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An Exploration of the Agri-food System of West Bengal and suggestive measures to attain sustainability

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Introduction

Food systems consists of range of actors from science, technology, data and innovation sector and their interlinked value-adding activities mainly production, aggregation, processing, distribution, consumption and disposal of food products sourcing from agriculture, forestry, fisheries and food industries along with wider economic, societal and physical environmental objectives. The sustainable food system contributes towards food security and nutrition for all in such a way that will not hinder the needs of future generation (Braun, *et al.* 2021). In the final report of Zero Hunger Challenge compendium (2014-15) summarized policy measures for sustainable food systems should increase agricultural productivity, gender sensitive agricultural production, enhance climate resilience, reduce greenhouse gas emissions from agriculture and related land use change, improvement of nutrition, strengthen value chains and improve market access.The food system's sustainability is influenced by natural and human factors. Creating enabling conditions shift into more sustainable food systems, for that requires system based approaches considering the range and complexity of interactions within production, distribution, consumption of food. These links between food production, distribution, consumption and nutritional health and the underlying social-economic, biophysical and institutional elements, ultimately affect the quantity, quality, availability and affordability of food as well as health and well-being. As per this report key determinants of a sustainable food system are natural system, agriculture and human system and within human system economic services as well as social services and conditions are included. Economic services like processing for nutritious and healthy food, economic development, inclusive and efficient markets, enabling policies and infrastructure; and social services and conditions include demographic changes, health, nutrition, urbanization etc. The sustainable food system is a dynamic concept can vary widely across countries, regions and among stakeholders, as developing countries has large number of poor and marginal food producers who may chronically or seasonally lack productivity capacity to cover own food needs or urban low income non-food producers. In order to mitigate climate disruptions several high alert mitigation strategies were suggested to adopted like climate resilient technologies; promotion of climate smart agriculture(CSA) and climate smart CSV activities in government ministries and agencies like MONREC; MOALI and NECCCCC which should foster collaboration among the various stakeholders (Oo *et al.* 2023).

Facts and Figures regarding Agrarian-food System

The food availability and storage statistics all India production (cereals and pulses) was 295.65 million tons during 2019-2020, it was 144.52 million tons for 2020-2021 (Priyadrshini and Abhilasha, 2021). All India procurement for cereals like rice, wheat and coarse grain was 865.52 lakh tons during 2019-2020 and 611.15 lakh tons for 2020-2021; per capita net availability of food-grains annually was 69.1 kilogram for rice, 65.2 kilogram for wheat, 17.5 kilogram for pulses in the year 2019. Allocation of food-grains was 659.57 lakh tons for the year 2019-2020 and 452.39 lakh tons for the year 2020-2021. The All India storage capacity of Food Corporation Of India and State Agencies were 802.70 lakh metric tons in 2020 and all India cold storage capacity was 36229675 metric ton in 2018. The total production from inland fisheries was 92443.80 tons and the nutrient of the fish species were having high potential. The employment and income of fisheries was 924. 43 crore (per annum) (Paul and Chakraborty, 2016).The productivity trend of onion had been 130MT/Ha~(2004-2014); total annual wholesale from 2010-2014 was found to be Rs.8,133/Quintal (Dhar *et al.* 2020).

Objective: To explore the Agri-food System of West Bengal

Methodology: Past literature reviews related to the agri-food system/supply chain/ agri-food management were reviewed. the major keywords used for inclusion of literature review in this study were agri-food system, supply chain, sustainable agriculture, agricultural scenario, stakeholders in the agri-food system, strategic measures to enhance future food chain/system. The main contents collected focused on the prevailing scenario of the food system in the state of West Bengal.

Table 1 : Inclusion Criteria and Rationale

Inclusion criteria	Rationale
Articles were published in peer-reviewed journals, conference proceedings and the bookchapters in English	Peer-reviewed journals, conference papers and Book-chapters considered to have better quality than non - peer-reviewed articles.
Articles were published between 2008 to 2023	The year 2008 was selected as the starting point at the term agri-food system
Judge relevance by fully reading all remaining abstract, introduction and conclusion	The remaining abstract, conclusion totally focusing on agri-food system in India majorly focusing on West Bengal
Judge relevance by fully reading all remaining articles	Articles focusing on the agri-food system of West Bengal and India were being selected

Agri-food System of West Bengal

1. Technological Interventions in West Bengal: With System of Rice Intensification Technique (SRI) in West Bengal the productivity increased from 37 percent to 83 percent, resulted in increase of net income of the farmers (Tawde and Banerjee, 2019).

2. Status of farmers of West Bengal: In West Bengal, the income level of farmers were found to be Rs. 11537 for rice growers and Rs. 15600 for potatoes (annually) (Ali and Ahmad, 2018). Agriculture played an important role in the

economy creation as primary livelihood activity of 43 percent. Value chain had lack of cooperation among the stakeholders; deficiency in the marketing system, unscrupulous players, information access difficulties, insufficient infrastructure like cold storage, roads, electricity, building and financial instability (Dubey *et al.* 2022).

3. Socio-economic element influencing the food system: The input dealers had the best reach of farmers and building rapport with them. Advisory service like news for pestilence and natural calamity earned; field survey; regular meetings; training sessions earned cent percent score others included daily record maintenance; market news; input supply; feedback activity; credit requirement issue along with campaigns and motivation workshops earned nearly 80-90 percent score. Relation of the role performance influenced by the factors like cosmopoliteness, extension participation, credit and information orientation and the types of inputs being sold had a vital contribution (Panja *et al.* 2022).

4. Organizational Contribution for agricultural commodities in West Bengal: There were several services being performed like a FPO safeguarded indigenous varieties; a company found converting wastes into resources; Non-governmental Orgainization (NGOs) present facilitated in construction of new value chains for the undervalued crops (Chatterjee and Bernzen, 2022).

Farmer producer companies needed to free themselves from the shackles of several organizational and managerial issues before proceeding towards functional and structural features of a business entity. It was very obvious from the fact that Farmers Producers Company was charging a low cost for potato Rs. 6 and Onions Rs. 10 along with transportation charges. But the local traders (middlemen) charged the same but without transportation facility. It included lack of trust and cooperation among the farmers to form producer's company; inadequate training and skills; improper managerial framework and poor organizational skills among the members and at last inadequacies in the supply chain of a producer company as proved through an illustrated experiment. Remedial mainly focused on the formulations of suitable interventions to empower the producer companies in order to make agricultural sector more sustainable for small farmers (Deka *et al.* 2020).

5. **Crop diversification for agricultural commodities in West Bengal:** Crop diversification, irrigation, fertilizer use, road connectivity, market and storage facilities had been founded as the major drivers of agrarian transition in favor of non-food grains.Districts of North and south Bengal were registered with a range of 0.71 to 0.80 for crop diversification index. In addition, climatic factors such as relative humidity; rainfall and temperature variations had also influenced the transition. Crop choice by the farmers was totally dependent on the aforesaid climatic factors. It was suggested to widen the extension services including promotion of universal education among the farming communities and investment in rural structure (Paria *et al.*2022).

India being the largest producer of banana and mango; second largest producer of litchi; 3rd largest producer of papaya and 4th largest producer of orange. Value deterioration and post harvest losses were found to be 25-30 percent. Main constraints identified in the post-harvest programme were lack of infrastructural facilities and lack of knowledge. First problem was a issue of government but the second could be nullified through various training and extension programmes (Mitra, 2008).

The overall losses incurred including loss in farm operations and total loss in storage for several fruits were apples(12.26%); banana(6.6%); mango(12.75%); grapes(8.3%); guava(18.05%); papaya(7.34%); cabbage(6.94%); cauliflower(6.88%); potato(8.99%); onion(7.51%) and tomato(12.98%) (Nedumaran *et al.* 2019). Suggestions were made to narrow down the gap between demand and supply by the implantation of proper agro-techniques; replacement of non-descriptive local varieties with high yielding pest and disease resistant varieties; adoption of new techniques and methods; development of area and region specific high yielding varieties and lastly creation of adequate and safe storage facilities.The state produced 786 kg ha^{-1} on an average but the demand was 15.82 lakh tons of pulses (Ray *et al.* 2013).

Nutrition status of population

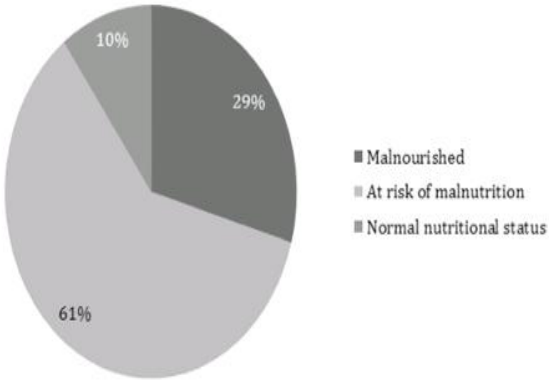


Fig. No 1: Nutritional Status of a study population in West Bengal (Lahiri *et al.* 2015)

Fig 1, informed along-with factual data regarding the nutritional status of the people of the West Bengal where 10 per cent were at risk of malnutrition; 29 per cent were malnourished and 61 per cent were maintaining normal nutritional status. In relation to the above mentioned figure, more number of awareness campaigns should be conducted in the state of West Bengal regarding nutritional value of several foods and via government several interventions of nutrition specific and bio-fortified food habits should be prevailed along with more emphasis on the below poverty level population.

5. Farmers problem:

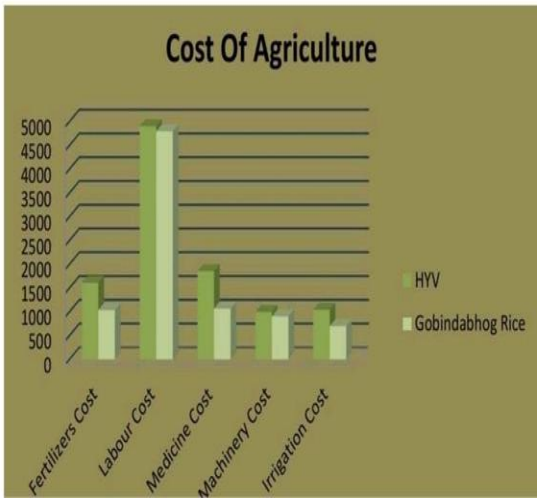
Variable	Description	Response (%)
Major problem for agriculture	Drainage congestion and waterlogging	43
	Soil salinity and acidic soil	37
	Lack of fresh water for irrigation	12
	Frequent climatic extremes	8
Reason of drainage congestion	Construction of closure	32
	Illegal land conversion	19
	Modification of khals for individual interest	22
	Lack of legal control	11
	Dumping and illegal construction	11
	Others	5
Effect of drainage congestion	Water logging in agricultural field	31
	Large scale water inundation during flood	18
	Loss of lateral connectivity of drainage	12
	Increase socio-economic constrains	22
	Transportation problem	10
	Others	7
Waterlogging intensity in monsoon	High (< 1.5 m)	27
	Medium (1.0–1.5 m)	42
	Low (0.5–1.0 m)	19
	Negligible (> 0.5 m)	12
Major problem related to waterlogging	Low yielding and monetary loss	30
	Monocropping and low land use efficiency	27
	Increase primary cost and low profit margin	24
	Mixing of saline water	12
	Increase disguised unemployment and poverty	7
Major source of income during waterlogging	Agriculture (Mainly paddy)	54
	Pisciculture	25
	Paddy fish farming	18
	Other commercial crop	3

Fig. No 2: Farmer's perception about drainage congestion and water-logging (Ghosh and Mistri,2020)

Fig 2, portrayed the farmer perception regarding the water-logging and drainage congestion situations and the responses on several variables were marked with proper description of each,lastly the responses were taken according to the frequency of the farmers responded on different situations. In relation to the above figure, proper technological advancement and knowledge enhancement should be made in the state to tackle the above-mentioned problems. The actors involved in the field of science and technology should implement concrete strategic

measures in order to overcome the problems related to water logging and drainage system.

Comparison between HYV-Local Cultivar



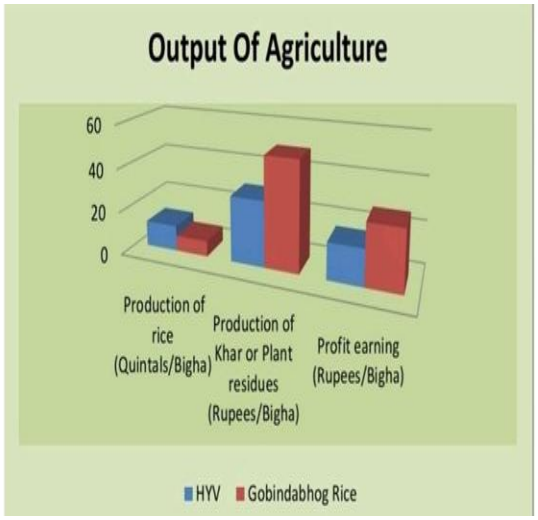


Fig. No 3: Comparative study between high yielding variety & Gobindabhog (indigenous cultivar) (Chatterjee and Samanta,2022)

Fig 3, depicted that the cost of cultivation of two rice varieties namely Gobindabhog and HYV where a comparative analysis had been carried out. It showed the cost of cultivation of HYV was higher in all aspects(fertilizer, labour, medicine, machinery, irrigation) than Gobindabhog but Fig 5, depicted that as HYV having high yielding attributes showed higher production than Gobindabhog but in terms of fodder and profit generation Gobindabhog found to be higher. Lastly, it was being suggested to carry out mixed farming of both the indigenous and high yielding variety. In relation to the above mentioned figure the indigenous variety had been proved to be more efficient and sustainable, and Gobindabhog being an land race cultivar of West Bengal the cultivation practise would be highly beneficial to the farmers. As mentioned it produced more residues so the left overs would be easily recycled by serving it as a fodder to the livestock.

Social background in West Bengal

The low caste person (fisherman, bagdis, dalits, Vaishanvas) were getting reeled down under the elite groups of Zamindars (landowners) exploited the rented farmers performing on their land and the profit was not found to be equally with the producers shared rather it was a gamble from the part of the landowners in the rural economy. The farmers were made to pay high rental interest (Saha, 2019).

Environmental sustainability in West Bengal

Potential use of inorganic fertilizers; more specialization of water and energy exhaustive crops were declining agricultural sustainability. The carbon footprint intensity of several crops were paddy (0.94); potato (0.34); wheat (110.39); oilseeds (6.26); pulses (18.23) and vegetables (5.22). suggestions were formulated regarding transformation of the cropping pattern with incorporation of pulses and oil-seeds along with non-productive investment of energy to re-implant a healthy agro-ecosystem (Ghosh and Chakma 2019).

The inherent nutrient status of the soil had declined due to overuse of inorganic fertilizers and had shown a potential negative effect on the productivity of paddy cultivation. Phosphate; Organic carbon, Potassium and soil pH were the main factors in paddy cultivation and having high content of acidity the study was suggested to be kept sustained with calcium carbonate and along-with use of organic inputs and green manures. Thus, as remedial measure adoption of integrated farming system with chemical fertilizer along with application of organic manures were suggested from the study (Chakaraborty and Mistri, 2015).

Production Viability of West Bengal

West Bengal is the second largest producer of potato and 80 percent of the cold storage were found to be dedicated to potato. The production of potato was 10 million ton and the storage capacity was found to be only 6.2 million ton. It revealed that commercial storage methods were rudimentary in nature; other factors like bad technical skills, non-monitoring of day-to-day temperature, lack of safety measures and high electricity bills had been the major bottleneck in efficient functioning of the storage. In addition, inadequate government policies, obsolete farming techniques and energy production had enhanced the low profitability status of these cold chain operations. Study suggested that parallel development of cold chain infrastructure was very much necessary to keep pace with the emergence of organized retail in India (Kumar, 2014).

Model and frameworks to be adopted to covert a food system more efficient and sustainable:

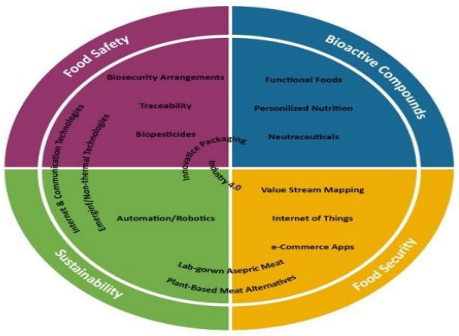


Fig. No 4: Innovative interventions to tackle four directions of food chain (Leach *et al.*2020)

Fig 4, depicted the major four components of sustainable and efficient food chain where food safety; bio-active compounds; food security and sustainability. Several new interventions had been depicted in the figure which would act as independent variable for attaining the goal of industry 4.0. The integration of the above mentioned figure in the state of West Bengal would be efficient through several demonstrations of internet use, lab food culture, e-marketing of commodities, use of organic input and food security and traceability by the food inspectors, agricultural experts and government officials among the targeted community. Other remedies could be workshops, campaigns and trial demonstrations according to the financial, social, cultural and rational aspect of the targeted population.

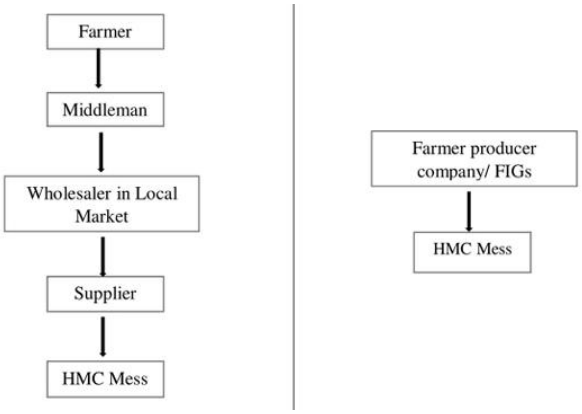


Fig. No 5: Existing and experimented supply chain (Deka *et al.* 2020)

Fig 5, depicted the two different supply chains to a mess called HMC. In the first column(existing supply chain) the commodity was being distributed to the consumers via several intermediaries like producer, middlemen, supplier ultimately to the mess but in the second column (experimented supply chain) the commodities were being directly distributed to the mess without any middlemen. The above mentioned figure would be helpful to sustain the food system of the state via elimination of several middlemen present and enhancing the participation level of the producers in various marketing activities and thus creating a profound ability among them to increase the number of Farmer Interest Groups. The food experts and extension agents could act as a supportive mechanism for nurturing the farmers in the sustainable area of production and also it would bring numerous positive effects towards the society of buyers in the market.

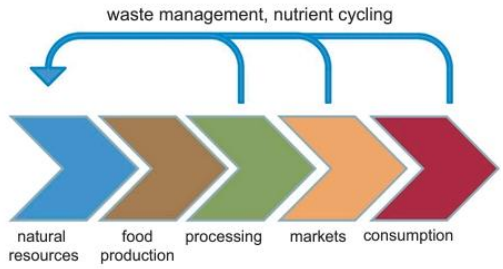


Fig. No 6: Food Value Components (Graef *et al.* 2014)

Fig 6, portrayed the various components in a food supply chain which included natural resources, food production, processing (post-harvest management), marketing (channels to sell, make contact, incurring profit etc) and ultimately reaching the consumers who were the receivers in the food chain without playing any major role. In the above bullet arrows, it depicted focus on the conservation, preservation and efficient use of the natural resources and management of the waste products to mitigate the effects of atmosphere and soil pollution. The above mentioned figure could be useful as an efficient and sustainable method of farming in the state of West Bengal through a proper management of each step mentioned starting from proper management of the natural resources, quality food production, proper processing and channeling in the market segment, ultimately consumption of healthy food items. Along with that balanced management of the residues should be conducted without creating much pollution in the environment and shifting cultivation, crop rotation should be practised for proper nutrient cycling in the soil without making it highly exhaustive.

Conclusion

The determinants like technological intervention, organizational role, discriminating and exploitative situation, environmental sustainability, production viability, crop diversification, innovative interventions, components of food chain, nutritional status, were being reviewed from past literature and been incorporated in the paper through relational facts and figures encircling the agri-food system. Some models were also being discussed which would highlight the future strategies in accordance for a sustainable food supply management system of west bengal.

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