Analysis the Pattern and Role of Crop Concentration and Diversification in Different Blocks of South 24 Pargana District, West Bengal

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Abstract

In late, the conflict between the growing human population and the planet's supply of freshwater has already started and may get worse. The increasing reliance on groundwater and the declining areas under surface irrigation are the prominent trends in Indian irrigation today. It has important implications for the local ecology and sustainability of agricultural production. The situation has become more alarming in recent years with increasing climatic variability, particularly for the rainfed and coastal regions that house the largest proportion of the country's total poor. Hence, appropriate cropping systems and practices with diversifying the lands have been critical aspects of agriculture, particularly in those vulnerable areas' agriculture which are more climate resilient, remunerative and environment friendly. This paper aims to analysis the concentration of major crops like paddy, potato, khesari, mustard and crop diversification as well as the ranking of cultivated crops in the twenty nine blocks of South 24 Parganas district of West Bengal. Secondary data from various sources are used for addressing the research objectives. Crop concentration indices has been computed for crops like paddy, potato, khesari and mustard using Bhatia's method and Gibbs and Martin's technique has been used for delineation of crop diversification regions during the period of 2014-15 of the study area . The present study reveals that the cropping pattern of different blocks of South 24 Parganas district is mainly Paddy oriented mono culture practice. But still a number of crops like mustard, potato, khesari, til, wheat are cultivated in this region extensively. Therefore, a strong possibility to shift in the cropping pattern by diversification of the food basket for promoting sustainable agricultural intensification in the coastal setup. Furthermore, this analysis focuses on the identification of dominant crops and diversification of crops for future agricultural planning and development in the different blocks of South 24 Parganas district generally.

Keywords: *Crop concentration, crop diversification, cropping pattern; coastal area, South 24 Parganas, West Bengal, Bhatia's method, Gibbs and Martin's index, sustainable agriculture*

I. INTRODUCTION

Even though, after sixty years of independence, agriculture plays an important role in the process of economic development of developing countries like India. More than 50 percent of people in India are still dependent on agriculture for their livelihood (Pani and Mishra, 2019). But, the paradoxical thing about the Indian economy is that, the share of agricultural labor in total labor force is slower than the declining share of agriculture in GDP of recent times (Chatterjee et al, 2018). Equilibrating the growth process and connect the rural-urban divide, inadequate infrastructural support, especially limited irrigation facilities coupled with policy bias (Pani and Mishra, 2019) regarding appropriate cropping are burning dispute for Indian economic reform programme linked with agricultural sector. In addition, declining crop yields, increasing agricultural risks, decreasing soil fertility, and environmental degradation are some of the main challenges that continue to threaten societal goals for improving quality of food, income and nutrition security, especially in smallholder agriculture in rainfed and saline areas of the nation (Reddy and Mishra, 2008). Rain fed and saline areas in the country still accounts for 70 percent of the cultivated area and these areas are home to majority of rural poor and marginal farmers (Pani and Mishra, 2019). Frequent occurrences of droughts and untimely and heavy rains and floods affected the livelihood of rural people particularly those living in the dry or saline zones where the irrigation facility is scanty. Therefore, the natural resource base of agriculture that provides sustainable production is shrinking and decaying and adversely affecting the productivity of the ecosystem.

However, as population growth and per capita income and demand from the industrial sector increase, the demand for agriculture is growing rapidly. Therefore, it is necessary to recognize the severity of the problem and bring it back into the path of high growth in order to restore its power to deal with the agricultural sector. However, these problems are unspeakable, especially as new avenues of science and technology have begun to offer incredible opportunities for application in agriculture (Lange et al., 2007). In this abundance, it is of utmost importance to explore the potential of sustainable farming practices to ensure food security in India in the future. Nevertheless, West Bengal an important state of India, lion sharing proportion of saline agriculture, remains primarily an agricultural state with ten of its districts deriving 30 per cent or more of their net district domestic product from agriculture (Ghosh, 2010). Although the share of agriculture in the net state domestic product is incessantly declining in West Bengal, the state continues to depend heavily on agriculture. Therefore, in the case of rapidly increasing value production in the state, there should be rapid agricultural development along with agricultural productivity per acre (Ghosh, 2011). The real distress for the farmers in the coastal region as well as in state was achieving a higher farmers' income and to sustain the improved income across the groups (Mandal et al., 2017).

Agricultural development is a multidimensional concept that encompasses many aspects such as agricultural land use, crop diversification and concentration, crop productivity, crop intensity, commercialization of agriculture, and environmental management (Bagchi, 2017). In a developing country like India, the importance of adopting appropriate cropping practices cannot be overestimated. Horizontal expansion of agriculture is not possible without huge capital investment. Only fair use of land by adopting higher reward cropping methods, scientific rotation of crops and multiple crops will help in overcoming the food and raw material problems of the country (Mandal et al., 2017). Furthermore, crop policy is influenced by terrain, climate and socioeconomic and agro-environmental factors (Roy and Barman, 2014). The cropping method gives farmers knowledge about agricultural practices and crop selection generally. Knowledge of various important parameters of agricultural studies such as physio-climate, crop concentration, crop diversification and other parameters is required to know about the cropping pattern of an area (Nayak, 2016).

Crop concentration and crop diversification are two fundamental aspects of agricultural geography because these two indicators help to understand the cropping pattern of an area in great detail (Bhatia, 1965). Consequently, knowledge about concentration and diversification in an arena can be considered very helpful in proper agricultural land use planning (Raju, 2012). Therefore, crop density and diversification not only provide an idea of a specific crop dominance area, but also play a guiding role in strengthening the agrarian economy and land use planning. Agricultural diversification will undoubtedly contribute to agricultural development in terms of change in crop pattern towards higher value crops. First, it was observed that the benefits of the new technology or green revolution in cereals would stop once they reached the 'optimum' level and agricultural development would remain stable until new high-value crops were introduced. Besides small and marginal farmers, who dominate the agricultural landscape of most Indian states, including West Bengal, can earn higher agricultural income and employment and reduce losses by adopting a diversified crop portfolio (Makate et al., 2016 and Kankwamba et al., 2012). Many small and marginal farmers in the southern and western districts of West Bengal, based on a small plot of land and without alternative sources of employment and income, were always able to produce because of the large population in surplus labor (Goswami et al, 2014). The country strives to maximize production on a given land. They try to grow more and more crops and choose such commercial crops.

Both the irrigated net and gross crop area in the state has increased in two years (Mandal et al., 2017). In addition, the use of fertilizing fertilizers per hectare has also increased. Both of these factors helped to increase the yield levels of large-scale food crops and some non-food grain crops, thus leading to diversification (Mandal et al., 2017; Goswami et al., 2014). The relationship between technical factors such as gross crop acreage per hectare in the state, fertilizer use and the amount of diversification in the state is a testament to the impact on diversification. Institutional reforms associated with technological change motivate marginalized farmers to realize the benefits of greater diversification and further increase their income levels (Kumar et al., 2015). Concerns about the associated detrimental effects on the environment and biodiversity, as well as the resilience and adaptability of crop systems to climate change. Crop diversification can stabilize the productivity of crop systems and reduce environmental impacts and biodiversity loss in the saltwater areas of West Bengal (Ojha, 2018). The end result from agriculture will depend on the efficiency of resource utilization and the actual technological advances in the area in the proper cropping pattern (Kumar et al., 2015). Crop patterns change from time to time depending on market forces and agro-climatic conditions (Geetha and Maniyosai, 2016). These changes will have many impacts on various aspects of agriculture and will also bring about some changes

in the economy as well as the social and economic aspects of farming families (Nayak, 2016).

Against this backdrop, the paper examines the structure and nature to know the block wise cropping pattern of South 24 Parganas district of West Bengal. The paper is to identify the dominant crop in the different blocks of South 24 Parganas district. Further it has to explain the concentration of selected crops in the blocks of this district and to show the potential spatial diversification of grown crops in this region during 2014-15. Furthermore, the important factors that are conscientious for diversification of the cropping pattern in the state are also examined. Hence, the paper has discussed the spatio- temporal pattern of crop concentration and diversification in south 24 Parganas district of West Bengal. The paper has six sections. Existing studies regarding the implications of crop specialization to diversified agriculture to promote the sustainable agricultural intensification in macro level manner discussed in next section. The third section presents the overall description of the study area. The fourth section deals with the methodology and sources of data which are composed and analyzed for drafting the paper. The subsequent section presents and analyses the findings. Beside this section designs a framework for interventions scenarios in respect of policies, technologies and practices, and examines the potential changes in agricultural system. The last section summarizes the major findings and highlights the necessary interventions.

II. LITERATURE REVIEW

West Bengal is primarily an agrarian economy and agriculture holds the key to overall development of the state, which remains backward, unstable, rain-fed, salinity, traditional and prone to natural calamities like droughts, floods and cyclone (Mithiya et al., 2018). Despite decline in its share of NSDP of West Bengal, agriculture continues to be a major source of livelihood to a significant segment of population (around 60 percent) (Dasgupta and Bhaumik, 2014). Therefore, agricultural development is crucial for the overall development of the state by providing employment and earning income. The Green Revolution, which has seen a 45 per cent increase in per capita food production in India, has provided enough food for India as a whole (Mithiya et al., 2018). The strategy did not explicitly identify the need to increase farmers' incomes, nor did it mention any direct measures to promote the welfare of farmers. But given the various obstacles and problems facing Indian agriculture, the possibilities of achieving such a goal have been largely discussed. The government of West Bengal is also working on a mission mode for the development of agriculture and the related sector in a holistic manner with the vision of doubling the income of farmers by 2022 by ensuring farmers' access to skills, technologies, markets and financial inclusion. (Beillouin et al., 2019). However, the state has access to a variety of natural resources and a wide variety of agro-climatic conditions that contribute to the cultivation of a wide range of crops (Rakshit, 2011).

The Green Revolution in West Bengal also began in the early 1980s and the state focused on growing paddy boro. However, when the effect of the Green Revolution began to wear off, the central government and state governments introduced many programs to diversify cultivation patterns in order to maintain food security (Rakshit, 2011). The composition of crops has changed further due to changes in technology, infrastructure, rural literacy level, urban population size and agro-climatic factors like rainfall (De and Chattopadhay, 2010). Then, horticultural crops began to occupy an important place and this state becomes the largest producer of horticultural crops accounting for 10.94 percent of the total horticultural production of the country in 2014-2015 (De and Chattopadhay, 2010). After economic liberalization, the international market played an important role in changes in the cultivation regime. As a result, a marked diversification of cultivation methods in apart from food grains has occurred in West Bengal since economic liberalization. The share of area cultivated in food grains have increased significantly over the past three decades. The percentage of area devoted to oilseeds, especially mustard, almost doubled between 1984-85 and 2014-15 (Singh et al, 2018). Agriculture in West Bengal has gradually diversified relied on high-value crops such as fruits and vegetables, and other horticultural crops as well as oilseeds and jute. Structural changes in agriculture cultivation in West Bengal took place gradually (Singh et al., 2018).

Crop concentration denotes the variations in the density of any crop in an area or region at any given time. The concentration of a crop in an area depends largely on its terrain, temperature, humidity and soil conditions (Bhatia, 1965). Each culture has a maximum, minimum and optimum temperature. It tends to have a high concentration in areas of ideal agro-climatic conditions and the density decreases as the geographical conditions become less conductive (Hussain, 2004). Crop diversification models, like that of crop concentration, are of great importance in planning the use of agricultural land. Diversification of cropping methods means rising a variety of crops for arable land, the more competition there is, the greater the extent of diversification (Murugesan et al., 2018). Many researchers have proven that farmers are risk averse and that crop diversification is often cited as a farm-level risk management strategy (Benin et al., 2011). Crop diversification has several economic, social and environmental benefits for small farmers. It increases farm household incomes and employment opportunities for farm workers,

improves conservation of natural resources, soil fertility and food security, reduces production shortages (Goletti, 1999; Joshi et al., 2004). The level of formal education of the farmer, distance to market, and size of farms and fragmentation of land are associated with greater diversification of crops. On the other hand, age, sex, access to credit, contact with extensions, fertilizers, agricultural tools and non-agricultural income do not have a statistically significant effect on diversification (Mandal et al., 2020).

Household size can have a negative and significant impact on diversification (Mango et al., 2018). Therefore, policies that support investment in research and development of climate-resistant varieties and encourage crop insurance specifically for non conventional crops, and in addition, extension services should sensitize farmers to diversification of crops. (Sikh and Bhuyan, 2018). High-value crops, which are more labor intensive, can provide sustainable employment and income to more rural households facing the severe problem of seasonal unemployment and unemployment in the mono-crop economy (Mango et al., 2018). A study by Chand (1995) may draw attention to infrastructure such as access to motor road, market and irrigation facilities, range of diversity, success and profitability through high-paying crops such as off-season vegetables.

Small and marginal farmers need crop diversification to meet their cost of living, but the flexibility of farmers to respond to diversification opportunities is in most cases limited by the size of markets, price risks, the suitability of the soil and the quality of the irrigation infrastructure, the availability and the cost of labor (Abro and Sadaqat, 2010). In their case studies in Mexico and Argentina, Wehbe et al. (2006) have shown that diversification of agricultural practices can be useful in mitigating climate risks as well as insurance, irrigation development and technologies that are sometimes hampered due to limited financial access, network poor information and market failures. Differences in diversification and access to adaptation strategies between large and small farms were also of concern and therefore argued for the role of the public sector. Recently, the Tanzanian government has also undertaken a feasibility study for diversification into various horticultural crops and also for export diversification to reduce the impact of declining export earnings from cotton and coffee during the recession period. (Makate et al., 2016). Global impact that mainly affected small farmers, which constitutes the majority of the farming community. Crop diversification can be seen as an attempt to increase crop diversity e.g. rotation of crops, multiple crops or associated crops to specialized agriculture with the aim of improving productivity, stability and the provision of ecosystem services (Kremen et al. 2012; Garbach et al. 2017; Wezel et al. 2014). This can be a measure to develop more sustainable production systems, develop value chains for minor crops (Meynardetal, 2018) and contribute to socio-economic benefits (Feliciano, 2019). Crop diversification and or additional diversification measures such as varying cropping time or changing cultivation patterns can lead to higher and more stable yields, increase profitability and lead to greater resilience of agro-ecosystems in a long run. (Rosa-Schleichetal, 2019). The main factor underlying diversification is in favor of horticultural crops like fruits and vegetables, plantation crops, etc. have experienced higher yields compared to food grain crops and job creation per hectare of horticultural crops is much higher than that of grains and legumes (Raju, 2012).

It is evident that, the crop concentration model is to differentiate between high and low density areas of individual crops in different parts of the region and to determine the regional dominance of a crop (De and Chattopadhay, 2010). It is clear that the district culture model is influenced by the physical and socio-economic factors of the study region (Jha et al., 2009). There are many ways to improve the current cultivation pattern. Marginal lands could be used by putting them under cultivation. Likewise, fertilizer should be used for poor soils to improve fertility. Perennial and non-perennial rivers could be used to the maximum without investing a lot of water (Chakraborty, 2012). Channels carrying water should be cemented so that there is not a lot of wasted water due to infiltration and evaporation (Kumar et al., 2015). Apart from this, the most important factor is that the hybrid variety should be used by farmers to improve production. The optimal cultivation model for the country and in particular for eastern India, where agriculture is the mainstay of the economy, is a serious challenge for the economist and planners. Some economists have suggested that shifting the area from traditional paddy and wheat cultivation to alternative crops is the solution (Shergill, 2005). Intensive rice cultivation without proper crop rotation using groundwater, expensive chemical fertilizers and pesticides is economically uneconomic and ecologically unbalanced. Thus, with the government, local populations must come forward to change the dominant agricultural scenario of rice (Dhaliwal et al., 2019). Crop change is also taking place due to government policies and the push on some crops over time, for example, the creation of the Oilseeds Technology Mission (TMO) to boost oilseed production as a national need for the country's requirement to depend less on imports (CMIE, 2018). The development of market infrastructures and certain price supports also induce crop diversification (Dhaliwal et al., 2019).

There are many opportunities to accelerate farmers' incomes by improving productivity and integrating

high-value crops into the region's farming practices (Dutta, 2012). Growth in agricultural production and income can be brought about from two angles namely, expansion of the area of land designated for agricultural uses and / or more productive use of the area of existing cultivable land. Irrigation is not considered a significant variable for diversification, as rainfed areas have benefited more from agricultural diversification in favor of high value crops by replacing coarse grains (Joshi et al., 2003). Decreasing the area devoted to cereals and pulses requires government interventions to provide farmers with a remunerative price and market for food crops (Singh et al., 2018).

The use of chemical fertilizers did not have a significant relationship with the level of diversification because farmers did not have easy access to chemical fertilizers in the almost unorganized input-output market in eastern India (Sau and Saha, 2016). In land size, farms and per capita income are expected to increase crop diversification in the eastern region. Small landowners may not be able to save land for growing crops other than staple foods due to their consumption (Dasgupta and Bhaumik, 2014). To accelerate the pace of diversification for increasing the income of the farming community, this will certainly pave the way for a second green revolution with optimal use of rich natural resources in a certain spatio temporal set up (Beillouin, 2019).

However, research on adaptation to climate change in agriculture has identified climate smart agriculture (CSA) as one of many sustainable agricultural practices (SAPs) that can enable households to resist the adverse effects of climate change on the variability of smallholder farming systems. (Manda et al. 2016). Experts, policymakers and other stakeholders concerned about the impact of negative externalities generated by climate change on well-being, food and nutrition security have broadly recommended adaptation of CSA as a key way to improve the livelihoods of vulnerable segments of the population. Although crop diversification is not a new practice, the birth of a new challenge, "climate change" in agriculture, has allowed it to gain popularity because its adoption can significantly reduce the risks associated with production, improve productivity, food security, income and nutrition in smallholder farming systems (Muchiri et al.,2019 ; Ng'ombe et al., 2020). Due to increased cases of malnutrition and food insecurity as a result of climate change, the government of Malawi has intensified its extension efforts for crop diversification in recent years. In Malawi, crop diversification mainly benefits the farmer in the sense that growing multiple crop species helps manage both price and production risks, which ultimately ensures more food options for the household and income through participation in the surplus market (Mango et al., 2018). The model of agricultural diversification taking into account the different definitions of agricultural diversification. According to Mugendi Njeru (2013), crop diversification not only enables more efficient use of agro-ecological processes, but also provides diversity for human consumption and improves income, which improves the purchasing power of households to purchase other foods.

Human Development Report (Govt. of West Bengal, 2009) highlighted that, the agriculture in the district is slowly becoming unpaid, which leads to a declining trend in the agricultural labor force and over-reliance on the area often leads to poverty. However, this does not mean that the opportunity to farm in these districts is gone. The options for agricultural cultivation are very limited with more water during the wet season (kharif), the scarcity of good quality irrigation water and the salinity of the soil during the dry season (rabi). Household production systems (HPS) are an integral part of the daily activities of households and produce food (fruits, vegetables, fish and livestock) for household consumption in coastal areas. HPS generates income from its surplus production which helps to mitigate prices or production shocks due to unforeseen events (Mandal et al. 2016) The sustainability of cropping systems in coastal areas is severely limited by internal constraints, such as existing agricultural practices, the adaptive capacity of households and socio-economic characteristics of the agricultural population, and external shocks such as climate change and variability, sea level rise and possible seawater intrusion, cyclones and floods, etc. (Agrawala , 2010).

Krupnik et al. (2017) highlighted various biophysical constraints and opportunities for increased crop productivity in the coastal area of Bangladesh, indicated that for intensification of cropping, other socio-economic barriers need to be considered in the framework of appropriate water governance policies. Improved cropping systems were kharif paddy-rabi paddy, kharif paddy-green gram, kharif paddy-ZT potato, kharif paddy-ZT potato-green gram, kharif paddy-Ridge potato, kharif paddy-corn, kharif paddy - vegetables and vegetable-vegetable-vegetable will take in to consideration in future growth have provided higher profitability over existing cultivation systems (Mandal et al, 2020). Furthermore, intensification of the proposed cropping system has the potential to increase cropping intensity to 200–300% in the study area from the existing 123% (Mandal et al, 2020). For better use of scarce freshwater resources, low cost drip irrigation systems can be promoted in the coastal area of West Bengal. Overall, the experiences of intensifying the cropping system in the field of farmers have opened up new opportunities (appropriate crops, soil and water

management), especially in the post-monsoon season (Rabi), even for smallholder farmers to increase cultivation intensities in the coastal area of West Bengal (Mahanta, 2004). However, small and marginal farmers need crop diversification to meet their cost of living, but the flexibility of farmers to respond to diversification opportunities is in most cases limited by the size of markets, risks, price, suitability of soils and quality of irrigation infrastructure, availability and cost of labor. (Makate et al., 2016).

It is considered to be one of the most environmentally friendly, cost-effective and rational ways to reduce skepticism in agriculture, especially with a focus on specialization and one or two crops (Sigh, 2002). It therefore has a wide potential to grow many crops by decomposing crops and intercropping. Further use of soil, crop rotation, intercropping and drip irrigation are effective measures to improve soil health, which facilitate minimal water use and reduce water pollution (Kumar et al., 2015). Therefore, sustainable economic intensity is only the future of agriculture, because this system is economically viable, environmentally safe and socially justified. Therefore, promoting rapid, sustainable and widespread development in agriculture is an important priority for the government (Sharma, 2007) as it plays an important role in the overall socio-economic development of the country.

III. LOCALE OF THE STUDY

South 24 Parganas is an important southernmost district of West Bengal, India (Fig.1). It is the largest district of West Bengal in terms of area covering an area of 9960 km2. The district is famous for the delta region called the Sundarban which is a tourist place that witnesses people from all over the world. The district is located on the southern part of West Bengal and has a lot of rivers and cluster of islands. South 24 Parganas lies between $21^0$19'00" N to 22^0 33'45" N and 88^0 03'45" E to 89^0 04'50" E. The district is surrounded by North 24 Parganas to the North, Howrah to the North-East, Purba-Medinipur to the west, Bay of Bengal to the South and Bangladesh to the East (GOWB, 2016). The district comprises of dense mangrove forest area as many rivers like Hooghly river from the western border of the Sundarban, Muriganga, Saptamukhi, Thakuran, Matla, Bidyadhari etc are flowing through this district (Choudhury, 2015). The land of this district is very fertile for newer alluviums. Major crops grown in this district are Paddy, Khesari, Potato, Mustard, Til, Wheat etc (Debnath, 2013). The mean maximum and minimum temperature is 36.3 degree centigrade and 13.3 degree centigrade respectively and annual rainfall ranges from 1750 mm to 1770 mm. The district presently has 29 community development blocks and 7 municipalities and 32 police stations. The district is comprises of 2042 villages and 111 Census Towns. According to 2011 census report, South 24 Parganas is the second most populous district of West Bengal, has a population density of 819 persons/sq km and sex ratio of 956 females per 1000 males. The literacy rate of the district is 77.51percent (GOI, 2011).

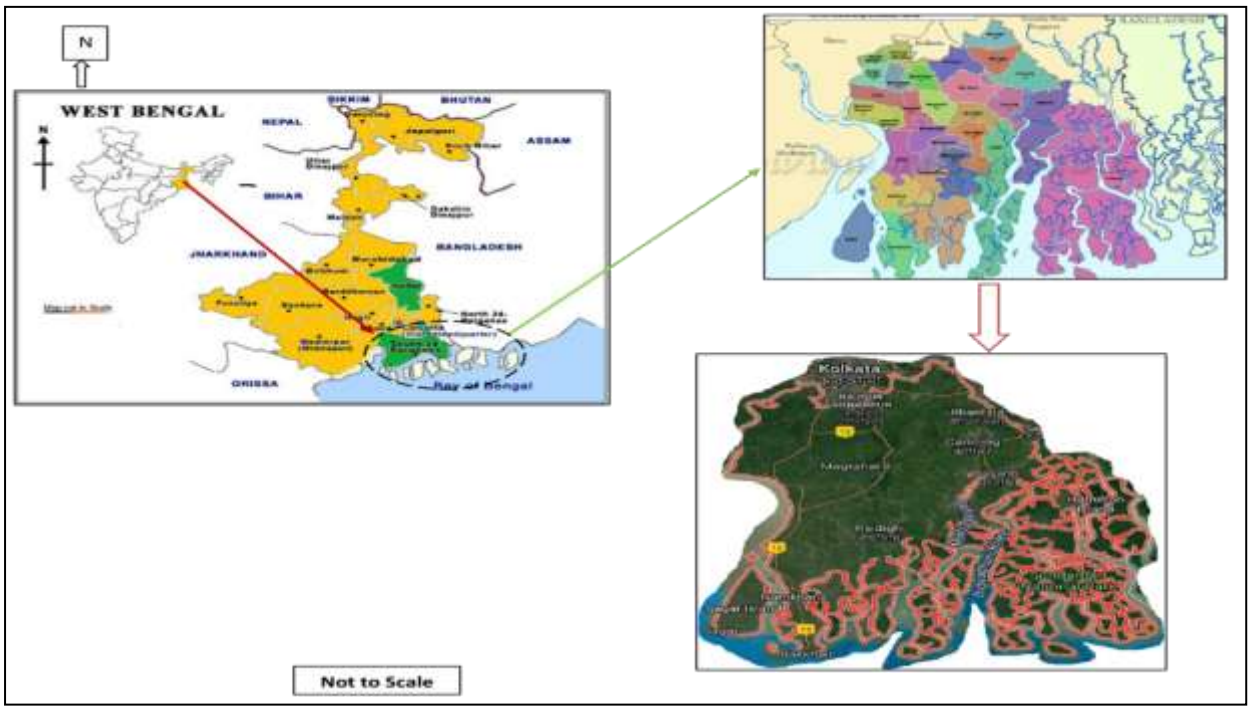


Figure 1: Location map of the study area

Source: By authors (From Google Maps)

In the South 24 Parganas, the cultivated area has gradually decreased while the area of land used for non-agricultural purposes has continued to increase (Table. 1). On the other hand, in the absence of extension of the irrigation facilities to the desired level, cultivation during the winter seasons becomes difficult (Bhattacharya et al, 2013). The problem is acute in the rice producing regions mainly, that is to say the southern blocks in particular. Government canals remained by far the main source of irrigation in this district in terms of area covered (Mandal and Dhara, 2012). Lack of adequate irrigation facilities is a major constraint leading to low crop intensity, less crop diversification and limited agricultural marketing. The crop's monoculture model is followed largely due to poor irrigation facilities and high soil salinity and less advance knowledge of the farmers (Das et al, 2016).

Table 1: Overview of agriculture of South 24 Parganas, West Bengal

Parameter	Description
Agro-Climatic Zone	Lower Gangetic Plain Region (Coastal Saline Zone)
Area (‘000 ha)	953.37
Major Soil	Clayey-Loamy (Saline Alluvial)
Net sown area (‘000 ha)	372.29
Area sown more than once (‘000 ha)	158.97
Gross cropped area (‘000 ha)	531.26
Cropping intensity (%)	159
Net irrigated area (‘000 ha)	115.73
Gross irrigated area (‘000 ha)	415.53
Irrigation Intensity (%)	30.91
Rainfed area (‘000 ha)	256.46
Cultivators (In 000)	362
Agricultural Laborers (In 000)	584
Small/Marginal Farmers (In 000)	325

Source: Economic Review, NABARD AND CRIDA, 2014-15

IV. METHODOLOGY AND DATA SOURCES

The research endeavor is to find out the spatial variation, concentration and diversification of crops in South 24 Parganas district during the period of 2014-15. The research work is based on secondary data taken from District Statistical Handbook, District Census Handbook and various other articles published on National and International journals and working paper by NABARD and CRIDA. Crop concentration indices for selected crops for all blocks has been calculated by using following Bhatia's Location Quotient Method and in order to measure the crop diversification, Gibbs and Martin’s (1962) formula has been used. Here, it should be mentioned that higher index values represent high concentration and vice versa. On the other hand, if value of diversification comes close to 1, the diversification will be higher. Besides for this purpose of this various mapping techniques and data calculation software of Statistical Package for SPSS 20 and Arc GIs Pro has been used to show block wise concentration and diversification of selected major crops in South 24 Parganas district. The intention is to make a more comprehensive comparative study across the C. D. Blocks of the district in terms of cropping concentration and diversification. A socio-economic regional classification of the twenty nine C. D. Blocks of this district has been used in this study for expediency of discussion (Table.2).

Table 2: Socio-economic regional classification of different blocks of South 24 Parganas district, West Bengal

Region	Location	Characters	Name of Blocks
I	North-western Region	Semi-transformed/ Semi-urban Region	Thakurpukur-Maheshtala, Budge Budge I, Budge Budge II, Bishnupur I, Bishnupur II, Sonarpur
II	North-east and Mid-western Region	Transforming Region	Baruipur, Bhangar I, Bhangar II, Falta, Diamond Harbour I, Diamond Harbour II, Kulpi, Magrahat I, Magrahat II, Mandirbazar
III	The Sundarban Region	Predominantly Rural and Backward Region	Canning I, Canning II, Basanti, Gosaba, Joynagar I, Joynagar II, Mathurapur I, Mathurapur II, Kultali, Patharpratima, Kakdwip, Namkhana, Saga

Source: Bagchi, 2017

A. Crop Concentration Index

Crop concentration means "variation in crop density in an area or region over a period of time" (Ghosh, 2011). The density of a crop in an area largely depends on its area, temperature, humidity, price and income, social factors, government policy, soil type and more. The most common method for studying crop density is Bhatia's position extract method. One of the classics studied on agricultural localization is Bhatia (1965)'s attempt to quantitatively research the regional nature of crop distribution (Gomati and Kumaraswamy, 2016). The geography of agriculture requires quantitative measures of crops to understand the physical and human interactions of an area (Rahman et al., 2015).

Cx = (x / y) / (x' / y')

Where, Cx = Crop concentration index

x = Area of particular crop in the component areal unit

y = Area of all crops in the component areal unit

x' = Area of particular crop in the entire region

y' = Area of all crops in the entire region

According to this method, high index value represent higher level of concentration of particular crop and low index value represent lower level of concentration of crops.

B. Crop Diversification Index

Crop diversification has a principle link in the planning of agricultural land use. Farmers all over the world, especially in developing countries, try to grow more than one crop on their farm during a farming year (Husain 1996). The nature of crop diversification does not match across the region as it is less heterogeneous in agro-climatic conditions. In this connection, socio-economic and technological factors also play an essential role in the evolution of crop diversification (Suryawanshi, 2010). However, in this modern period, the demand for various agricultural products has increased and therefore has an indirect relation with the diversification of crops. Furthermore, means of transport, market prices and high-yielding varieties have also influenced crop diversification (Mithiya et al., 2018). To understand the diversification in the different blocks of South 24 Parganas, here the Crop Diversity Index is tracked with reference to district wise circles in India using Gibbs and Martin's Diversification Index which provides a useful alternative index to measure the degree diversification in the cropping pattern in an area (Gangai, 2011).

$C.D = 1 - \Sigma x2 / (\Sigma x)\ 2$

Here, ' x ' is the percentage of total cropped area occupied by a particular crop.

According to this technique, crop diversification varies from 0.1 to 0.9. Generally, higher the index higher the diversification and lower the index lower the diversification. If the index came closer to 1 that means the diversification will be higher.

V. RESULT AND DISCUSSION

A. Pattern and role of crop concentration

Crop concentration indices for all blocks have been calculated by using Bhatia's mentioned method for major crops like Paddy, Khesari, Mustard, Potato, Til (Table.3) during 2014-15 of different blocks of South 24 Parganas, West Bengal. After ascertaining the indices values they are arranged in very high, high, moderate and low concentration zones. The results show that there is direct relationship between physical setup of the respective blocks of the study area.

Table 3: Block wise crop concentration in South 24 Parganas district, West Bengal during 2014-15

Sl. No.	C.D Blocks	Paddy	Khesari	Mustard	Potato	Til
1	Thakurpukur-Maheshtala	1.0597	0.0000	0.0000	0.0000	0.0000
2	Bishnupur-I	1.0597	0.0000	0.0000	0.0000	0.0000
3	Bishnupur-II	1.0597	0.0000	0.0000	0.0000	0.0000
4	Budge-Budge-I	1.0597	0.0000	0.0000	0.0000	0.0000
5	Budge-Budge-II	1.0597	0.0000	0.0000	0.0000	0.0000
6	Sonarpur	1.0537	0.3889	0.0000	0.0000	0.0000
7	Jaynagar-I	0.8686	2.4888	5.1347	2.2094	2.7074
8	Jaynagar-II	1.0597	0.0000	0.0000	0.0000	0.0000
9	Kultali	0.7457	6.3073	4.2555	4.8241	19.3467
10	Baruipur	1.0328	1.7492	0.0000	0.0000	0.0000
11	Bhangar-I	0.9571	0.0209	2.3898	1.2583	4.1725

12	Bhangar-II	0.8521	0.0997	7.0466	5.4001	3.1696
13	Canning-I	1.0399	1.0279	0.0000	0.5382	0.0000
14	Canning-II	0.8918	3.3151	1.0526	13.6074	0.0000
15	Basanti	1.0487	0.0213	0.0885	0.0000	0.0000
16	Gosaba	1.0524	0.0818	0.1393	0.2784	0.3542
17	Mograhat-I	1.0439	0.6852	0.0431	0.3280	0.0149
18	Mograhat-II	1.0223	0.3022	0.1491	0.6261	0.0000
19	Mandirbazar	0.9904	3.7319	0.0000	0.9848	0.0000
20	Kulpi	0.9931	3.2135	1.4459	0.0000	0.0404
21	Falta	1.0429	1.0975	0.0000	0.0000	0.0000
22	D. Harbour-I	0.8959	9.4109	0.4497	0.8122	0.0433
23	D. Harbour-II	0.9239	8.5838	0.0000	0.0000	0.0000
24	Mathurapur-I	1.0036	2.5954	0.3459	0.9052	0.0000
25	Mathurapur-II	0.9983	0.5055	0.0926	0.0063	0.0209
26	Kakdwip	0.9997	3.8314	0.0000	0.0000	0.0000
27	Namkhana	1.0313	1.2241	0.0434	0.1334	0.0000
28	Sagar	1.0441	0.5674	0.1042	0.1982	0.6144
29	Patharpratima	1.0151	0.0555	0.0575	0.1507	0.0000

Source: Computed by authors

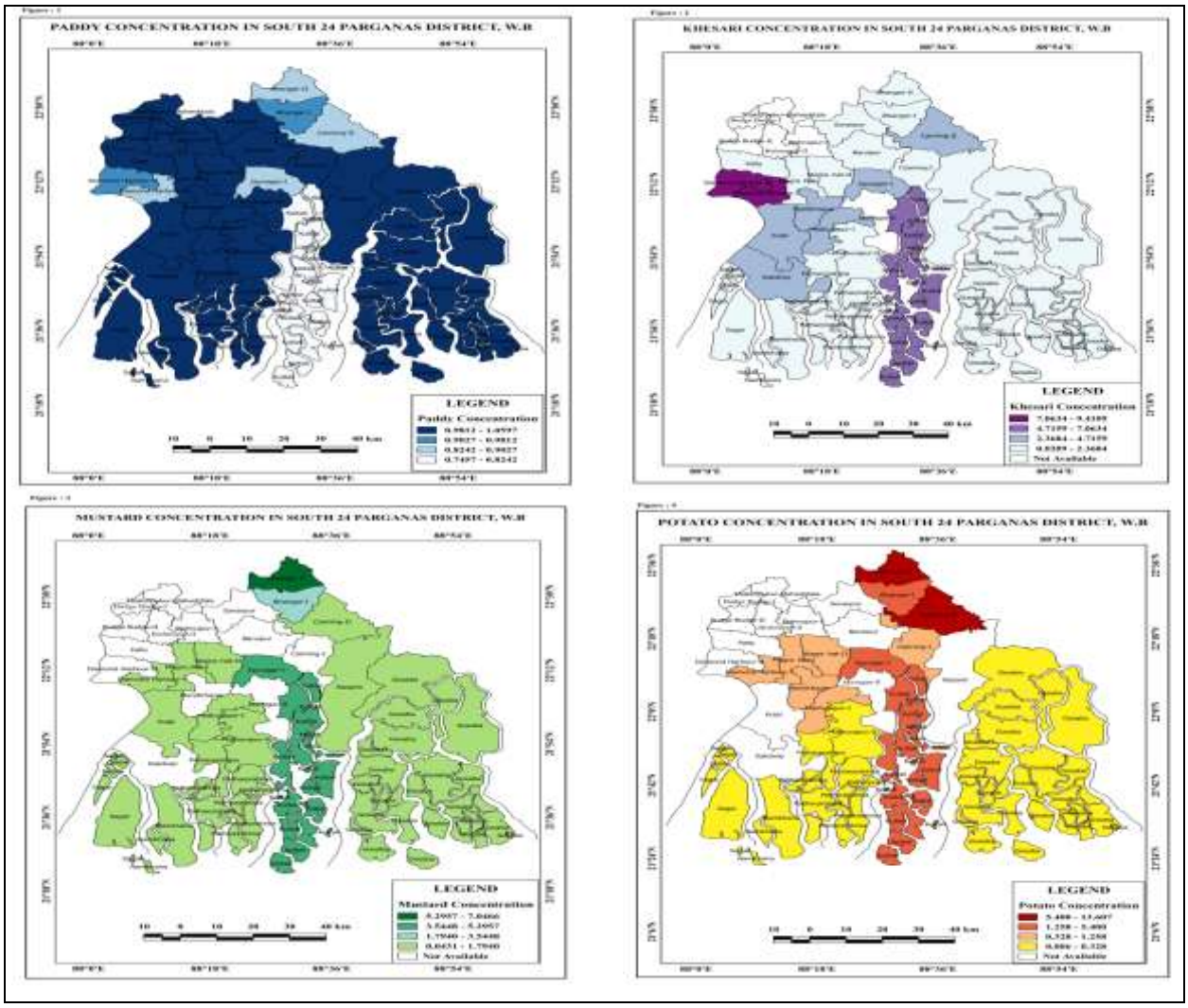
Figure. 2, clearly shows that Paddy is the most important as well as the leading crop of South 24 Parganas district as it is cultivated in all blocks. Very high concentration of Paddy is found in Thakurpukur-Maheshtala, Budge-Budge-I, Budge-Budge-II, Bishnupur-I, Bishnupur-II, Falta, Mograhat-I, Mograhat-II, Sonarpur, Baruipur, Canning-I, Mandirbazar, Jaynagar-II, Mathurapur-I, Mathurapur-II, Kulpi, Kakdwip, Patharpratima, Gosaba, Basanti, Sagar and Namkhana block. High concentration is found in Bhangar-I and D. Harbour-II block. Moderate concentration found in Bhangar-II, Canning-II, D. Harbour-I and Jaynagar-I block. Whereas, Kultali block has the lowest concentration of Paddy.

The second most important crop of this district is Khesari. It is cultivated in most of the blocks of South 24 Parganas. D. Harbour-I and D. Harbour-II block has the highest concentration of Khesari. Comparatively high concentration of Khesari is found in Kultali block. Moderate concentration is found in Canning-II, Jaynagar-I, Mandirbazar, Mathurapur-I, Kulpi and Kakdwip block. Sagar, Gosaba, Namkhana, Patharpratima, Basanti, Falta, Mograhat-I, Mograhat-II, Canning-I, Mathurapur-II, Sonarpur, Baruipur, Bhangar-I and Bhangar-II block. Whereas, Khesari is not cultivated in some blocks like Thakurpukur-Maheshtala, Bishnupur-I, Bishnupur-II, Budge-Budge-I, Budge-Budge-II, Jaynagar-II (Figure-2).

Mustard is another important crop of this district. Among 29 blocks Mustard is cultivated in 16 blocks in various proportions (Figure-3). Highest concentration of Mustard is found in Bhangar-II block. Jaynagar-II and Kultali block has comparatively high concentration of Mustard. Bhangar-I block has the moderate concentration. Low concentration of Mustard is mainly found in Canning-II, Gosaba, Basanti, Patharpratima, Kulpi, D. Harbour-I, Mograhat-I, Mograhat-II, Mathurapur-I, Mathurapur-II, Sagar and Namkhana block.

Potato is also another important crop of this district. It is cultivated in same number of blocks as Mustard in this district. Very high concentration of Potato is associated with Bhangar-II and Canning-II block. Relatively high concentration is confined into Jaynagar-I, Bhangar-I and Kultali block. Moderate concentration occurs in Canning-I, Mograhat-I, Mograhat-II, Mathurapur-I, Mandirbazar, D. Harbour-I block. Sagar, Namkhana, Patharpratima, Gosaba, Mathurapur-II block has comparatively low concentration of Potato. High concentrations of crops are found in mentioned blocks because of the presence of suitable agro-climatic conditions for agriculture in these regions.

Figure 2: Block wise distribution and degrees of crop concentration in four major crops in South 24 Parganas district, West Bengal during 2014-15



Source: Prepared by authors

B. Pattern and role of diversification of crop

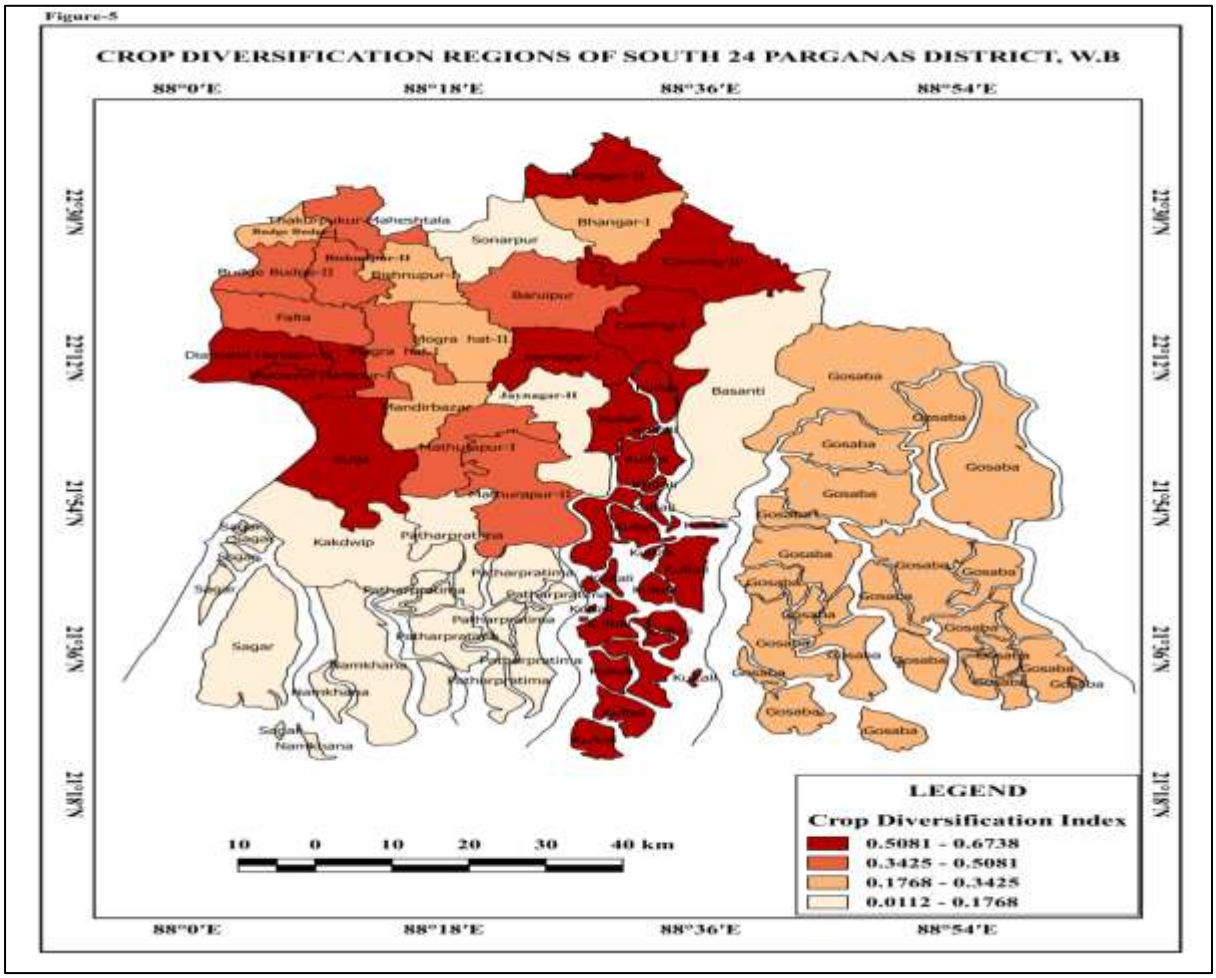
Crop diversification is very useful element for knowing which crop is best suited in a particular area or region. Simply it indicates the rising of various crops in a region and also enhances the agricultural output. It is intended to give a wider choice in the production of a variety of crops in a given area so as to expand production related activities on various crops and also to reduce risks (Lawin et al., 2019). Crop diversification indices for all blocks of South 24 Parganas have been calculated using Gibbs and Martin's method (Table .5). Based on indices values all blocks have been categorized into very high, high, medium and low diversification zone. Based on Figure 5, it is clear that very high level of crop diversification occurs in Kultali, Kulpi, D. Harbour-I, D. Harbour-II, Jaynagar-I, Jaynagar-II, Canning-I, Canning-II and Bhangar-II block. Comparatively high level of crop diversification is found in Mathurapur-I, Mathurapur-II, Mograhat-I, Falta, Budge-Budge-II, Bishnupur-II, Thakurpukur-Maheshtala and Baruipur. Moderate diversification found in Bhangar-I, Budge-Budge-I, Bishnupur-I, Mograhat-II, Mandirbazar and Gosaba block. Sagar, Namkhana, Patharpratima, Kakdwip, Jaynagar-II, Basanti and Sonarpur block belongs to the low crop diversification zone (Fig.3).

Table 5: Block wise crop diversification in South 24 Parganas district, West Bengal during 2014-15

Sl. No.	C.D Blocks	CDI*		Sl. No.	C.D Blocks	CDI*
1	Thakurpukur-Maheshtala	0.4692		16	Gosaba	0.2475
2	Bishnupur-I	0.2184		17	Mograhat-I	0.4455
3	Bishnupur-II	0.4327		18	Mograhat-II	0.3041
4	Budge-Budge-I	0.2335		19	Mandirbazar	0.2318
5	Budge-Budge-II	0.4563		20	Kulpi	0.5501
6	Sonarpur	0.0112		21	Falta	0.4024
7	Jaynagar-I	0.5395		22	D. Harbour-I	0.6738
8	Jaynagar-II	0.0218		23	D. Harbour-II	0.6043
9	Kultali	0.6447		24	Mathurapur-I	0.4057
10	Baruipur	0.4278		25	Mathurapur-II	0.4590
11	Bhangar-I	0.3059		26	Kakdwip	0.1095
12	Bhangar-II	0.6382		27	Namkhana	0.0557
13	Canning-I	0.5340		28	Sagar	0.0419
14	Canning-II	0.6271		29	Patharpratima	0.1436
15	Basanti	0.0499		* CDI = Crop Diversification Index		

Source: Calculated by authors

Figure 3: Block wise distribution and degrees of crop diversification in major crops in South 24 Parganas district, West Bengal during 2014-15

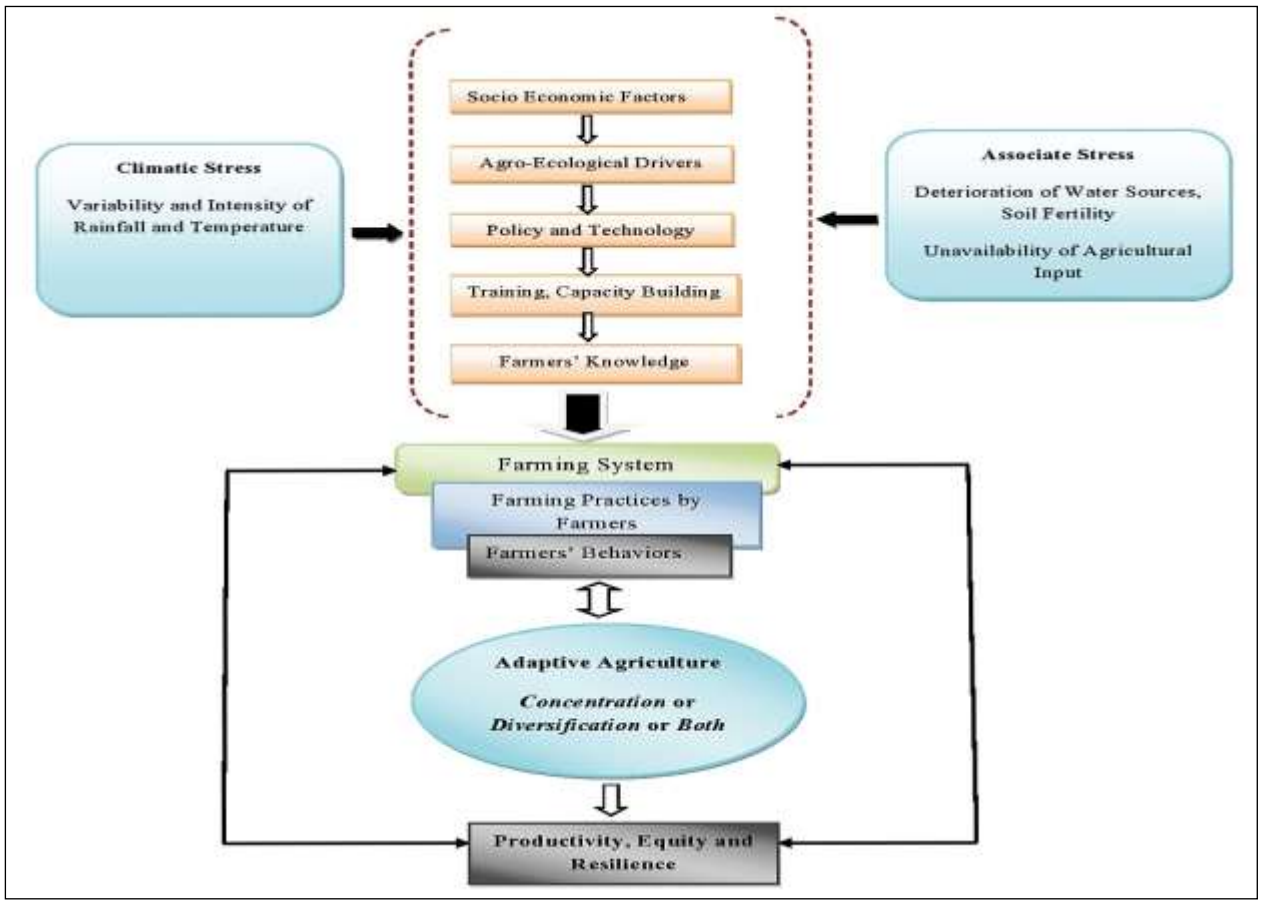


Source: Prepared by authors

C. From concentration to diversification possibility

Intense stress on rice mono culture affects crop diversification (Dhaliwal, 2019). Basically, lack of adequate knowledge about other profitable crops and their potential has forced farmers to practice rice cultivation. It is evident that, most of the blocks of South 24 Parganas, where the level of diversification is quite high, but where the shares of other crops to gross cultivated area (GCA) are actually insignificant (Table.5). Therefore, it is clear that the cultivation pattern of the district is influenced by the factors physical and socio-economic study region (Debnath, 2013). However, the growth in the proportion of the area of small and marginal farms has shown a significant positive impact on diversification towards potato and mustard. It is evident that in variations in market expansion, road densities, fertilizer use and minor irrigation, availability of irrigated water, farm size, farmers' knowledge shows that farmers' knowledge is significant are responsible for significant inter-block variations in South 24 Pargana district (Mandal et al., 2011). The political implication of the study can be affirmed that the creation of basic infrastructure with an appropriate link between a crop model optimizing water, climate-resistant crops (tolerant to salt) and appropriate irrigation techniques to create synergies between surface and groundwater in the study area is made for appropriate agricultural planning (Fig. 4). However, for a sustainable agrarian development, farming methods and techniques must be adopted after taking into account the agro-ecological constraints of a region (Agrell et al., 2004; Hussain et al., 2019).

Figure 4: Framework on sustainable agriculture



Source: By authors

VI. CONCLUSION AND SUGGESTION

The present study reveals that the cropping pattern of South 24 Parganas district is mainly oriented towards paddy as it is a dominant crop in this region. The fertile soil and suitable agro-climatic conditions contribute to good paddy production in this district. Although paddy is the main crop in this region, a number of crops like mustard, potato, khesari, til, wheat, etc. are still cultivated in this region. In South 24 Parganas, there is a spatial variation in the concentration of crops can be observed due to various influencing factors such as hydrological, educational, socio-economic and other conditions. The low level of crop diversification is mainly due to monoculture. This practice of monoculture is one of the biggest problems facing the

agricultural system of the country as it gradually weakens the resistance of the soil, thus harming the farmers as well as the hydro-landscape of this saline region. Strong crop diversification helps to change the way of cultivation and reduce risks. If a block has an appropriate rate of diversification, then the district will be a multi-stock area for crop diversification in favor of horticulture and cash crops. The reforms and policies adopted since the second green revolution have further accelerated the pace of diversification of the food basket. Among food grains, the area share of traditional rice varieties such as aus and aman will decrease while that of boro rice will increase considerably. Among non-food grains, the area shares of oilseeds, potatoes and pulses will increase to varying degrees. There will be an opportunity to move the acreage in favor of higher yielding and higher priced crops which are boro rice, potatoes and major oilseeds, legumes from different thriving blocks of South 24 Parganas. Evidence at the micro level suggests that some crops are more remunerative within given resource endowments and institutional framework. Farms in the region specialize in these crops and such specialization has not increased the risks on the farm.

Considering the scarcity of good quality irrigation water, especially during the dry months, promoting a drip irrigation system for growing high-value vegetables could be remunerative and the productivity of farmers. Crops can be multiplied by several with the available water resources. These interventions can significantly increase the incomes of smallholders by reducing the yield gap in the coastal area of West Bengal. Availability of good quality and quantity of irrigation water from ponds or canals, availability of timely inputs in common agricultural lands and risk management capacities of farmers were crucial to expand these cultivation systems over a larger area. For better use of scarce freshwater resources, low cost drip irrigation systems can be promoted in the coastal area of South 24 Parganas to diversify the food basket to reduce the area of water-intensive crops. Policy implications for crop diversification as a necessary strategy for agricultural development to improve agricultural resources, productivity and agricultural efficiency in India. Mainstreaming inclusion in decision making in crop choices and marketing in agricultural development not only improves the productivity of agriculture, but also strengthens the lives of marginal people in rural areas in the arena of the country's national food security mission. Besides, the management of the agricultural system and practices based on beliefs, the system of values, the norms and the practices of the community (of farmers), from the government to the local level agencies or formal or informal farmers' club. It has a very possible impact on a spatio-temporal scale for decentralized agricultural development (Pani and Mishra, 2019).

The study suggested that the government should take appropriate measures on the management of existing institutional drawbacks to strengthen the support system of the agricultural extension mechanism and develop education to improve the knowledge and capacity of farmers. Therefore, policies that support for the investment in research and development for salinity resistant varieties of crops, farming techniques and promote crop insurance, especially for non-traditional crops, can reduce production risks and therefore promote crop diversification. In addition, extension services should educate farmers on crop diversification to promote long-term agricultural development.

ACKNOWDLEMENT

Authors are also thankful to editor and reviewers for their constructive and insightful comments which have helped improve the paper immensely.

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