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Dynamic trends and spatial heterogeneity in crop diversification: Insights from Hooghly District, India

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Abstract: The present study explores the block-wise status and evolving trends of crop diversification in Hooghly district, West Bengal, using a consistent dataset from 2007 to 2022 and the Simpson Index. The analysis reveals that between 2007 and 2012, eight blocks (the highest in Balagarh, with -11.05%) experienced negative growth in diversification, which increased to twelve blocks (the highest in Chanditala–II with -15.49%) between 2012 and 2017 and further rose to fifteen blocks (maximum in Serampore–Uttarpara with -23.26%) between 2017 and 2022. This trend indicates a growing concentration of agricultural activities and fewer crops over time. In terms of spatial distribution, nine blocks were identified as highly diversified in 2007, compared to eight in 2022, while the number of low-diversity blocks decreased from three in 2007 to two in 2022. This analysis reveals a relatively static pattern of diversification in the Hooghly district over time.

Key Words: *Crop diversification, Simpson index, cropping pattern, inter-block disparity, Hooghly District*

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Introduction

To achieve food and nutritional security in the twenty-first century, the world's food and feed production needs to double while still using existing cultivated lands (Alam, 2022). The global agriculture sector faces major challenges, especially from climate

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change, which drives extreme weather events such as droughts, heat waves, and floods. These issues, along with declining food quality, biodiversity loss, and resource degradation, threaten ecosystem health and food security (Prajapati et al., 2024). To address this challenge, there needs to be a significant boost in food production, coupled with a substantial decrease in the environmental impact of agriculture. These can be achieved through gradual agricultural expansion, enhanced crop efficiency, bridging the yield gap, dietary modifications, and reduced waste. Introducing diversified crops in agriculture can enhance the resilience and vitality of ecosystems in several ways (Alam, 2022). Crop diversification involves growing multiple varieties of crops, from the same or different species, within a defined area to foster a robust agricultural system, particularly in communities and economies that rely on agriculture.

It is generally seen as a transition from conventionally cultivated, less lucrative crops to newer, more profitable crops (Gebisco et al., 2023). Many scholars (Mukherjee, 2015; Thapa et al, 2017) contend that crop diversification serves as a strategy to address the limitations of mono-cropping, while others (Bithal and Harzana, 2019; Anjua et al., 2020) view it as a strategy to enhance the diversity of crop portfolios, focusing on high-value crops such as fruits and vegetables. In summary, crop diversification is viewed as a significant economic choice that significantly impacts farmers' income, increases production, enhances food security and ensures the sustainability of the nation's crop production system (Gebisco et al., 2023).

In the early 1990s, the integration of the Indian economy into the global market through neo-liberal policies sparked a transformation in cropping patterns within the agricultural sector. Indian agriculture is predominantly characterised by small-scale, marginal, peasant-based operations, with approximately 83.3% of operational holdings being less than 2 hectares (Mukherjee, 2021). The Green Revolution in India is the agricultural transformation initiated during the mid-1960s through the introduction of High Yielding Variety (HYV) seeds, chemical fertilizers, irrigation expansion, and modern agricultural technology, particularly in states such as Punjab, Haryana, and western Uttar Pradesh. It substantially increased food grain production, especially wheat and rice, and helped India achieve food self-sufficiency, although its benefits remained regionally uneven and socially differentiated. The Green Revolution of the mid-1960s introduced new agricultural technologies, particularly those involving water use, improved seeds, and fertilisers, leading to a noticeable shift towards the cultivation of high-value cash crops such as fruits and vegetables (Kumar & Singh, 2018). Over the past twenty-five years, India has also experienced a significant rise in non-food grain cultivation, especially mustard and potatoes. Between 2014–15 and 2023–24, food grain output grew by 22.74%, while oilseeds, pulses, and sugarcane recorded growth rates of 32.87%, 36.67%, and 23%, respectively (Ministry of Agriculture, 2023–24).

As cereal production started to level off, small and marginal farmers, especially in states like West Bengal, turned to crop diversification to boost income and reduce risk (Mithiya, 2018). High-value, labour-intensive crops offer steady employment, helping tackle seasonal rural underemployment (Mukherjee, 2015). This shift is a key livelihood strategy for these farmers.

Crop diversification in West Bengal started during 1983—1984 (Nag, 2021). With 96.21% of farmers owning small or marginal landholdings, they opt for high-value crops to maximise output and earn essential income (Mithiya et al., 2018). The Diversified Cropping Programme promotes alternative, low-water crops like pulses, maize, and groundnut in 69 rain-fed blocks, supported by improved varieties and practices (Economic Review, 2021-22). Among the districts of West Bengal, Hooghly is one of the agro-based industrial districts, relying heavily on agriculture, which contributes about

one-third of its income and supports 57% of the population (Human Development Report, 2010). Fertile soil and good irrigation make 69.5% of the land cultivable. Despite gains from the Green Revolution and land reforms in the 1980s, crop diversification remains limited. Socio-cultural norms, economic disparities, and lack of awareness sustain rice monoculture and traditional farming (Dutta, 2012).

This study examines temporal changes in crop diversification across blocks in the Hooghly district. It tracks shifts in cropping patterns and the adoption of new crops over time. The study also analyses spatial disparities across blocks (administrative units) to identify areas with high and low levels of diversification. By highlighting these differences, it aims to understand the factors driving diversification and suggest strategies for balanced agricultural development. The present research aims to address the following questions: Has Hooghly district become more diversified or specialised over time? and How does crop diversity vary across the different blocks of the Hooghly district?

This study makes a unique contribution to the agricultural landscape of a micro-region like Hooghly by offering insights into the evolving patterns of crop diversification over time. Additionally, it uncovers variations in crop diversity across different blocks within the district, providing a comprehensive understanding of the spatial disparities in agricultural practices.

Figure 1: Location Map of Hooghly District

Many studies have examined crop diversification globally and regionally. Gebiso et al. (2023) used the Simpson Index in Ethiopia, highlighting risk mitigation and food self-sufficiency as key drivers. Kujawska et al. (2021) applied the Herfindahl-Hirschman Index in Poland, noting regional differences and effects of drought and frost tolerance.

Thapa et al. (2017) found that high-value crops improve welfare and reduce poverty in Nepal, especially when they contribute over 35% of farm income. In India, Mukherjee (2021) used the Simpson index to show moderate crop diversification in West Bengal, mainly towards cash crops, boosting income and food security. Similar findings by Nag et al. (2021), Kumar et al. (2018), and Mithiya et al. (2018) showed high cash crop diversification in Jalpaiguri and Uttar Pradesh. Alam (2022) found significant diversity in northern West Bengal using the Crop Diversification Index. Birthal et al. (2015) linked high-value crop diversification to poverty reduction but noted that it is constrained by capital and labour constraints. Rahaman and Singh (2019) and Rahaman (2022) used the Gibbs-Martin method to observe rising diversification, especially among marginal farms in Malda district, with economic benefits. Chhatre et al. (2016) highlighted the need to shift policy from paddy and wheat to horticulture for better returns. Dutta (2012) found moderate diversification in Hooghly, with only a few blocks highly diversified. Despite numerous studies on diversification in various regions of India, no research has been conducted after 2012 on how diversification operates in the agriculturally advanced Hooghly district (Figure 1).

Dutta (2012) highlighted the potential to leverage alluvial, fertile soil and enhanced irrigation facilities to achieve proper diversification. Dutta suggested that with these improvements, the district could transform into a multi-crop granary in the near future. At present, agriculture provides the livelihood for more than 55% of the Hooghly district's population (District Statistical Handbook Hooghly, 2022). Therefore, understanding the evolving trends in crop diversification and their inter-block dynamics within the district is crucial. By addressing these, the present study will provide a comprehensive understanding of how agricultural diversification has evolved in the Hooghly district since 2012. This research is critical for policymakers, agricultural planners, and local farmers, as it will offer insights into the effectiveness of past initiatives and suggest pathways for future development to achieve sustainable and diversified agricultural growth in the region.

Database and Methodology

The present study relies solely on secondary data obtained from the Bureau of Applied Economics & Statistics, Planning & Statistics Department, West Bengal Government. It analyses the extent of crop diversification using data on the area under different crops across various blocks. For analytical purposes, the study considers data from three periods: 2007—2012, 2012—2017, and 2017—2022. The crops studied include major grains such as Aus Paddy, Aman Paddy, Boro Paddy, Til, Lentil, Sugarcane, Gram, Khesari, Bhadui Kalai, Summer Maize, Summer Kalai, jute, wheat, potato, and mustard.

To assess the index of crop diversification, the study utilises the Simpson Index. Simpson is considered one of the most appropriate indices for assessing the distribution of enterprises within a particular territory. To determine it, the following mathematical formula is used:

Top of Form

Simpson Index of Diversification (SI) $= 1 - \sum P\text{i}^2$

Where $P_i = A_i \,/\, \Sigma A_i$

P_i signifies the ratio of the acreage of the i^{th} activity to the total acreage of all activities. The Simpson Index of Diversification (SID) ranges from 0 to 1. A value near zero suggests that the blocks specialise in cultivating specific crops, whereas a value of 1 indicates absolute diversification (Meena, 2016).

Line graphs were employed to evaluate the trend of crop diversification. The diversification index is shown in a line graph spanning 4 years, illustrating crop dynamics. Additionally, for the block-level analysis, diversification levels were calculated using various indices, and the results were visually depicted in ArcGIS 10.8.

Results

Trend in crop diversification in Hooghly district

In regions like the Hooghly district, understanding trends in crop diversification helps evaluate farmers' adaptive capacity to changing climatic conditions and market demands. Examining these trends provides insights into how agricultural practices are evolving and the factors driving these changes.

Table 1: Trend and Growth rate of crop diversification in Hooghly District

	Diversification values				**Growth rate in percentage**		
	2007	2012	2017	2022	2007—2012	2012—2017	2017—2022
Serampore—Uttarpara	0.41	0.72	0.65	0.50	75.61	-8.62	-23.26
Pandua	0.67	0.62	0.69	0.62	-7.74	12.64	-10.04
Balagarh	0.74	0.66	0.73	0.73	-11.05	10.99	0.02
Chinsurah—Magra	0.56	0.55	0.64	0.60	-1.93	16.14	-5.62
Polba—Dadpur	0.64	0.58	0.69	0.59	-9.29	19.70	-14.61
Tarakeswar	0.73	0.70	0.69	0.70	-3.73	-1.65	1.57
Haripal	0.71	0.72	0.69	0.68	0.94	-4.21	-1.10
Singur	0.64	0.68	0.68	0.63	6.73	-0.28	-6.39
Jangipara	0.67	0.74	0.69	0.72	10.47	-7.03	4.92
Chanditala—I	0.66	0.66	0.72	0.65	0.59	8.27	-9.01
Chanditala—II	0.57	0.67	0.57	0.47	18.78	-15.49	-17.63
Dhaniakhali	0.71	0.71	0.69	0.68	-0.40	-3.00	-0.17
Goghat—I	0.73	0.68	0.73	0.63	-6.13	6.15	-12.59
Goghat—II	0.75	0.75	0.69	0.61	0.46	-7.80	-12.07
Arambag	0.67	0.72	0.72	0.69	8.27	-0.81	-4.10
Khanakul—I	0.74	0.77	0.71	0.70	4.73	-8.50	-0.98
Khanakul—II	0.73	0.78	0.74	0.70	6.50	-5.04	-4.64
Pursura	0.71	0.69	0.65	0.64	-2.00	-6.07	-0.94

Source: Computed by the authors based on data obtained from the District Statistical Handbook of Hooghly

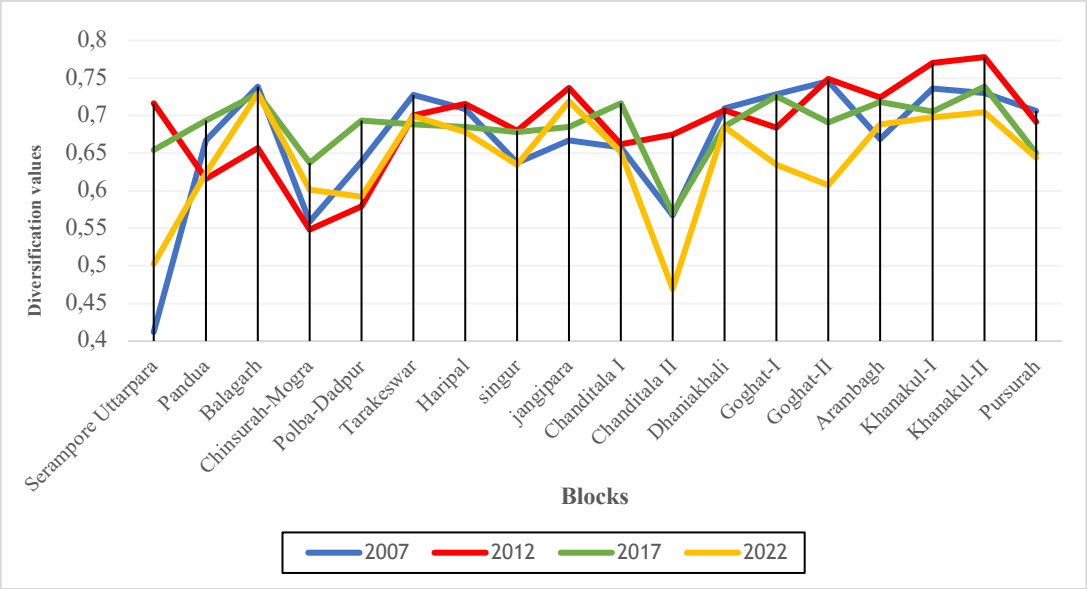

Figure 2: Trend of Crop Diversification in Hooghly District (2007-2022)
Source: Computed by the authors based on data obtained from the District Statistical Handbook of Hooghly

Table 1 presents the trend of crop diversification across various blocks in the Hooghly district from 2007 to 2022. Figure 2 shows the degree of diversification and its changes over the study period. In 2007, the Goghat—II (0.75) block had the highest crop diversification, as indicated by its diversification index. This means that a wide variety of crops were grown in this block. Eight blocks, namely Balagarh, Tarakeswar, Haripal, Dhaniakhali, Goghat—I, Khanakul—I, Khanakul—II, and Pursura, had an index value of more than 0.700, indicating significant crop diversification. In the same year, the Serampore—Uttarpara block (0.41), initially having a very low diversification index, improved by increasing the number of crops grown from 1 to 2.

Additionally, several other blocks (Pandua, Chinsurah-Magra, Polba Dadpur, Singur, Jangipara, Chanditala–I, Chanditala–II, and Arambag) had medium index values ranging from 0.500 to 0.700. This range suggests a moderate level of crop diversification, indicating these blocks grew a fair variety of crops but not as many as those with higher index values. In 2012, nine blocks, including Serampore—Uttarpara, Tarakeswar, Haripal, Jangipara, Dhaniakhali, Goghat—I, Goghat—II, Arambag, Khanakul—I, and Khanakul—II, had a maximum diversification index of more than 0.700, indicating significant crop diversification. Blocks such as Pandua, Balagarh, Singur, Chanditala I, Chanditala II, Goghat I, and Pursura had a diversification index ranging from 0.600 to 0.700, categorising them as medium-crop-diversified blocks. Chinsurah-Magra and Polba Dadpur had index values below 0.60 (Table 1 and Figure 2).

In 2017, the Khanakul—II (0.74) block recorded the highest level of crop diversification, followed by Balagarh, Chanditala–I, Goghat—I, Arambag, and Khanakul—I. Blocks such as Serampore—Uttarpara, Tarakeswar, Haripal, Jangipara, Dhaniakhali, Singur, Pandua, Chinsurah—Magra, Polba—Dadpur, Goghat—II, and Pursura scored more than 0.600 on the index, indicating moderate diversification. In the same year, Chanditala–II (0.57) was the least diversified block in the district (Table 1 and Figure 2).

Compared to 2012, during 2017, some blocks, such as Goghat—II and Serampore—Uttarpara, experienced a decrease in their diversification index to moderate levels (between 0.600 and 0.700). Meanwhile, blocks like Balagarh and Chanditala–I improved their diversification levels, entering the high-diversification category.

In 2022, the blocks of Balagarh, Tarakeswar, Jangipara, Khanakul I, and Khanakul II achieved a high crop diversification index value of more than 0.700. In contrast, Chanditala–II (0.47) had the lowest diversification index, below 0.500, indicating minimal crop diversification. Additionally, two other blocks, Serampore—Uttarpara and Polba-Dadpur, reported index values below 0.600, indicating low levels of crop diversification. These blocks might face similar challenges to those of Chanditala–II, including inadequate resources and infrastructure, or market dynamics that favour fewer crop varieties. Blocks such as Pandua, Chinsurah—Magra, Haripal, Singur, Chanditala–I, Dhaniakhali, Goghat—I, Goghat—II, Arambag, and Pursura had a moderate diversification index ranging from 0.600 to 0.700. These moderate levels suggest that these blocks have fairly favourable agricultural conditions and partial access to the resources and infrastructure needed for diverse cropping. (Table 1 and Figure 2). In both 2017 and 2022, several blocks, such as Goghat—I, Goghat—II, and Arambag, remained in the moderate diversification category (0.600 to 0.700).

Table 1 further captures the growth trends of crop diversification in the Hooghly district. Between 2007 and 2012, the diversification growth rate was positive in 10 blocks. Among them, Serampore—Uttarpara (75.61), Chanditala II (18.78), and Jangipara (10.47) recorded more than 10% increase, with Serampore—Uttarpara (75.61) being particularly notable. However, other blocks showed negative growth rates, with Balagarh (-11.05) showing the largest decline.

Compared with 2012, 2017 witnessed a significant increase in the number of negatively diversified blocks, which were twice as many as the positively diversified blocks. Twelve blocks exhibited negative growth rates, while six blocks (Pandua, Balagarh, Chinsurah—Magra, Polba—Dadpur, Chanditala–I, and Goghat—I) showed a positive growth rate. Among these, Polba—Dadpur (19.70) recorded a remarkable positive growth rate, whereas Chanditala–II (-15.49) recorded a significantly negative growth rate, suggesting a sharp decline in crop diversification (Table 1).

Between 2017 and 2022, 15 blocks recorded negative growth in crop diversification, while only 3 blocks (Balagarh, Tarakeswar, Jangipara) recorded positive growth. Jangipara (4.92) recorded the highest positive growth rate, suggesting increased crop diversification, whereas Serampore—Uttarpara (-23.26) recorded the most negative growth rate, reflecting decreased diversification (Table 1).

However, to thoroughly understand the reasons behind the decline in diversification over this period, a comprehensive analysis is necessary. Such an analysis should examine various aspects, including economic conditions, policy impacts, climatic factors, and infrastructural developments. Studies like those by Bhat and Salam (2016) highlighted the importance of in-depth investigations to discern the underlying causes and develop effective strategies to promote and sustain crop diversification in the future.

Inter-block disparity in crop diversification in Hooghly district (2007 & 2022)

This section presents a scenario of inter-block disparity in crop diversification across two periods: 2007 and 2022. In the Hooghly district, such an analysis not only provides valuable insights into the varying agricultural practices and resource distribution across different regions but also reveals patterns and disparities in how different areas adopt and benefit from crop diversification strategies. Understanding these spatial differences is

essential to developing region-specific policies and interventions that promote sustainable, inclusive agricultural growth.

According to the Simpson diversification Index, the crop diversification index for Hooghly was 0.78 in 2007. This value ranged from 0.41 in Serampur—Uttarpara to 0.75 in Goghat—II. Higher levels of crop diversification were identified in the blocks of Balagarh, Pursura, Dhaniakhali, Haripal, Tarakeswar, Khanakul—I, Khanakul—II, Goghat—I, and Goghat—II (Figure 3).

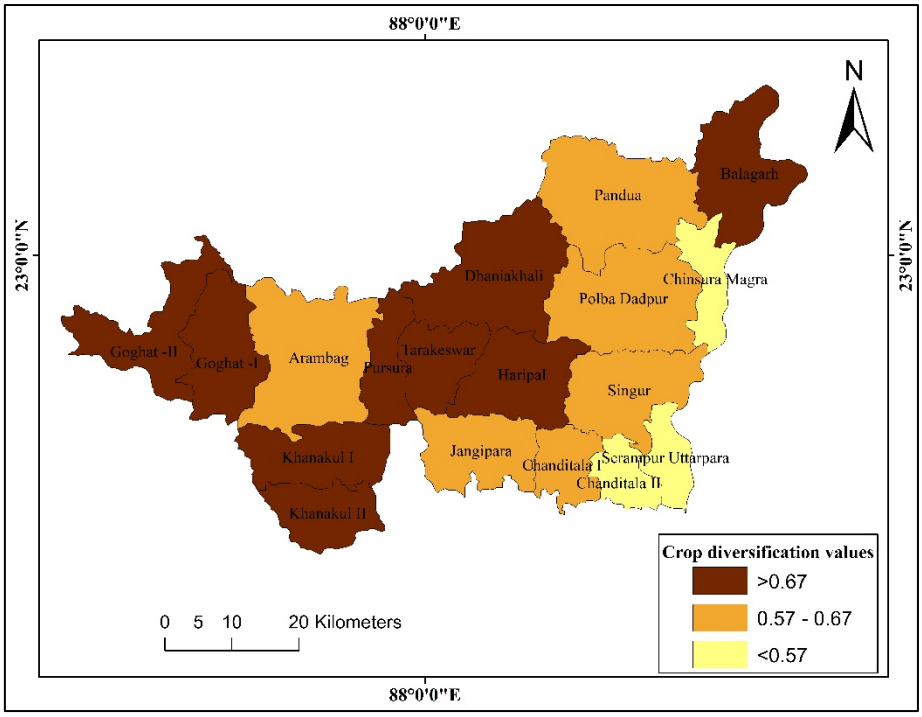

Figure 3: Interblock Disparity in Crop Diversification (2007)

Source: Computed by the authors based on data obtained from the District Statistical Handbook of Hooghly 2007

These blocks demonstrated significant crop variety, indicating robust agricultural practices and favourable conditions for diverse cropping. Moderate levels of crop diversification were observed in Pandua, Polba—Dadpur, Singur, Jangipara, Arambag, and Chanditala–I. These blocks showed a fair amount of crop variety, reflecting reasonably favourable agricultural conditions and partial access to resources and infrastructure that support diverse cropping patterns. Conversely, lower levels of crop diversification were evident in Chinsurah—Magra, Chanditala–II, and Serampur-Uttarpara, with Serampur—Uttarpara exhibiting the lowest diversification index at 0.41.

The overall crop diversification index in Hooghly decreased from 0.78 in 2007 to 0.72 during 2021—2022. A comparison with the 2007 data reveals that most blocks have transitioned from high-value to medium-value diversification. The diversification index values ranged from 0.50 in Serampore—Uttarpara to 0.73 in Balagarh. Higher levels of crop diversification were identified in Balagarh, Pursura, Dhaniakhali, Haripal, Tarakeswar, Khanakul—I, Khanakul—II, and Arambag, indicating robust agricultural practices and favourable conditions for diverse cropping (Figure 4).

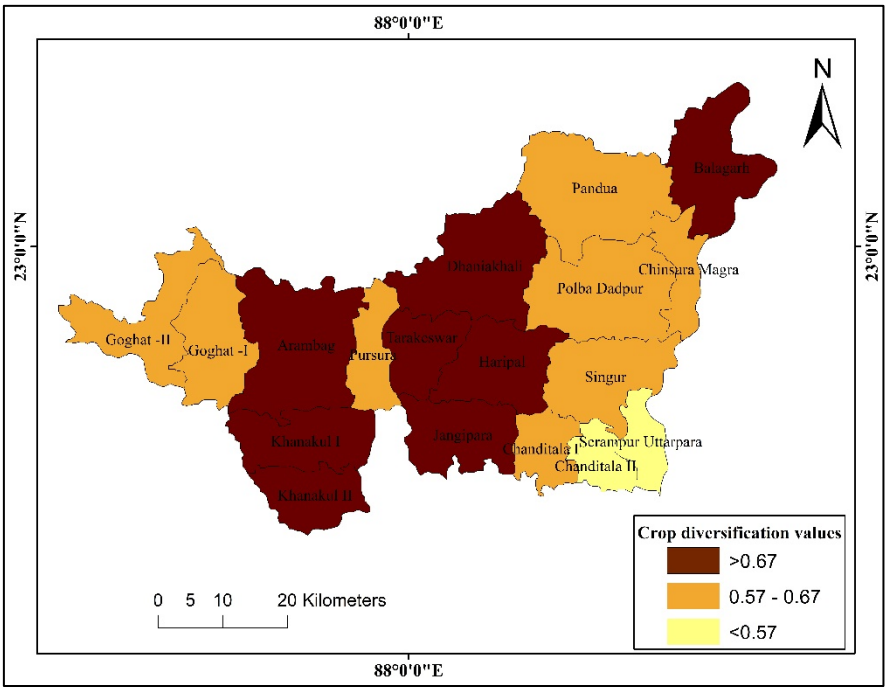

Figure 4: Interblock Disparity in Crop Diversification (2022)

Source: Computed by the authors based on data obtained from the District Statistical Handbook of Hooghly 2022

Moderate levels of diversification were observed in Goghat—I, Goghat—II, Pursura, Pandua, Polba—Dadpur, Singur, Chinsurah—Magra, and Chanditala–I. These blocks exhibited a fair amount of crop variety, reflecting reasonably favourable agricultural conditions and partial access to resources and infrastructure necessary for diverse cropping patterns. Conversely, low levels of crop diversification were observed in Serampore—Uttarpara and Chanditala–II. Compared to 2007, the blocks of Goghat—I, Goghat—II, and Pursura, which were previously highly diversified, have now shifted to moderate levels of diversification. Jangipara, on the other hand, has moved from moderate to high diversification, and Chinsurah-Magra has transitioned from low to medium diversification. The remaining blocks have maintained the same level of diversification observed in 2007.

Discussions

An examination of changing crop diversification patterns reveals a decline across most blocks in the Hooghly district during 2007—2022. A significant intra-regional disparity in crop diversification is observed within the district. The predominant factors driving this shift towards high-value crops and, consequently, reducing diversification include irrigation, fertilisers, and mechanisation (Kumar & Singh, 2018). The highly diversified areas are primarily situated in the central part of the district. This diversification is largely attributed to their location along the Mundeshori and Damodar rivers. The availability of irrigation facilities and fertile alluvial soil are the main factors contributing to this

diversity. Jangipara has transitioned from a medium to a high level of diversification due to the expansion of agricultural land (13.99% increase in land area), the extension of irrigation facilities (21.22%), and higher fertiliser consumption (District Statistical Handbook Hooghly, 2022).

In comparison, Arambag is also undergoing medium-to-high-level diversification, with increased irrigation facilities (10.42% extended irrigation facilities). The high level of crop diversification may be attributed to favourable soil conditions, efficient irrigation systems, agricultural extension services, and supportive government policies promoting diverse cropping patterns. These factors have helped the blocks sustain or enhance crop diversification through the continued adoption of advanced agricultural practices. Farmers in these blocks might be gradually transitioning to more diversified farming practices due to increased awareness of the benefits of crop diversification, such as risk reduction and improved soil health.

Conversely, Serampore—Uttarpara and Chinsurah—Magra have experienced lower levels of diversification as they have shifted towards industrialisation. These blocks likely faced challenges such as less favourable soil conditions, limited irrigation infrastructure, and economic and infrastructural constraints that hindered the adoption of diverse cropping systems. Mondal et al. (2021) also identified that low levels of agricultural development persist in these two blocks due to lower shares in total cultivable area and net sown area, very low cropping intensity, limited availability of agricultural facilities, etc. In Chanditala–II, the reduction in agricultural land and the decline in irrigation facilities indicate that farmers are gradually moving into other occupations. The blocks of Goghat—I and Goghat—II have experienced expansion of irrigation facilities, increasing irrigated land by 33%. However, despite this improvement in irrigation infrastructure, both blocks also experience substantial reductions in agricultural land: 41% in Goghat—I and 42.11% in Goghat—II. These changes have likely contributed to reduced crop diversification in these blocks. The reduction in crop diversification may be attributed to several constraints, including unfavourable soil conditions, limited access to water and irrigation facilities, inadequate agricultural support services, and the continued dependence on monoculture crops driven by market demand or traditional farming practices. These blocks may also face economic and infrastructural limitations that restrict the adoption of diversified cropping systems. This pattern reflects relatively stable agricultural practices, while also indicating the need for further interventions to enhance crop diversification levels.

The remaining blocks display a near-stagnant level of diversification, suggesting a need for targeted interventions (such as improved agricultural policies, infrastructure development, and market access) to promote and sustain crop diversification effectively across the district.

The growth rate analysis indicates a trend where blocks like Serampore-Uttarpara, Chanditila II, Goghat—I and Goghat—II are moving away from crop diversification. Despite the expansion of irrigation facilities, especially tube wells and deep tube wells,in the Goghat I and Goghat II blocks, farmers are increasingly specialising in their cultivation practices. This shift is marked by a growing emphasis on cultivating specific crops, such as Aman paddy, potatoes, and fruits. While specialisation can offer advantages such as increased productivity and market competitiveness, it also poses risks. Dependence on a limited number of crops makes farming vulnerable to market fluctuations, pest outbreaks, and changes in consumer preferences. Moreover, it can impact biodiversity and soil health if not managed sustainably.

The district's cropping pattern has predominantly favoured rice and potato cultivation, with land distributed accordingly. The expansion of rice cultivation has increased water

demand, leading to the overexploitation of groundwater resources due to limited surface water availability. This decline in agricultural production has had significant consequences for the district's agricultural economy, including resource depletion, nutritional shortages, declining groundwater reserves, and greater income volatility. Consequently, there is an urgent imperative to investigate strategies aimed at enhancing diversification (Sajjad & Prasad, 2014). This trend is largely influenced by robust market demand and the spread effect originating in urban areas such as Howrah, Kolkata, Seoraphuli, Singur, and Tarakeswar (Kundu & Chattopadhyay, 2018). Urbanisation is a significant factor contributing to the ongoing decline in agricultural activities for economically productive pursuits (Shee, 2017). While agriculture remains the primary economic activity and a vital source of income for rural inhabitants in the district, there is a discernible decline in the area of agricultural land and a consistent rise in non-agricultural land use. This gradual transition reflects a shift from agriculture towards non-agricultural pursuits. Upon analysing the distribution of land area dedicated to various crops across blocks, it is apparent that the allocation of land to primary crops decreased in 2022 compared to 2007. The decline in crop diversification across most blocks of the district in 2022 may be attributed to economic pressures, market preference for a few high-return crops, adverse climatic conditions, and limited opportunities for further diversification. Inadequate agricultural extension services, insufficient infrastructure, and policy support favouring specific crops may have further encouraged monoculture practices. In addition, increasing land encroachment associated with urbanisation and the gradual shift away from agriculture have raised concerns regarding livelihood security. Low crop diversity may also intensify environmental problems such as groundwater depletion, soil degradation, waterlogging, and salinity, ultimately affecting crop productivity and agricultural sustainability. Therefore, promoting agricultural diversification is essential for enhancing environmental resilience, reducing risks, and ensuring long-term agricultural sustainability (Kamraju, 2017).

Conclusions

The present study aims to measure the crop diversification scenario in the Hooghly district and the trend of crop diversification across different periods. The study reveals that crop diversification is not uniform across the blocks; most blocks have experienced negative growth rates. As observed, in both time periods, 2007 and 2022, blocks like Serampore—Uttarpara and Chanditala–II have recorded the lowest levels of diversification. Blocks namely Pandua, Polba—Dadpur, Singur, and Chanditala–I were identified as moderately diversified, while Khanakul—I, Khanakul—II, Dhaniakhali, Tarakeswar, and Haripal have recorded a high level of diversification. Overall, the analysis reveals significant spatial heterogeneity in the pattern of crop diversification across the Hooghly district (Mukherjee, 2021).

The study's outcomes validate the core hypothesis that crop diversity has substantial potential to secure rural food security, owing to its geographic advantages, rich alluvial soils, and extensive irrigation infrastructure. Various policy actions can be implemented to reduce production and marketing risks and assist diversified small farmers in boosting basic food crop production. Low-diversity blocks, primarily industrial areas, need crop-specific research to help farmers adapt to changing incentives and adopt diverse cropping patterns within a season. In the Hooghly district, river-adjacent blocks benefit from river lift irrigation, while distant blocks like Goghat—I and —II, reliant on groundwater,

require improved irrigation through rainwater harvesting. Additionally, developing rural roads is essential to ensure market access for both cash crops and surplus food crops. Moreover, establishing cooperative systems across production, processing, marketing, consumption, and credit and savings can ensure the supply of cost-effective, locally based, resource-based technology, along with enhanced access to credit and marketing facilities (Mukherjee, 2021).

This study's reliance on secondary data limits its depth, requiring a detailed on-ground investigation into stagnant or declining crop diversification. Future research will explore how diversification affects the economic status of small and marginal farmers. Nonetheless, the findings provide valuable insights for policymakers and agricultural scientists to promote development and reduce disparities in India and the Hooghly district, West Bengal.

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