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CROP DIVERSIFICATION AND AGRO-ECONOMIC TRANSFORMATION: A SPATIO-TEMPORAL ANALYSIS IN NADIA DISTRICT, WEST BENGAL

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ABSTRACT

Located almost in the central part of Ganga delta and endowed with alluvial soil and resources, Nadia is one of the prosperous agricultural districts of West Bengal. Diversification in cropping pattern is a very recent phenomenon in Nadia district. The proportion of area under cereal crop cultivation has continuously decreased over the two decades; interestingly the proportions of area under other cash crops have continuously increased. The district is also blessed with a great deal of diversity of crops. In this paper an attempt has been made to delineate crop diversification regions using two different methods like Jasbir Singh and Allan Rojers method. Two sets of maps have been drawn for 1991, 2001 & 2011 separately to show both spatial & temporal changes in crop diversification in 17 Blocks of Nadia district. In 1991-1992 maps, very high crop diversification index was noted in only one block according to Jasbir Singh, whereas in Allan Rjers method it was 2 blocks. In 2001-2002 and 2011- 2012 the crop diversity regions are completely different according to 2 methods, not only in number of blocks but also in their location. Thus, from the above analysis it appears that crop diversification regions in Nadia District based on 2 methods are not only different spatially but also temporally influenced by other factors like physical, economic & cultural. In this context the paper also examines the impact of diversification on income and employment generation with the help of primary rural survey. It is clear from the result that diversification towards horticultural crops has significant positive impact on farmers income and employment.

KEY WORDS

Crop land use, Crop Diversification, Employment opportunity, Farmers' income.

INTRODUCTION

Agriculture is the most important sector of rural economy and an integral part of the entire economy. Though, the contribution of gross domestic product from agriculture and allied sector to national gross domestic product of India is continuously decreasing over the decade. Indian agriculture is also predominantly small and marginal farmers-based economy. In this situation it is very difficult by the farmers to improve their income only by improving the productivity of existing food grain crops. However, it is possible for farmer to improve their income only by introducing transformation of agriculture towards high value crops and agribusiness sector. This transformation being more labor intensive may provide stable employment and sustainable income to large part of rural household who faced the problem of unemployment and low income.

Crop diversification is an essential dynamic feature of agricultural growth and transformation. The level of crop diversification largely depends on the geo-climatic or socioeconomic conditions and technological development in a region. In general, it is saying that higher the level of agricultural technology, lesser the degree of diversification. Moreover, the rich farmers prefer to specialize in agricultural enterprise while the poor and subsistent farmers are generally more interested in the diversification of crops (Majid Hussain 1996)(1). Crop diversification is influenced by several infrastructural and technological factors like irrigation, high yielding variety of seeds, fertilizer, marketing facilities, transport, and communication facilities and so on(Bhattacharya 2008, Acharya et al 201) (2, 3). Dhawan et al., (1996) (4) examined the possibility of diversification of Indian agriculture from the point of view of food security. In this context, another state-wise study entitled, “Crop Diversification and Food Security” by Sharma et al., (1996) (5) showed that the percentage of area under cereals has been decreasing and that there is substantial scope for increasing the degree of diversification without adversely affecting food security for the nation.

Located almost in the central part of Ganga delta in West Bengal and endowed with fertile alluvial soil and ground water as well as surface water resources provided by a good network of rivers and their distributaries for irrigation, Nadia is one of the prosperous agricultural districts of West Bengal. Nadia is also an important district of West Bengal in the context of agricultural production. From a scrutiny of the percentage of area under major crop land for two decades of Nadia district shows that the proportion of area under cereal crop cultivation has continuously decreased from 1991(about 60 %) to 2011(about 42%). Interestingly the proportions of area under oil seed and other cash crops have continuously increased. It may therefore be hypothesized that the increasing pressure of population on land and low income had led to the conversion of the same area under cereal crop cultivation to an area under high value crop cultivation. Almost all-important crops like field crops, vegetables, fruits, and flowers are profitably grown in this district. Farmers are very interested in crop diversification techniques in view of avoiding uncertainty due to biological and climatic vagaries. It also enhances the net returns and overall productivity of farms. So, crop diversification is an essential dynamic feature of sustainable agricultural development. If it is possible so, the contribution of agricultural sector at least at substantial level to the gross domestic product is to be maintain and the negative growth of contribution is to be checked for smooth development of the economy.

The majorities of the existing literature as discussed, however does not through much light on the transforming agriculture towards employment generation and enhance household income of the farmers in the rural areas. So, this research carried out an in-depth study in micro level focusing on the transformation of agricultural practice to agro-based economic development of rural areas of Nadia district block level from 1991-2011.

STUDY AREA

The district of Nadia latitudinally extends from 22º52'30" N to 24 º54'N and longitudinally it is located between 88 º8'10" E and 88 º48'15" E. Therefore, the latitudinal as well as the longitudinal extension is 2 º1'30"and 40'5" respectively. It means the latitudinal extent of the district is almost equal to three times its longitudinal extent. This ratio is also reflected in the north-south and east-west extent of the district in kilometers where the N-S extension is 135 km, and the E-W extension is 45 km.

Nadia is one of those ten districts of West Bengal which has an international boundary with Bangladesh on its east. On the other hand, It is one of the four deltaic districts of West Bengal, besides Murshidabad, North 24 parganas and South 24 parganas. Sandwiched between Murshidabad in the north and North 24 Parganas in the south, this district is in the moribund deltaic part of West Bengal. In the west, it is bounded by the river Bhagirathi.

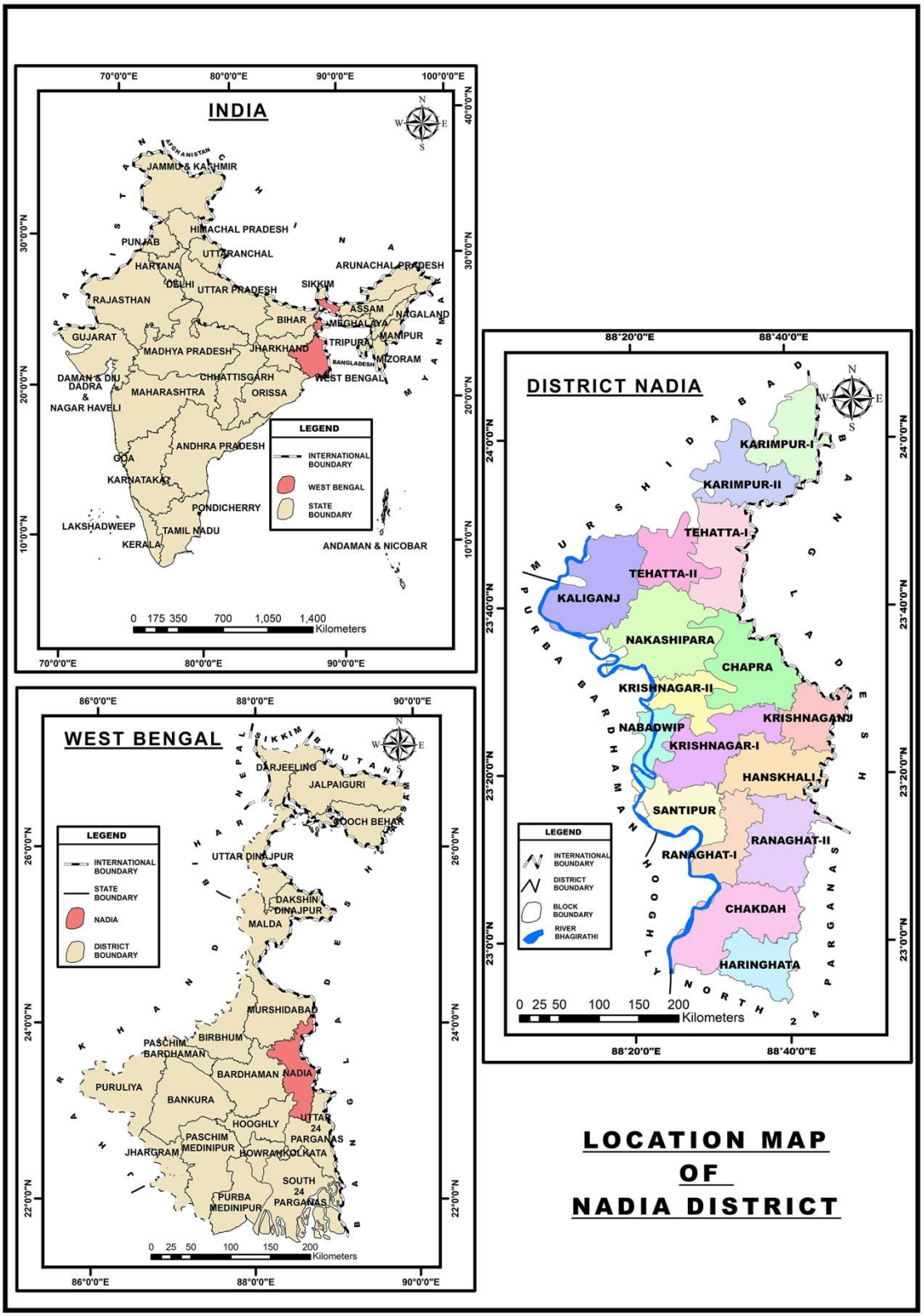

Figure 1: Location map of the study region, Source: Based on Census of India and Google Earth, 2019

STATEMENT OF THE PROBLEM

It is almost a general picture throughout India that the impact of the Green Revolution initiated in the mid-sixties of the last century was not equally felt not only in different States and Union Territories of India but also even in different districts within the same States. Nadia district is a good example of such a situation after Green Revolution we know that West Bengal was one of the few states of India where the impact of the Green Revolution on agricultural

production as well as crop diversification had significantly failed. As a matter of fact, in Eastern India perhaps West Bengal was the only state which was fortunate to implement different aspects of the Green Revolution namely irrigation, use of chemical fertilizer and HYV of seeds etc. because of its multipurpose river valley projects. However, in West Bengal at best five districts namely Bardhaman, Hoogly, Howrah, Birbhum and to some extent Bankura failed to receive any positive impact of Green Revolution as these districts were within the realms of the Damodar Valley Project and Mayurakshi Projects. Thus, Nadia was one of the remaining unfortunate districts of West Bengal where there was no canal irrigation required for chemical fertilizer and HYV seeds. In that respect, it is assumed in this research project that the absence of those elements of Green Revolution was a big handicraft to the crop diversification and agricultural transformation of the district. Nevertheless, there is an overwhelming use of chemical fertilizer and truck farming in the district depending on mainly shallow and deep tube well irrigation and river lift irrigation some extent.

OBJECTIVES

Against this background the objective of the present study are as follows:

1. To determine the crop diversity based on computing diversity indices considering the major crops grown in the study region.
2. To investigate the spatio-temporal nature in crop diversification of Nadia district from 1991 to 2011 and delineate the crop diversity regions at different levels.
3. To analyze the benefits of crop diversification and its impact on farmer's income and employment generation in rural areas of Nadia.

MATERIALS AND METHODS

Materials: The present study is based on both primary and secondary sources of data. Primary data was collected from village survey in Nadia district. Total 451 household was surveyed using stratified and simple random sampling. Secondary data collected from different published and unpublished report both State and Central Government sources such as:

Principal Agricultural Office, Krishnagar, Nadia. (ii) District Horticulture Office, Krishnagar. (iii) District Agricultural Marketing Office, Ranaghat. (iv) Department of Food Processing Industries Government of West Bengal, Kolkata. (v) District Industrial Office (MSME), Krishnagar. (vi) Agri-irrigation Department, Krishnagar. (vii) Department of Planning and Program Monitoring, Government of West Bengal, Kolkata. (viii) Bureau of Applied Economics and statistics, Kolkata.

Methodology: Crop diversification in any region at a given point of time may be derived by using several indices. Among many geographers who attempted to study crop diversification mention may be made off two Indian geographers-Bhatia (6) and Jasbir Sing (7) and two foreign geographers-Gibbs Martin (8) and Allan Rogers. From these only two Josbir Sing and Allan Roger's methods have been applied below to the degree of diversification of crop at block level for Nadia district since 1991 through 2001 to 2011.

Jasbir Singh's (1976) method is now elaborated as follows:

Crop Diversification Index= Total/N

Where, Total=∑Crops that individually occupy 5% or more of gross cropped area. N= Total number of crops.

The only difference between Bhatia's method &Jasbir Singh's method is that whereas Bhatia consider all those crops which occupy 10% or more of gross cropped area. Thus, it does appear that in all probability Jasbir Singh's method was a modified form of that of Bhatia.

Refined diversification index (RDI) according to **Allan Roger's** (1979) method is elaborated below as follows:

Refined diversification Index = (CDI for any block-CDI for district) / (Maximum CDI-CDI for district).

Where, CDI =∑Cumulative of cumulative % (% to total cropped area).

It is of special interest to note that whereas the earlier indices crude diversification index, this one is a refined diversification index, where refined diversification index is derivative of CDI. For calculating CDI according to Rogers for each block area of % under different crop were arranging descending order of magnitude then cumulative % were calculated and finally summed up to have the CDI of the block. In a similar way the CDI for the district of Nadia was also calculated. Science 7 crops were considered for the calculation of CDI of any block; the maximum cumulative % would be 700. Then the RDI for each block was calculated using the formula elaborated above.

Average net return: $\{\sum_{i=1}^{n}$ Gross return of crop (Rs/hectare) – Cost of cultivation of crop (Rs/hectare)$\}$/n, where n = no of crops

RESULT AND DISCUSSION

Changing pattern of crop land use: Cropping pattern is a good indicator of development of resource endowments and agricultural production. Selection of crops for cultivation depends on variety of factors; as a results, cropping pattern varies not only district level but also block level and village level too.

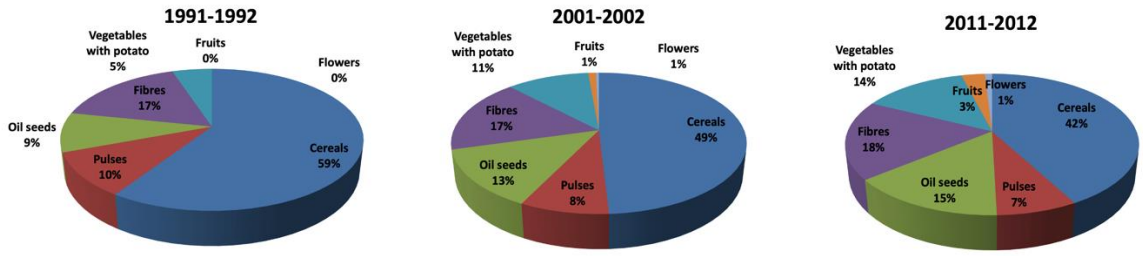

Figure 2: Changing pattern of crop land use from 1991 to 2011.

From the scrutiny of the percentage of area under major crop land use categories for two decades of Nadia district shows that the proportion of area under Rice and Wheat cultivation has continuously increased from 1991 to 2001 and decreased (Figure: 2) from 2001 to 2011. The share of pulses has also decreased from 10% in 1991 to 7% in 2011. Interestingly the proportions of area under oil seed, fiber and other horticultural crops have continuously increased. Almost the same pattern of change in share of cropped area of the district is reflected in the cropping pattern at village level (Figure 3). The area under vegetable and flower cultivation in Nadia district gradually increased but the maximum increase in vegetable has been reported in only five blocks Chakdah, Ranaghat-ii, Haringhata, Krishnagar-i and Nakashipara. The total area under flower cultivation was concentrated in only four blocks; the maximum increase in the area has been reported in Ranaghat-ii and Nakashipara. It is clear form the primary rural survey that the share of Rice has decreased from 46 % in 2001 to 34% in 2019 but the share of flower increased from 23% in 2001 to 44% in 2019 in Chapra village which belongs to Ranaghat-ii block. The vegetable and flower cultivation has immense potential for development of economic condition of fermers of the district; it plays a vital role in the empowerment of rural women as well as generates farm employment throughout the year.

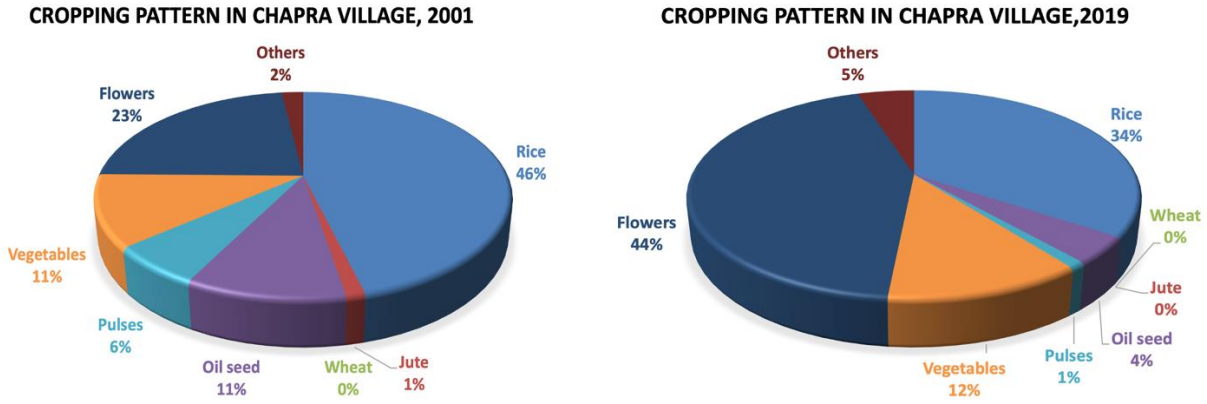

Figure 3: Changing pattern of crop land use in surveyed village Chapra, Block Ranaghat-ii.

Crop Diversification: Results of crop diversification is presented in Table 1 and 2.

Based on the data and methodology the corresponding calculations and maps have been prepared are as follows:

Table 1

Sl.No	Name of Block	1991	2001	2011
1	Karimpur-i	19.67	19.85	19.99
2	Karimpur-ii	19.67	19.99	19.99
3	Tehatta-i	19.56	19.96	19.89
4	Tehatta-ii	19.58	19.95	19.80
5	Kaliganj	19.55	23.99	22.95
6	Nakashipara	19.29	19.94	23.09
7	Chapra	19.95	19.96	19.98
8	Krishnaganj	19.88	19.91	24.02
9	Krishnagar-i	23.52	24.32	23.52
10	Krishnagar-ii	19.75	19.90	24.08
11	Nabadwip	23.75	23.51	19.87
12	Shantipur	19.00	19.62	19.38
13	Hanskhali	23.72	19.90	20.00
14	Ranaghat-i	23.41	24.21	24.49
15	Ranaghat-ii	19.87	24.19	24.49
16	Chakdah	29.89	30.32	31.35
17	Haringhata	19.13	23.42	31.45

Table 2

Sl.No	Name of Block	1991	2001	2011
1	Karimpur-i	152	9	251
2	Karimpur-ii	152	277	16
3	Tehatta-i	450	102	77
4	Tehatta-ii	39	384	133
5	Kaliganj	343	674	452
6	Nakashipara	122	472	336
7	Chapra	300	292	413
8	Krishnaganj	300	164	239
9	Krishnagar-i	413	638	375
10	Krishnagar-ii	346	481	337
11	Nabadwip	277	410	305
12	Shantipur	216	347	377
13	Hanskhali	571	486	479
14	Ranaghat-i	483	700	781
15	Ranaghat-ii	452	572	682
16	Chakdah	697	748	801
17	Haringhata	244	653	701

Table 1: Crop diversification index (CDI) according to Josbir Singh; Table 2: Refined diversification index (RDI) according to Allan Roger's method. Source: Computed by researcher.

Crop diversification index according to Josbir Singh:

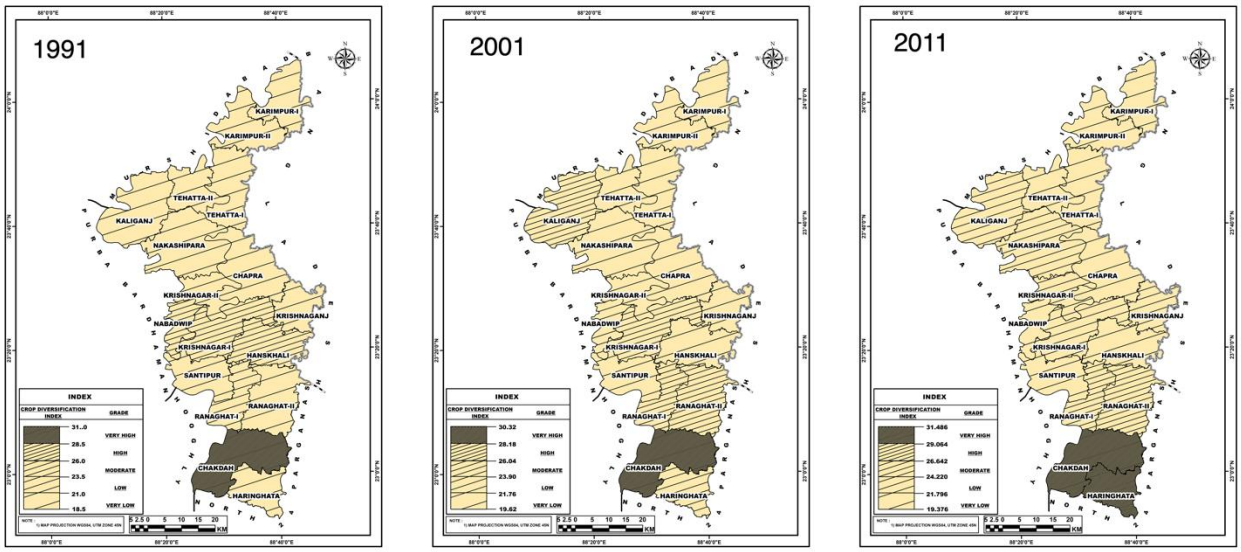

Figure 4: Crop diversification index according to Josbir Singh

From a comparison of three map of crop diversification in Nadia district for 1991, 2001 & 2011 reveals that the degree of diversification has gradually increased. For instance, in 1991 & 2001the degree of diversification has also exhibits almost the same pattern; there were only one block Chakdah recording very high degree of diversification. But in 2011 the degree of diversification has increased there were just two blocks namely Chakdah & Haringhata registering very high diversification of crops.

The above discussion thus reveals that the number of crops being cultivated in different blocks of the district has not only increased but their corresponding % of area has also increased.

Refined diversification index according to Allan Roger's: From a comparison of three map of refined diversification index in Nadia district for 1991, 2001 & 2011 reviles that the degree of diversification has increased in 2001 & then decreased in 2011. For instance, in 1991 there were 2 blocks namely Hanskhali & Chakdah recording very high and 3 blocks namely Ranaghat-I, Ranaghar-ii &Tehatta-I having high degree of diversification. But in 2001 there were 5 blocks namely Kaliganj, Krishnagar-I, Ranaghat-I, Chakdah, & Haringhata recording very high and 4 blocks namely Nakashipara, Hanskhali, & Ranaghat-ii having high degree of diversification. In 2011 there were just 4 blocks (Ranaghat-I, Ranaghat-ii, Chakdah & Haringhata) registering very high degree of diversification of crops.

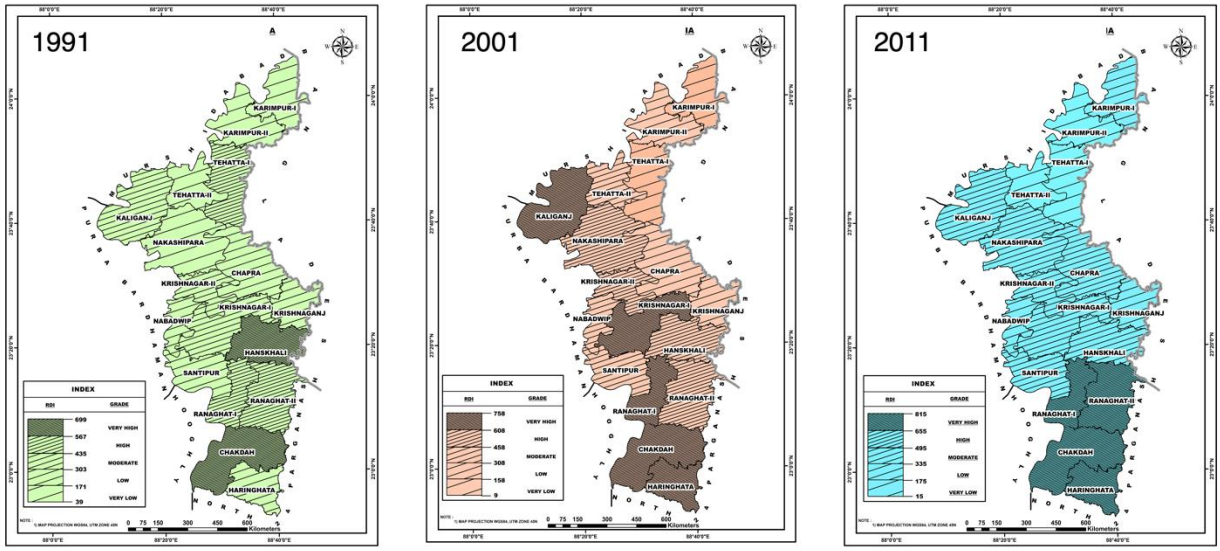

Figure 5: Refined diversification index according to Allan Rogers

Nadia district agriculture is mainly Rice dominant agriculture. Rice concentration is also high till now, but the magnitude of rice concentration has shown declining trend in this district over the two decades. From the secondary data analysis and from the primary rural survey it is clear that the Nadia district agriculture has diversified towards high value cash crops like vegetables, fruits, flower, plantation crop, oil seed, fiber etc.

The main advantage of all maps showing the level of diversification lies in the fact that it helps in the future planning and development of agriculture. In Nadia district, the regions or blocks which have high degree of diversification of crops generally deserve special attention of planners for development of agriculture. A comprehensive plan for each of the regions of high diversification may go a long way in enhancing their agricultural productivity and in reducing the regional inequalities in agricultural development and agro economic scenario also. There is increasing awareness among the exports of agriculture that crop diversification with suitable crop rotations is necessary for the maintenance of soil condition or soil fertility and for making agriculture more productive and sustainable.

The benefits of crop diversification and its impact on farmer's income and employment generation in rural areas of Nadia: It is clear from the results that the crop diversification is taking place for economic development in the study region. The high value horticultural and commercial crops are found to be carrying significant potential for expand farmers' income and provide them employment throughout the year (Debasis Mithiya et al 2018) (9). It shows there is a direct impact on income and employment by diversification of crops, but the indirect effects are also present. Increase in the high value horticultural crops like fruits and vegetables, results in increased the development of processing industry that demands more labor also for these activities.

From the primary rural survey, it is clear that crop diversification can help in generate additional employment opportunities in rural areas.

Crops	Nursery	Transplanting	Whole cultivation process	Picking or Harvesting	Total labor
Rice	6	45	30	100	181
Jute	5	5	75	220	305
Brinjal	5	30	200	150	385
Cabbage	5	30	170	105	310
Cauliflower	5	30	170	110	315
Parwal	5	15	665	160	845

Table 3. Requirement of labor for some selected crops (per hectare) in Nadia district, Source: Field survey, 2019

Per hectare requirement of labor for different crop cultivation collected from primary rural survey (Table: 3) which indicates that vegetable cultivation as compared to cereal crop cultivation requires a large number of operations like nursery, land preparation, transplanting, frequent watering, spraying, digging, hoeing, staking, picking or harvesting etc. So, the per hectare labor requirement for vegetable crop cultivation is not only much higher but also more evenly distributed throughout the period of crop cultivation. In case of cereal crops, the major labor requirements are during sowing and harvesting times of the crop. It also creates labor problem for that time among all cultivators. In case of parwal cultivation the labor requirement is very high from other vegetables. The process of prawal cultivation needs

the manual cross pollination which is very labor intensive; for this purpose, female worker is more suitable than male. It has been estimated that one hectare shift in area from Rice to Parwal would generate about 650 additional labor days. From this analysis it is hypothesized that diversification towards high value horticultural crops and commercial crop provides more employment opportunities in compared to cereal crops in Nadia district.

The present study expects to show that the horticultural crops generated more income for the farmers compared to cereal crop. The analysis has been done using data (Table: 4) collected from primary rural survey.

Name of crops	Gross return	Cost of cultivation	Average Net return
Rice	81075	71140	9935
Jute	152200	77210	74990
Oil seed	96000	39195	56805
Pulses	54750	29600	25150
Vegetables	680000	421000	259000
Flower	675000	166200	508800

Table 4: Average Net Return from different crops (Rs/hectare). Source: Field survey, 2019 (Village Chapra, Block Ranaghat ii, N= 97).

The main driving force for shifting production portfolio in favor of high value horticultural crop is higher profitability. It is revealed from analyzing Profitability of different agricultural crops in surveyed villages that most of the horticultural crops are more profitable than cereal and other crops. The average net returns per hectare from vegetable, flower, jute, oilseed, pulses are Rs 259000, Rs 508800, Rs 74990, Rs 56805, and Rs 25150 respectively. On the other hand, net return from rice have remained quite low, per hectare net return from rice is Rs 9935. Therefore, the above discussion clearly reveals that diversification towards horticultural crops would generate considerable income and employment opportunities for farmers, particularly marginal and smallholders.

CONCLUSION

It is evident from the whole analysis that agriculture which was the backbone of economy of Nadia district has undergone a huge transformation for the last two decades as a result the economy has also changed. The share of major crops like rice, wheat, pulses has decreased over the two decades, the main reasons underlying the diversification is in favor of horticultural crops have witnessed higher net return relative to food grain crops.

It can be inferred that diversification towards horticultural crops has significant positive impact on farmers income and employment. Thus, crop diversification towards high value crop should be promoted for the development of processing industry and agri-business sector as well as economic development of Nadia district or any region of the country.

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