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CASE STUDY

Challenges and Remedial Measure for Sustainable Crop Production in Jhargram Red-Latertic Belt of West Bengal-A Case Study

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ABSTRACT

Sustainable crop production is an integral part of food production system. Food and agriculture allied sector depend on the natural resources, so future food production will depend on how well these resources are conserved and used. Crop productivity is impacted by urban land expansion and by higher water demand from other sectors. Observation for last five year (2018 to 2023) in different block of Jhargram district revealed that, digitalisation holds considerable potential to transform the food, agriculture and soil productivity system. Mobile devices, proper data analytic, high quality satellite imagery in different pocket, precision equipment, and artificial intelligence – among others – could contribute greatly to increase productivity, sustainability and resilience across the district for higher crop output. Use of appropriate and new technological developments could make it possible for farmers to monitor their crops and livestock with greater precision, to fine-tune applications of inputs (such as fertilizers and feed supplements), and to use large amounts of data to determine optimal agriculture production choices. There is a growing urgency for governments to realign policies in light of the emerging challenges and opportunities. Changing policies for credit system, crop insurance scheme to food growers of Jhargram and adjoining tribal belt in agriculture is seldom easy, as potential impacts on rural livelihoods, income distribution, and competitiveness create significant uncertainties.

HIGHLIGHTS

- Proper and scientific techniques of crop cultivation under limited resources become very much challenging and this need to be addressed at individual block levels, keeping in mind farmer's limitations.
- High potential for an intensive rainfed farming system under the umbrella of modern tools (digitization) with time time-bound field extension service.

Keywords: Food production, challenges, red-lateritic belt, climate change, sustainability

Agriculture is the foundation of the civilization, culture and heritage of tribal and poorly developed rural India of Red-Latertic belt of West Bengal. Post-Independence, the Indian agriculture transformed from a food-scarce to food-exporting country primarily due to science led innovations that caused multifold increase in the agricultural production from 135 million tons in 1950/51 to over 1300 million tons in 2021/22 in spite of increasing abiotic and biotic stresses and depleting along with deteriorating natural resources (Pathak *et al.* 2022). However, this part of India, could not contribute

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significant amount in total food basket, this might be due to many production challenges that stop it from realizing its full potential, such as small operational landholdings, lack of irrigation, soil degradation, soil acidity, poor soil organic matter, secondary and micronutrient deficiencies, meagre utilization of ground water resources, soil and water pollution and poor technical support. Agriculture in this region, is a complex mosaic of distinct agro-ecosystem, differentiated by climatic, soil, vegetation and other natural features. Red and lateritic soils are the third-most important group of soils in the world, covering 13% of the land area. These soils cover large area of potentially arable and grazable lands and are abundant in the semi-arid to humid tropical climates (Ghosh, 2019). In Jhargram block of West Bengal (red-lateritic belt), stressed natural resources due to unfavourable weather, monsoon and natural calamities resulted in crop failures leading to food shortage that made serious impacts on the rural livelihood. Jhargram district is located in the south- western part of West Bengal between 21°52′ and 22°48′ North latitude and between 86°34′ and 87°20′ East longitude. The geographical area of the district is 3,02,439 ha. It is bounded by Bankura and Purulia districts in Northern side, Mayurbhanj district of Orissa in the Southern side and Singbhum district of Jharkhand in the western side. The weather is extremely humid and tropical. Temperature can reach as high as 46-48°C in the hot and dry months of May and June but can plummet to 7-10°C in the chilly chilly nights of December and January. The district comprises of one sub-Division, Jhargram consisting of 8 blocks. Most of these block has small operational landholdings limit the amount of land available for cultivation, which in turn limits the number of field and horticultural crops that can be produced. Limited land availability also affects crop rotation and the use of sustainable agricultural practices, as small farmers may not have the space to rotate crops effectively or implement sustainable soil management practices. This can lead to reduced yields and decreased soil fertility over time. Insufficient access to water for irrigation, coupled with poor soil management practices such as over-tilling, over-fertilising in patches, and monocropping, can reduce soil fertility, leading to lower yields and lower-quality produce. Lack of irrigation can be particularly detrimental during dry spells or droughts, where crops can quickly wither and die due to insufficient water supply. Pests and diseases were constant threat to crops as per our observation particularly in rice and pulses. Climate change, such as changing weather patterns, droughts, floods, and other natural disasters, is another significant challenge that can lead to crop failures and losses, which ultimately affects the sector's overall output. Land lease constraints also pose a challenge, particularly for small farmers who may not have access to adequate land for cultivation. The limited outreach of farm insurance and farm mechanisation, combined with a lack of access to institutional credit for small and marginal farmers, contribute to lower productivity of red-latertic soil of west bengal. Although, different block of Jhargram district recognized as one of the top producers of fruits and vegetables, and the horticulture sector has consistently performed well in terms of production.

Our study for last 5 year 2018-2023, revealed that 32% of respondents had medium level of knowledge regarding rice and other field crop cultivation technology, while 43.74 % had overall knowledge about Integrated Pest and Diseases Management and soil and fertilizer management. The farming system in Jhargram district revolves around a mix of traditional and modern practices, with a focus on rainfed farming. Forestry programme is very fruitful in this part of red soil. Presently the forests of Jhargram District covers the Civil Blocks viz. Binpur-I (the portion on the West of the Kangsabati river), Binpur-II, Jhargram, Jamboni, Gopiballavpur-I & Gopiballavpur-II and police stations of Belpahari, Binpur, Jamboni, Jhargram, Gopiballavpurand Beliyabera. The Jhargram Forest Division lies between 21° -52′ and 22° -48′ North latitudes and 86° -34′ and 87° -20′ East longitude approximately (https://jhargram.gov.in/district). On the North it is bordered with the civil districts of Purulia and Bankura and on the East it is bordered by the river Kangsabati (from the western border of Midnapore Division) and partly by the river Subarnarekha from the western border of Kharagpur Division. It is having common borders with the State of Orissa on the South and on the West with the Jharkhand State. While the region faces challenges related to climate and infrastructure, efforts are being made to enhance agricultural productivity and the livelihoods of the local farming community through government

initiatives and technology adoption. Our study in term of strength, weaknesses, opportunity and challenges analysis revealed that, crop production become very challenging due to :

1. **Uneven and inadequate precipitation :** In general, the rainfall is low and highly variable which results in uncertain crop yields. Besides its uncertainty, the distribution of rainfall during the crop period is uneven, receiving high amount of rain, when it is not needed and lack of it when crop needs it. Further, due to late onset of monsoon, the sowing of crop are delayed resulting in poor yields.
2. **Poor moisture retention capacity :** The crops raised on red soils, and coarse textured soil suffer due to lack of moisture whenever prolonged dry spells occur due to their low moisture holding capacity. Loss of rain occurs as runoff due to undulating and sloppy soils.
3. **Lack of fertility in soils :** Red-latertic soil are not only thirsty, but also hungry too. Soil fertility has to be increased, but there is limited scope for extensive use of chemical fertilizers due to lack of adequate soil moisture.
4. Lack of inadequate quality planting material, improved hybrid seeds etc.
5. Inadequate technical knowledge at various levels.
6. Lack of awareness regarding pre and post harvest management practices, proper marketing infrastructure / marketing channels with forward and backward linkages.
7. Slow promotion of processing of horticulture produce, value addition and less availability of processing industries (such as Cashewnut processing unit) in the sector.
8. Lack of human resource development, professional capability of department staff.
9. Poor extension functionaries because lack of technical personnel at block / grass root level.

Crop production and area

Major crops grown in the District are aus, aman and boro paddy, potato, wheat, mustard, til, groundnut, vegetables,pulses, watermelon and maize. Recently millets introduced in wider area depend on it production feasibility. This zone had wide scope of horticultural crops and largest source in food chain basket of rural economy. The district produces mostly crops such as vegetables (Gopiballavpur I & II, Jhargram, Sankrail, Jamboni and Binpur I Block. Cashewnut is an important plantation crops in all blocks of Jhargram Disricts. Vegetables, fruits and Cashew nuts are profitable crops and the cultivation of these crops helps raise economic status in a short period under optimum crop management system. Our institute provide number of training programme regarding improvement in production technology of the above mentioned crops.

Net cropped area of the district is about 1,68,448 ha. Gross cropped area 2,27,921 ha having 135% cropping intensity. Cropping intensity is very poor due to sever shortage of water and timely availability of location specific seed and fertilizer input etc. The district faces both flood and drought, and sometimes one is followed by another in a same year. Sankrail, Gopiballavpur-I &II, Binpur –I have flood prone areas of about 2,120 ha. As well as most of Blocks have drought prone area of about 1,14,099 ha. The average rainfall of the district for last 10 years is 1,609.46 mm but it is the experience of the people that the district faces scattered and uneven distribution of rainfall almost in every year and the monsoon showers come always in late (http://wbdmd.gov.in).

Constrains and challenges

Various constrains faced by farming community, however among these few are here enlisted on the basis of various interview and literature, which affect at ground and sustainability become a question mark for more crop output :

- The crop production is plagued by the problem of low productivity due to outdated farming techniques, no irrigation facilities, and irrational use of fertilizers (particularly urea) and pesticides that led to lower yields and lower profits for farmers.
- Vulnerable to the impact of climate change, which has resulted in erratic weather patterns, prolonged droughts, and floods, affecting the production and availability of crops and leading to higher prices for consumers.

Plate 1: Maintenance seedling of plantation crop

Plate 2: Cashewnut plantation in Gopiballavpur I under limited resources

Plate 3: Plastic mulches for water conservation under red-lateritic belt (water stress condition)

Plate 4: Resource conservation in forestry system of crop cultivation

- A lack of infrastructure in rural areas, including poor roads, inadequate storage facilities, and limited access to credit have made it difficult for farmers to transport their produce to markets and resulted in a lack of investment in the sector.
- A lack of awareness among farmers about the use of modern technology and best practices in the field has limited their ability to adopt new farming techniques and improve their yields.
- The agriculture sector in India is dominated by small and marginal farmers with limited access to inputs and resources, making it difficult for them to compete with larger players in the market.

Measure for higher crop productivity

Application of suitable and time bound programme become very effective for farmer welfare and sustainable crop production in Jhargaram block of West Bengal. Soil fertility and suitable crop cultivar become challenging due to different constraints related to soil, climate and edaphic variation (Mukherjee, 2023). Different measures had been pointed out after discussion with different sample size in four different block of Jhargram region. These are as follows :

1. Crop diversification and crop rotation

Rotating the location of crops allows for different nutrients to be distributed throughout the soil from year to year, helping to balance the structure of the soil. Crop rotation is the practice of planting different crops sequentially on the same plot of land to improve soil health, optimize nutrients in the soil and combat pest and weed pressure (Mukherjee, 2023). Rotating crops helps maintain or improve soil health and maintain or increase the productivity of the farm over time. Crop rotations must be planned to suit the local growing conditions and the demands of the local market. Focus should be growing green manures to build soil fertility, growing crops with different nutrient demands,

leaving bare soil for long periods of time should be avoided and leaving a gap of at least three years between growing plants in the same family. A crop rotation has break periods when fertility-building leguminous plants (Fabaceae family) are grown to replenish the nitrogen in the soil. No income is made directly from growing them, but they are essential for making sure that all the other crops grow well.

2. Rain-water conservation

Since water is the most limiting factor in crop growth, strategies aimed at conserving it and optimizing its use can substantially moderate drought effects. Watershed-based planning with maximum emphasis on rain-water conservation is crucial in attaining the objectives of improved crop production. Drip or sprinkler irrigation become a good option, however this need intense support from Government end (Mukherjee, 2014).

3. Cultivation problem due to soil

Soil degradation, soil acidity, low water and nutrient holding capacity, high P fixation and toxicity of Fe, Al and Mn, are the major constraints of these soils. To alleviating soil acidity is liming. The rate of liming needed to increase soil pH, say up to 6, can be relatively high.

4. Climate change threat on corp production

Climate change can disrupt food availability, reduce access to food, and affect food quality (Mukherjee, 2022). Observation revealed that, in Jhargram block increases in temperatures, changes in precipitation patterns, changes in extreme weather events, and reductions in water availability may all result in reduced crop production per unit area. Adaptation to mitigate climate change may only be carried out when (a) farmers can perceive that climate change is really occurring, (b) farmers are capable of identifying adaptation options available for them to mitigate climate change and (c) farmers respond to climate change adaptation as per their production practices followed in agriculture and allied sector (Adiyoga, 2018). Therefore, a complete understanding of farmers' perception on climate change is very important as because it establishes farmers' readiness to adapt themselves towards mitigation of climate change by considering some adjustments to their existing cultivation and production practices.

5. Extension programme with modern tools

Social media tools are playing a major role in the dissemination of Agricultural technology Time bound information. Social media has revolutionized the way of communication in the 21st century. The usage of social media increasing day by day in rural areas and its usage touched almost every field. With changes in communication technologies, the extension system also adopted new developments in ICTs to reach farmers more effectively during Covid -19 and after Covid-19 pandemic. This is new innovation tools in recent past and become very effective in remote part of the village. Different approaches such as training and visit, demonstration of novel food products, producers' meetings, educational materials, mass

Table 1: Impact of climate change and assessment on farming community

	Factor	Cause	Assessment level	Major impact
Climate change impact	Threat (Weather event)	Increase damage impact, frequency, intensity and distribution pattern of insect, pest and disease etc. in crop field	Reduction in economic yield and productivity of land.	Challenge to farming community
	Vulnerability	Characteristics of food growers and feature of agro-ecosystem that determines by severity of threat.	Change in behavioral pattern of farmer's and need to aware challenges due to climatic variability on crop.	Threat to food security
	Time bound measurement	Natural resource degradation.	Location specific and effective training and field level demonstration etc.	Increase efficiency of farming community against various challenges of climate change.

media, field days, farmers fairs, clinical camps and video film shows etc., it is obvious that lot of emphasis is given to technology development and its transfer to the client with a primary aim of increasing processing of agricultural food items. The technology is predictive, problem-solving and innovative in nature. However, no single technology can claim its role in development entirely. Extension approaches of technology transfer teach farmers about improved technologies so that they can increase agricultural crop as well as post-harvest processing and value addition, thereby improving their living standard of red soil belt of Jhargram district of West Bengal.

6. Adoption of innovative and digital farming technologies

Agricultural institutions such as SAU, KVK, AEO, Krishi Seva Samiti etc. are essential to disseminate information related to Digital Agriculture technologies. Data acts as a fuel for digital agriculture practices as it is the life source of digital technologies (such as AI, Satellite Image processing). Accurate and updated data on weather conditions, soil type, market, crop variety, crop yield is required to develop and implement innovations and interventions. There is a need to create a trusted and centralized digital data repository to enable efficient data access to different stakeholders, which will help reduce time and cost for digital intervention. Further there is a need for data sharing, data validation and interoperability and data privacy mechanisms. It is essential to create data-driven solid policies and regulatory agencies for facilitating standardization and interoperability. Finally, digital infrastructure such as internet connectivity, mobile phone network, and the cost of internet and digital devices are crucial for the farming community's extensive adoption and continuous use of digital technologies. People in rural areas still do not have access to basic facilities like all-season roads, regular electricity and clean drinking water. Policymakers must prioritize the rapid creation of digital infrastructure in rural areas and promote the development of agro-based startups in each Gram Panchayat to get benefits of new technologies to farmers and increase their income. Now the time is apt to transform traditional agriculture into digital agriculture and create "e-Farmers" or "Smart Farmers" in India.

Different AI-based Expert systems also called knowledge-based systems benefits to agricultural different sectors. It helps farmers optimize their use of resources like water, fertilizers, and pesticides by providing personalized recommendations based on the specific needs of their crop. Automation of farming practices has proved to increase the gain from the soil and also has strengthened the soil fertility. Pattern identifications, Climate predictions, and adopting different learning methods to decide by knowledge-based expert systems

7. Technology interference

Lack of access to reliable and timely information in the remote and farflung area of few blocks. Technology can help bridge this gap by providing farmers with real-time information on weather patterns, market prices, and crop health. This can help farmers make informed decisions about crop management and improve their overall productivity. The use of technology will help to improve supply chain management in the crop production.

Opportunities for farming community development

Our critical observation for the last five year, reveals that red-latertic belt of Jhargram district with eight block as ample scope for higher agriculture productivity within limited available resources. Red-lateritc belt is an agrarian economy with a vast potential for agricultural development. Several opportunities can be leveraged to promote sustainable and inclusive growth in the agricultural sector.

1. Malnutrition and low availability of nutrient rich or bio-fortified food items become a challenging issue in Jhargram block. Huge demand for food and agri products in this belt. This demand can be met by increasing crop productivity by efficient soil management and improving the supply chain.
2. Cultivation of variety of crops under different agroforestry system, giving ample opportunities for an increase in the income of farmers through diversification.
3. An agro-forestry and agro-tourism, a booming sector in Jhargram as most of the

Plate 5: Mustard cultivation under water stress situation at RRS, Jhargram

Plate 6: Groundnut cultivation under optimum resource conservation technique

Plate 7: Distribution of planting materials

Plate 8: Capacity building programme for crop production

Plate 9: Moringa (Sajne) cultivation under limited resources in Gopiballavpur I

Plate 10: Capacity-building programme for Cashewnut cultivation

area such as Belpahari, Ayodhay pahar, Kangsabati rive trip etc. if capitalized, will provide ample scope for huge income to local tribals (Lodha, Santhal etc.) and promote sustainable land use practices. Jhargram is famous for its forest beauty and topography culminating in the hill ranges of Belpahari, Kankrajhor to the north and Subarnarekha to the south. It is a favorite destination for people who love forests. The ancient temples, royal palaces, and folk tunes and rhythms make this area attractive.

4. Latest time bound technology can be used to improve the efficiency of farming operations. Drones and satellite imagery can be used for mapping and surveying farms to help

farmers identify problem areas and take corrective action against low water or poor water availability zone. Similarly, smart irrigation systems (drip or pitcher irrigation etc.) will optimize water usage and minimize wastage.

5. Government launched several initiatives to promote agricultural development, such as the *Pradhan Mantri Fasal Bima Yojana*, *Pradhan Mantri Krishi Sinchai Yojana*, and the e-NAM (National Agriculture Market) initiative. In addition to these few state level promotion programme for farming community such as SDRF (compensation of crop damage), *Bangla Fasal Bima Yojana*- BFBY, Awarenes campaigning for issuing new *Kissan credit card*, *Krishak Bandhu Programme* etc. These initiatives offer farmers with ample opportunities to access insurance, irrigation facilities, and market information to enhance their productivity and income. However, these initiatives had very limited access to real food growers community, due to poor government and extension machinery system etc.

Capacity-building programme

Time bound capacity building programme, become very important for tribal farmers of Jhargram through various training and lab to land based progrmme. The main objective of this training programme is to suggest crop diversification plans in plantation and rice-fallow lands mainly or the lands where rice crop is marginally suitable and not suitable. These lands will be brought under alternative and profitable crops/ cropping systems while preferences will be given to pulses and oilseed crops. Further, create awareness among farming community regarding the importance of agroforestry and Cashewnut cultivation (main crop in this region) for higher income to marginal farmers.

Focus areas for future line of work

1. Improve productivity by way of quality germplasm, planting material and water use efficiency.
2. Enhance horticulture production (fruit and cashewnut plantation), augment farmers' income and strengthen nutritional security.
3. Encourage aggregation of farmers into farmer groups like FIG/FPOs to bring economy of scale and scope.
4. Support skill development and create employment generation opportunities for rural youth in horticulture and post harvest management, specially in the cold chain sector.

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