

# Chapter 7

## Household Analysis of Crop Diversification and Socioeconomic Classifications of Agriculture Practitioner



Rukhsana and Asraful Alam

**Abstract** Crop diversification is a significant tool for the acceleration of agricultural development in developing countries by supporting income, employment generation, food and nutritional security, poverty alleviation, and ecological management. The farming system in West Bengal is being shifted by integration between a set of cash crops and main food cropping process. This transformation into diversified farming systems, where smallholders have a production base in rice, can affect output complementarity, technical efficiency, and performance of farms. This study aims to examine the status of crop diversification and effects on smallholders based on both primary and secondary data. The results of the study show that agricultural sector of West Bengal is gradually diversifying toward high-value commodities.

**Keywords** Agriculture · Household · Demography · Education · Economy · Crop diversification

### 7.1 Introduction

Despite substantial improvements in food security over the last few decades, under-nutrition remains a global burden. Approximately 800 million people are chronically hungry, most of them living in developing countries (Food and Agriculture Organization of the United Nations 2015). Global agricultural systems are currently undergoing rapid changes. The acknowledged responsibility of agriculture for environmental degradation, the changes in the demand for food and nonfood products, the globalization of trade leading to fluctuations in the prices of farm products,

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and the changing role of agriculture in territories are major driving forces which require a shift toward new production systems (Meynard et al. 2012). Conservation agricultural systems represent a break with conventional practices. Today, farmers throughout the world face a wide range of situations and significant variability in the efficiency of CA systems (Erenstein 2012). The movement of low-value agriculture to high-value agriculture includes crop diversification pilots that increase agricultural production. Crop diversification has become an important option in developing countries to achieve the objectives of production growth, employment generation, and sustainability of natural resources (Petit and Barghouti 1992). Crop diversification is necessary for an agro-based economy. Over the years, practices known to farmers have forced them to diversify agricultural activities to meet their families' cash needs and water tables, reducing floods and droughts, climate change, and net sown to reduce risks such as reducing the area (Sinha and Ahmad Nasim 2016). Crop diversification is getting a lot of attention due to the availability of resources, market infrastructure, public participation, research, development, price, policies, and globalization of agriculture (Singh et al. 2013). Crop diversification has a variety of benefits, including income growth, poverty reduction, food and nutritional security, employment generation, proper use of land and water resources, sustainable agricultural practices, and environmental development; also in many situations, diversification is needed to restore degraded natural resource base or improve natural resources. It is generally said that cropping systems have diversified or that new cropping systems have been introduced to maintain or increase the value of natural resources. It has also been observed that due to the pattern of diversification, diversification tends to stabilize agricultural income at higher levels, such as accommodating more and more rewarding crops (Saleth and Maria 1995). Crop diversification is an important scientific method and relates the spatial variation of crops to each other, which directly defines the number of crops growing. It focuses on a movement of low-value to high-value agriculture and is an important way of increasing agricultural production (Dutta 2012). Crop diversification is fundamentally regulated by both physical and socioeconomic conditions of the region where there will be a higher level of agricultural technology and a lower degree of diversification (Raju 2012). Farmers are more vulnerable to the overall effects of climate change since they have limited resources to invest in expensive coping strategies (Lin 2011). Farmers' access to production factors (land, capital, labor, inputs, mechanization, and knowledge) varies greatly not only between countries but also between regions and even between different types of farms in one country. For these reasons, cropping systems need to be tailored to local conditions; a range of different agricultural systems needs to be co-designed with the farmers at field, farm, and landscape scales; and supporting measures need to be developed to accompany agricultural extension activities (Husson et al. 2015). Diversity of livelihoods and farmers' strategies is one of the backbones of sustainability, as it is through diverse farm livelihoods that greater resilience against stresses and shocks may be ensured (Block and Webb 2001; Ellis 2000; Tesfaye et al. 2004). At regional level, sustainability targets call for a holistic perspective taking into account the whole range of farmers' responses.

**The following objectives** have been taken into consideration for the study: first to explore regional disparities and status of crop diversification at the district level in West Bengal, second to check the status of crop diversification to small farmers at household level, and third to make suggestions and options for furthering the diversification toward the sustainability of agriculture in the region.

## 7.2 Study Area

The state is situated between  $21^{\circ}31'$  and  $27^{\circ}13'14''$  North Latitudes and  $85^{\circ}45'20''$  and  $89^{\circ}53'$  East Longitudes. The total geographical area of the State of West Bengal is 88,752 sq km, which constitutes about 2.7% of the total land area of the country. West Bengal is organized into 19 districts, 66 subdivision, and 341 development blocks (Census 2011). It is a state in the eastern zone of India which has a wide range of physical variety and shares international borders with Bangladesh and Nepal. In West Bengal, diversification in cropping pattern is a very recent phenomenon other than the case of plantation crop tea, from the pre-independence period. It is basically a rice-producing state which has achieved a very high level of productivity in paddy cultivation during the 1980s and 1990s and is now the largest producer of rice in the country. However, diversification toward high-value crops is being considered as a way to increase the contribution of non-rice crops to output ratio to attain higher agricultural growth rates in the future. Besides enhancing growth, it is felt that diversification will also be able to contribute toward a higher nutrition level, poverty alleviation, employment generation, and sustainable natural resource management.

## 7.3 Materials and Methods

The present study is based on both primary and secondary data which have been collected from various issues of Statistical Abstract and Economic Review of West Bengal, published by the Bureau of Applied Economics and Statistics, Government of West Bengal. For the study of the extent of diversification, there are various methods which are available in the literature. There are number of statistical methods which measured the magnitude of diversification including index of maximum proportions, Simpson index, entropy index, modified entropy index, composite entropy index, ogive index, Herfindahl-Hirschman index, etc. Benin et al. (2004) and Chand (1996) have used these indices in their studies. Each of these tools has its own advantages and limitations in terms of data requirement, level of sophistication, and ease of computation and interpretation. Additionally, the results obtained through these methods are more or less similar.

Crop diversification index (CDI) in determining crop diversification for the particular crops of interest has been computed. The CDI has been obtained by subtracting the Herfindahl index (HI) from one. The CDI is an index of concentration

and has a direct relationship with diversification such that a zero value indicates specialization and a value greater than zero signifies crop diversification. Thus, it becomes easy to identify those farmers that are practicing crop diversification.

To delineate the crop diversification region in the study area, Herfindahl index formula has been applied. Herfindahl index given below is computed by taking the sum of squares of acreage proportion of each crop in the total cropped area. Mathematically, the index is given as below:

$$\text{Herfindahl Index (HI)} = \sum_{i=1}^N P_i^2$$

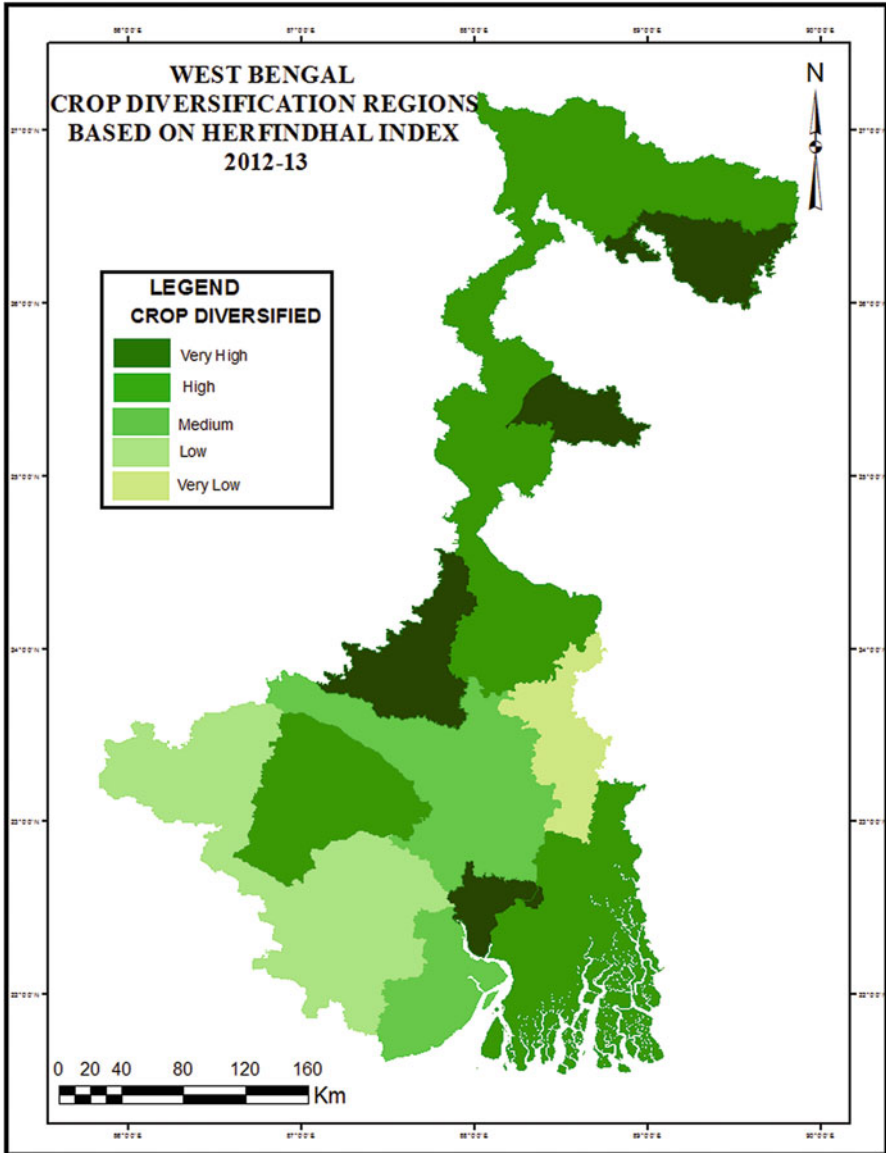
where  $N$  is the total number of crops and  $P_i$  represents the area proportion of the  $i$ th crop in total cropped area. With the increase in diversification, the Herfindahl index would decrease. This index takes a value 1 when there is complete concentration and approaches 0 when diversification is perfect. Thus, the Herfindahl index is bounded by 0 and 1.

### 7.3.1 Process of Selection of Sample Study Area

Primary information has been collected through intensive field survey. For field investigation, 15 sample blocks, 68 villages, and 1472 households of West Bengal have been selected from 3 districts based on stratified and purposive sampling. Firstly, West Bengal has been divided into five regions, very high, high, medium, low, and very low in crop diversification regions (Fig. 7.1) on the basis of secondary data in order to find out the volume interdisparities in agricultural practices. Secondly, from each of crop diversification region, three districts have been chosen (Fig. 7.2), and one district has been chosen from each category of crop diversification region (5% of the total districts). Thirdly, selected districts again have been categorized into three regions of crop diversification (very high, high, medium, low, and very low). Fourthly, a total of 1472 households based on 15% sampling figured out has been randomly selected from the total household of each selected village (total sample 68 villages, 3% sampling of the total number of villages of selected block). Survey has been done with the help of well-prepared questionnaire.

## 7.4 Results and Discussion

West Bengal is mainly divided into five categories (very high, high, medium, low, and very low) based on the Herfindahl index of crop diversification. Table 7.1 depicts that the present scenario of crop diversification in West Bengal during 2012–2013 significantly moves as compared to the previous records of agricultural sector. Figure 7.1 describes the annual crop diversification index by regions in West



**Fig. 7.1** Crop diversification in West Bengal regions based on Herfindahl index

Bengal. The sample mean of the Herfindahl index is 0.057 which counted as the highest Herfindahl index. Conversely crop diversification mainly occurs in northern regions of West Bengal. Figure 7.1 and Table 7.1 portrayed that District Howrah is the very highest diversified district followed by Dakshin Dinajpur (0.01), Birbhum (0.01), and Cooch Behar (0.01) while highest diversification reported in eight

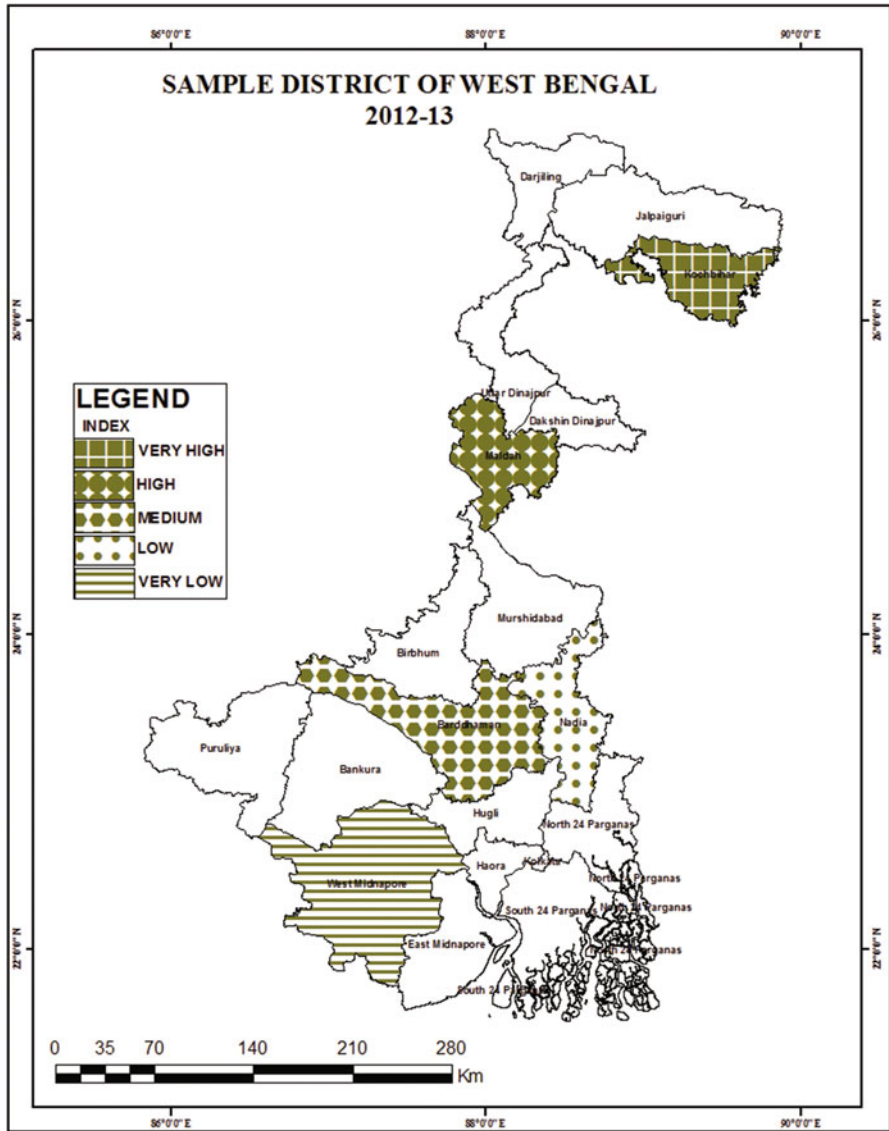


Fig. 7.2 Sample district in West Bengal regions based on Herfindahl index

districts, namely, South 24 Parganas (0.03), North 24 Parganas (0.02), Bankura (0.02), Jalpaiguri (0.03), Uttar Dinajpur (0.02), Malda (0.03), Murshidabad (0.03), and Darjeeling (0.04) in terms of agricultural practices during 2012–2013. Therefore, it is observed that districts like Birbhum along with Uttar Dinajpur have made tremendous improvement in terms of crop diversification during the said period in the State of West Bengal. The moderate diversification has been noticed in the

**Table 7.1** District-wise disparity of crop diversification in West Bengal

S. no.	Name of the district	2012–2013
1	Burdwan	0.06
2	Cooch Behar	0.01
3	South 24 Parganas	0.03
4	North 24 Parganas	0.02
5	Bankura	0.02
6	Dakshin Dinajpur	0.01
7	Darjeeling	0.04
8	Howrah	0.00
9	Malda	0.03
10	Hooghly	0.08
11	Jalpaiguri	0.03
12	Murshidabad	0.03
13	Nadia	0.25
14	Paschim Medinipur	0.17
15	Purba Medinipur	0.08
16	Uttar Dinajpur	0.02
17	Purulia	0.13
18	Birbhum	0.01
Total average		0.057

*Source:* Compiled by the author after taking from Statistical Handbook West Bengal (2011), Bureau of Applied Economics and Statistics Department, Kolkata, West Bengal

districts of Hooghly (0.08), Burdwan (0.08), and Purba Medinipur (0.08). These districts have made significant improvement in agricultural field in general and crop diversification in particular during 2012–2013 due to improvement of irrigation facilities and changes in institutional holding size and accessibility to market.

From three categories of West Bengal crop diversification region, three sample districts have been selected which include *Cooch Behar District* from very high diversification region, *Bardhaman District* from medium category of diversification, and *Paschim Medinipur District* from low diversification region. Five from each sample district with a total of 15 sample blocks have been chosen for field investigation (Fig. 7.2).

Table 7.2 describes that out of the total sample population (6608) of the total sample household (1472), the percentage of male (52.66%) is found to be more than the female (47.34%) population. On the other hand, the highest percentage of female population have been registered in Tufanganj I block (50.82%) followed by Mathabhanga II (52.03%), Katwa II (50.57%), and Sabang (51.24%), while the remaining sample block was reported highest in male than female population. The role of education in improving the choice and quality of lives enhances social and economic growth. The same table reveals that out of the total sample population, more than 71.78% of the population are literates, where the highest literacy rate is found in the blocks of Sabang (92.72%) while lowest found in Ketugram II (47.22%).

**Table 7.2** Distribution of sample villages, sample household, population, and sex ratio in selected blocks

S. no.	Sample districts	Name of the sample blocks	Total no. of sample villages	Total sample household/respondent	Total sample population	Sex structure		Literate population	Illiterate population
						Male	Female		
1	Cooch Behar District	Tufanganj I	2	28	122	49.18	50.82	65.57	34.43
2		Mathabhanga II	2	89	394	47.97	52.03	75.13	24.87
3		Tufanganj II	2	116	505	50.1	49.9	69.7	30.3
4		Mekhliganj	5	260	1147	52.66	47.34	67.61	31.39
5		Sitalkuchi	2	37	160	57.75	41.25	77.5	22.5
6	Bardhaman District	Jamuraia	1	25	96	47.96	51.04	62.5	37.5
7		Katwa II	2	40	176	49.43	50.57	67.18	31.82
8		Katwa I	2	263	1199	51.54	47.46	69.97	30.03
9		Ketugram II	2	24	144	76.39	23.61	47.22	52.78
10		Jamalpur	4	146	677	51.11	47.89	67.98	31.02
11	Paschim Medinipur District	Keshpur	18	146	638	50.31	49.69	70.53	29.47
12		Garbeta II	9	70	323	52.8	47.2	90.4	9.6
13		Mohanpur	3	53	222	47.65	51.35	77.48	22.52
14		Sabang	7	128	604	50.83	49.17	92.72	7.28
15		Sankrail	7	47	201	51.24	47.76	72.14	27.86
Total			68	1472	6608	52.66	47.34	71.78	27.22

Source: Primary survey (2017–2018)



**Table 7.3** Distribution of income structure (in percentage) in the selected block according to respondents from sample villages

Name of blocks	Income structure (%)			Monthly average per capita income
	Below 4000	4000–8000	Above 8000	
Tufanganj I	39.29	35.71	25	1934
Mathabhanga II	41.57	32.58	25.84	1898
Tufanganj II	41.38	37.07	21.55	1853
Mekhliganj	42.31	37.08	19.62	1786
Sitalkuchi	59.46	29.73	10.81	1500
Jamuria	50	45.83	4.17	1583
Katwa II	23.08	47.72	27.21	2068
Katwa I	36.5	47.15	16.35	1721
Ketugram II	42.31	50	7.69	1250
Jamalpur	37.58	50.34	12.08	1643
Keshpur	36.49	37.51	25	1981
Garbeta II	44.95	44.95	10.09	4731
Mohanpur	37.6	37.5	23.9	10,252
Sabang	57.61	31.17	11.22	4377
Sankrail	27.23	47.21	24.55	19,781
Total average	41.22	41.04	17.74	3891

Source: Primary survey (2017–2018)

**Economic Classification of Sample Population** Table 7.3 shows the block-wise distribution of monthly income structure in the selected study area. Some of the villages, namely, Sitalkuchi (59.46%), Sabang (57.61%), Garbeta II (44.59%), and Ketugram II (42.31%), have been suffering due to poor economic condition; almost 50% household of these blocks are coming under the income group of <4000. Only 17.74% family has their monthly family income above 8000. The total monthly average of per capita income is 3891 rupees that is very crucial to fulfill their basic needs of the total sample population. Some serious steps should be taken to create equality in income structure and better economic condition among household. These are to create employment avenues for smallholders outside agriculture and increase agricultural productivity; small as well as marginal farmer's supplementary sources of income, i.e., poultry, dairying, etc., can directly increase their income level.

#### 7.4.1 Crop Diversification at Household Level

Though, agricultural sector made immense progress in terms of the total output of different crop productions, but Indian agricultural sectors still bear some traditional problems associated with it like dominance of small and marginal farmers, fragmented and smallholdings, rural poverty, lack of modern means and technology,

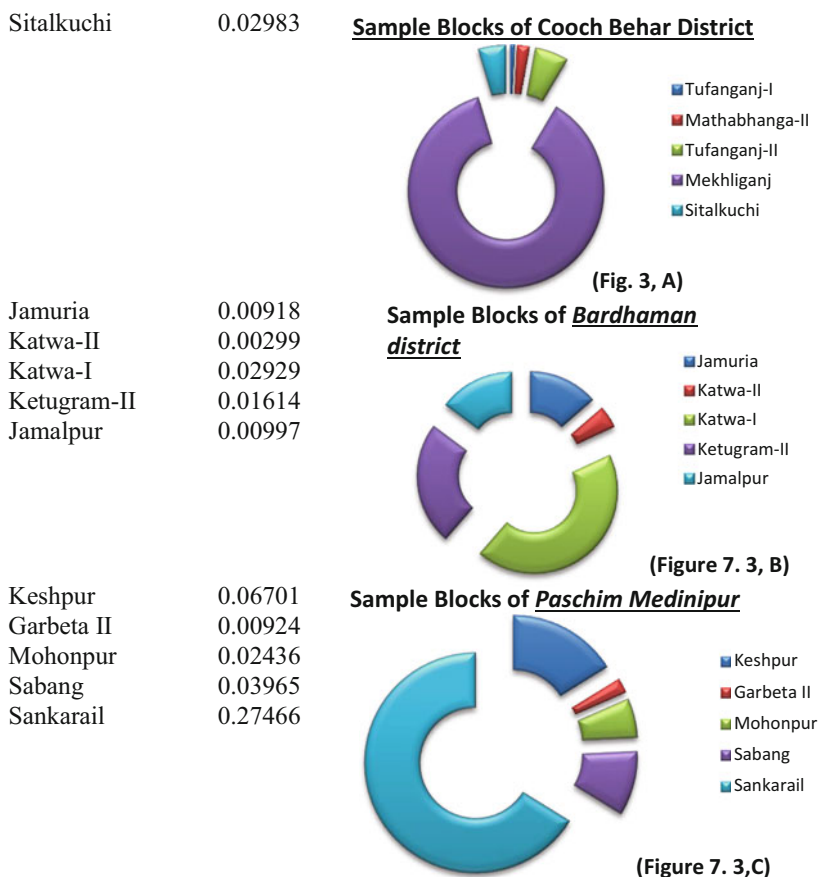
**Table 7.4** Distribution of crop diversification based on Herfindahl index in the selected block

Name of the block	Crop diversification based on Herfindahl index	
Tufanganj I	0.005	Figure 7.3a
Mathabhanga II	0.0137	
Tufanganj II	0.03654	
Mekhliganj	0.56434	
Sitalkuchi	0.02983	
Jamuria	0.00918	Figure 7.3b
Katwa II	0.00299	
Katwa I	0.02929	
Ketugram II	0.01614	
Jamalpur	0.00997	
Keshpur	0.06701	Figure 7.3c
Garbeta II	0.00924	
Mohanpur	0.02436	
Sabang	0.03965	
Sankrail	0.27466	

Sources: calculation based on collected data from field survey at household rank during 2017–2018

heavy dependency on monsoon, etc. In addition, to understand the diversification at village level, information of district-level agricultural practices have been analyzed. Further, to consolidate the block level, Herfindahl index has been utilized to understand the disparity of agricultural diversification in different sample blocks at household level.

Table 7.4 shows the crop diversification by Herfindahl index of sample block. From the Herfindahl index, it has been mentioned that the highest diversification was found in blocks Katwa II (0.002), Tufanganj (0.005), Jamuria (0.009), Jamalpur (0.009), and Garbeta (0.009). The sample blocks are geographically located in river-based area in that this area is getting sedimentary fertile soil during flood condition frequently. As a result, various types of crops have been grown in this area compared to other districts. All figures in Fig. 7.3 portray the analysis of crop diversification in sample block of selected districts at household point. Based on household survey conducted in 5 blocks of selected 5 districts with 1472 households, it shows a great variation in sample blocks with more diversified agriculture in Tufanganj I, Ratua II, Garbeta II, Jamalpur, Jamuria, and Katwa II, and the remaining blocks have been reported to be less diversified in terms of agriculture. Figure 7.3a shows that only one block, i.e., Mekhliganj, has very lowest crop diversification due to the cultivation of only one crop, namely, tea, while highest diversification was found in Tufanganj I; these blocks are located in Cooch Behar District selected from very high diversified regions of the state. The findings of the study show that the level of crop diversification varies across the regions and different income groups. On an average, the households in the sample study area grow more than doubled crops, with the highest number of crops being grown by the cultivator group, the households in sample study area growing at most two crops, with as high as 17.08% of sample households



**Fig. 7.3 (a-c)** Distribution of crop diversification based on Herfindahl index in the selected block. (Sources: calculation based on collected data from field survey at household rank during 2017–2018)

growing only one crop per annum. There is a low level of crop diversification in Mekhliganj, Sankarali, Sabang, Mohanpur, and Keshpur blocks; these sample blocks lie in selected districts from lowest diversification region of the state except Mekhliganj, which has a lack of awareness about diversification, weak socioeconomic in nature, nonavailability of quality seeds, and presence of pests and diseases (Fig. 7.3a-c). It has been seen from survey result that productive assets such as land and livestock, labor availability, and access to credit differ across smallholder groups. Therefore, though all the smallholder groups face these limitations because of poor asset base, the severity of the constraints is more for the landless laborer groups and least for the resource-rich salaried class. High volatility in prices, absence of market, and lack of access to technical know-how are the main cultivator group. A large proportion of small and marginal farmers gain income through production on small pieces of land. Economy which is the main function leads to increase the crop diversification or any development in the region; these poor economic blocks proved

the same such as Sitalkuchi, Sabang, Garbeta II, and Ketugram II which have been suffering due to poor economic condition. These blocks reported low crop diversification also which lies in selected very lowest diversified District Paschim Medinipur (Fig. 7.3c) except Ketugram II which lie in Bardhaman District.

### 7.4.2 *Summary*

Crop diversification is influenced by a number of factors both in the supply side, which includes infrastructure development, technology adoption, relative income, and resource endowments, and the demand side, containing the size of population and per capita income as well as climatic variable (rainfall). Economy which is the main function leads to increase the crop diversification or any development in the region; these poor economic blocks proved the same such Sitalkuchi, Sabang, Garbeta II, and Ketugram II which have been suffering due to poor economic condition. These blocks reported low crop diversification also which lies in selected very lowest diversified district except Ketugram II which lie in Bardhaman District. Per capita income of the study area is very low to afford better livelihood which results in low level of capital formation. Most of sample block in western, northern, and southern portion of West Bengal faced natural disaster year to year which prevents the rural households to move from for better development in field of agriculture and diversification (90% of the population favored to face natural disaster in their respective area). The poor households in the rural area need credit facilities to develop their better life and mounting to agricultural technology. Without access to institutional credit, they are not able to undertake any income-generating activity which requires some initial investment due to increasing price of technology used for crop diversification or in agricultural practice. As a consequence, they are forced to engage themselves in less remunerative nonfarm work and wage work. Many households or small farmers are unable to get loans for lack of collateral requirements of the financial institutions. Most of the marginal and small farmers borrow money from a money lender or large farmers at a high rate of interest. Irrigation plays a vital role in crop diversification run by electricity for more water so keeping this importance; it has been recorded that West Bengal is the most generated electricity state in India due to sufficient rainfall, but still few sample blocks face poor electricity and water supply for better agricultural development specially diversification. Because of poor infrastructure, few sample blocks which are recorded for their low crop diversification are facing the same problem. Education has also a great role for transforming traditional agriculture to modern agriculture, for augmenting crop diversification from low-value to high-value crop, for generating employment, and for making the region economically sound. Only 71% of the population is literate in the sample study area. Thus, the above-said weakness is very necessary to enhance the low diversified region. Targeting of education and skill development trainings toward poor households in the rural areas is likely to have a relatively large impact on their ability to diversify livelihood options. There should be made to make remunerative developed farm sector opportunities accessible to the rural households,

particularly in the backward regions of West Bengal. This includes the development of rural infrastructure in terms of road, market, electrification, awareness, training, education, new agricultural technology, telecommunication, storage facilities, etc. and also institutional innovations to reduce entry costs and barriers to poor smallholder.

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