solutions. The climate solutions module addresses various management aspects of jute production. It includes selecting the appropriate jute variety, managing irrigation effectively, controlling weeds, managing pests and diseases, employing mechanization, optimizing retting techniques, and implementing suitable jute-based cropping systems (Fig.1). The logical frameworks have been developed for applying irrigations, weedicides, and pesticides (disease and insect-pests) for jute cultivation, which will act as an expert system. For example, if a farmer wants to choose a suitable variety for a specific land, first the farmer needs to select the land condition whether it is upland or low land, then need to select drainage condition of the land whether the drainage is good or bad, then type of jute whether it is *C. olitorius* (tossa/mitha pat) or *C. capsularis* (desi/tita pat) and finally, the promising variety of the location. The irrigation management module provides a structured irrigation strategy based on plant growth stages, recent rainfall occurrences, and soil conditions. In the early stage (0-60 days), if no rainfall has occurred, 5-6 irrigations of 373 mm water should be applied at 7–10-day intervals. If soil balls form properly, no further irrigation is needed, whereas soil ball formation with cracks requires 2-3 irrigations of 220-225 mm water at 30-day intervals, starting from 15 days after sowing. If no soil balls form, 4-5 irrigations of 315mm water should be applied at 15–20-day intervals. In the later stage (60-120 days), if rainfall has occurred, no irrigation is

required, but if there is no rainfall, 1-2 irrigations of 100-150 mm water should be applied at 20–30-day intervals (Fig. 3). The framework behind the weed management module for identifying the type of weedicide or herbicide, first the farmer has to select the timing of weed management whether it is before or after sowing, next step would be to select the type of weed whether the weed is broadleaved, sedges or grassy and finally the output will be given by the app (Fig. 4).

Fig.1. *Design of web-dash board on Climate Expert on Jute*

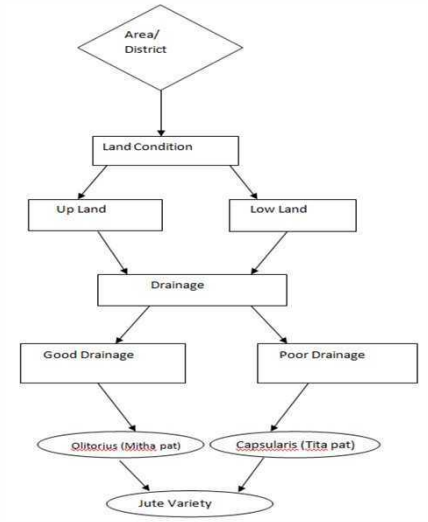

Fig.2. *Module to identify jute variety*

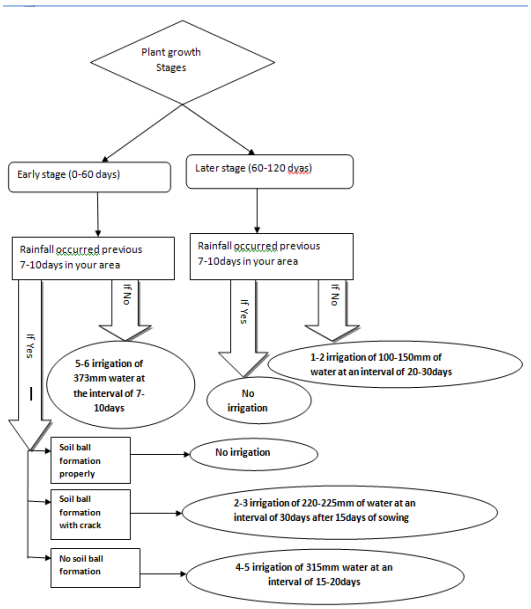

Fig.3. *Module for irrigation management*

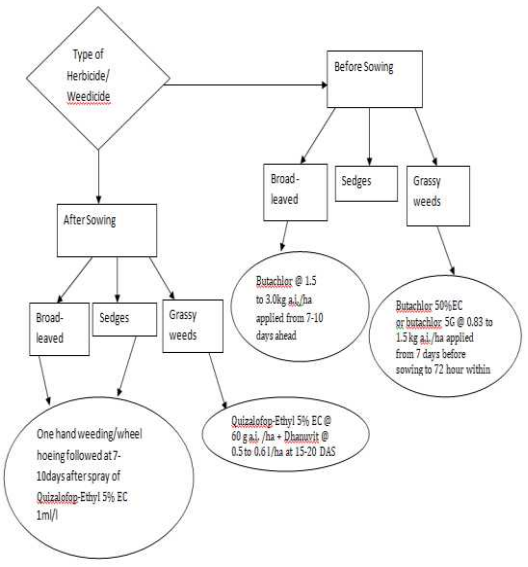

Fig.4. *Module for weed management*

CONCLUSIONS

"JuteClimet" and "Climate Expert on Jute" will serve as innovative ICT-based solutions to address the challenges posed by climate change in jute farming. By providing real-time climate information and expert guidance, these tools empower farmers with data-driven decision-making for better jute cultivation management. These digital interventions not only enhance farm productivity and sustainability but also bridge the gap between traditional farming practices and modern technological advancements, ultimately benefiting the jute farming community and stakeholders.

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REFERENCES

Bachu, V., Polepalli, K., & Reddy, G. S. (2006). eSagu: An IT based personalized agricultural extension system prototype-analysis of 51 farmers' case studies. *International Journal of Education and Development using ICT (IJEDICT)*, 2005, 2(1), 79-94.

Barman, D., Chakraborty, A., Das, P.K., Roy, S., Saha, R., Mazumdar, S.P., Bandyopadhyay, S., Singh, A.K., Mitra, S., Kundu, D.K. and Bagui, A. (2022). Net ecosystem CO_2 exchange from jute crop (*Corchorus olitorius* L.) and its environmental drivers in tropical Indo-Gangetic plain using open-path eddy covariance technique. *Environmental Monitoring and Assessment*, 194(4), pp. 251.

Krishna Reddy, P., and Ankaiah, R. (2005) "A framework if information technology-based agriculture information dissemination system to improve crop productivity". *Current Science*, Vol. 88, Issue 12, 1905-1913.

Marwaha S. (2012). AGRIDAKSH—A Tool for Developing Online Expert System. *Proceedings of 3rd National Conference on Agro-Informatics and Precision Agriculture* (AIPA), pp. 18-23.

Singh, N., & Gupta, N. (2016). ICT based decision support systems for Integrated Pest Management (IPM) in India: *A review*. *Agricultural reviews*. 37(4), 309-316.

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