Crop Diversification Strategy against Stunting Diversification Index: An Evidence from West Bengal, India

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Research Article

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Abstract

The food basket of the world is diversifying towards high-value crops. A diversified cropping system offers multifaceted opportunities to the farmers. The nature of diversification in developing countries is significantly different at both farming and cropping levels; thus, it is felt important to investigate such a study at different land size holding. This study is conducted to examine the trends of crop diversification under different land size classes in the state of West Bengal, which assumes as a representative image of India. The study uses secondary data obtained from Agriculture Census for the year 1995-96 and 2015-16. Gibbs-Martin's technique is employed for the calculation of the diversification index. Overall analyses reveal that the stunting change in diversification is noted in marginal, small, large, and all land classes. The implication of such growth pushes the rural economy in a skewed direction.

Introduction

The food basket of the world is diversifying towards mainly vegetables and horticulture. Various studies suggest the proposition in favor of diversifying food basket induced by vegetable farming. Newman et al. (2014) have studied the multifaceted opportunities of vegetable farming and conclude that diversification of crops towards vegetables is needed and supported by specific policy intervention from public and private partners. Another study by Joshi et al. (2004) have found that the nature and extent of crop diversification in South Asian countries in the past 20 years has shifted towards high value commodities, namely, fruits and vegetables, livestock and fish production. Due to multistage opportunities in crop diversification systems, the high value crops are getting more area through changing cropping pattern or crop replacement. Zentner et al. (2002) conclude that the cropping system in the Canadian Prairies has shifted from traditional cropping towards an extended and diversified rotational cropping of oilseeds and pulses crops with cereal grains. To support growing consumerism, increase income and maintain nutritional intake, crop diversification does find its way in recent years. A study on 'Long-term Changes in Indian Food Basket and Nutrition' by Kumar et. al (2007) examines the pattern of food consumption during 1983 to 1999-2000 and find that the recent extends of crop diversification has gained momentum toward fruits, vegetables, oilseeds, milk and eggs over traditional coarse cereals. Large scale diversification in developing countries goes with cereals along with high profit crops to ensure households consumption and maintain livelihood options. A temporal study by Satyasai and Viswanathan (1996) shows that the crop diversification during the period of 1952-53 to 1992-93 in India has shifted from cereals and pulses to high value food of oilseeds, fruits and vegetables but coarse grains crop still remain in entire production systems.

Since demands of food crops are different at spatiotemporal context and hence nature of diversification is attributed at different levels such as food crops, non-food crops, commercial crops or cash crops and so on. Large scale commercial farming in developed agriculture has already set the example of vertical diversification in different pockets of Europe and North America. And therefore, the nature of diversification is getting limited to small scale or even at window gardening (Womack 2018). In developing countries, agricultural system is mainly diversifying from food to non-food crops due to increasing vertical diversification (Yahya 2001). Large scale diversification at cropping level is phenomenal in south Asia and Africa but limited to few crops only but small-scale diversification is growing at fastest rate in agriculturally developing countries like India, Sri Lanka, Nigeria, Brazil and others (UNDP 2019). In countries like India, the nature of diversification does match with global trends but significantly different at farming and cropping level both. With more than 75 per cent marginal farmer, India's diversification is mostly driven by risk aversion, income generation and policy pushed impetus. The present study sets as a representative image of India with an actual analysis from a state, i.e., West Bengal as this state is inhabited by more than 96 per cent marginal and small farmers therefore nature and extent of diversification would be identical with India as whole.

The necessity of crop diversification has been felt at many different levels. Crop diversification boosts income as the high value crops such as vegetables and root crops not only intensify the cropping system but also give higher financial return per unit of land (Kasem and Thapa 2011). A study on 'Diversification into Horticulture and Poverty Reduction: A Research Agenda' by Weinberger and Lumpkin (2007) have found that diversification into horticultural crops assists small and poor

farmers in developing countries to escape poverty by increasing income and employment. A similar study is conducted by Chand (1996) in Western Himalayan Region and observed that diversification through horticulture crops has a huge potentiality to augment income and employment among marginal and sub marginal holdings compared to the bigger farmers due to more family labor engagement. Adding to horticultural crops, diversification towards commercial crops also assists the small and marginal farmers to uplift their economy through increasing their farm output (Shiyani & Pandya 1998).

The diversified agriculture towards high value foods of oilseeds, fruits and vegetables has witnessed a significant improvement of food security in terms of per capita calories consumption (Satyasai and Viswanathan 1996). Ensured calorie intake is necessary to all people at a time which is greatly focused by Bamji (2000). In his study on 'Diversification of Agriculture for Human Nutrition' concludes that diversification of agriculture towards high value commodities of fruits, vegetables, and livestock furnishes food and nutrition security at both national and household level. Crop diversification towards high-value commodities brings varieties in household dietary patterns, leading to nutritional security among household and individual access levels. In a study, Rajendran et.al. (2017) have examined the relationship between household dietary and crop diversification. The study has pointed out that crop diversification, though not directly influences, helps farmers increase their income, which gives them opportunities to spend more on market-based food and thus, ultimately improve household dietary diversity. Another study by Mango, et al. (2018) posit that households with higher crop diversification intensities are more likely to have a diverse diet. Farming households who grow multiple crops tend to be more secure in food supplies and income. Therefore, crop diversification enhances food security by providing food stock in terms of quantity and variety to small holding farmers.

Various available literatures suggest crop diversification as an important adoption to cope with environmental change and soil conversion. Crop diversification has the potential to deal with environmental risk and enhances agricultural sustainability (Piedra-Bonilla et al. 2020). Climate change is one of the growing concerns of environmental risk that needs to be controlled. Ochieng et al. (2020) have analysed how crop diversification can act as a strategy to counter climate variability and changes. The study has found that small farmers in warmer regions extend crop diversification as a risk management strategy. Cultivation of the same crops again and again in the same field affects the soil negatively, and therefore, farmers diversify their farms towards those crops that help the soil regain fertility. In a case study of Malawian smallholder farmers, Kerr et al. (2007) have found that farmers choose to adopt legume diversification over existing maize-based cropping system which is beneficial for soil conservation as it helps to improve soil fertility through enhancing Nitrogen (N) and Phosphorus (P) and recycling nutrients in the soil. Nunes et al. (2018) also have observed that tillage practices and diversified cropping systems in the form of crop rotation and cover crops have beneficial effects on soil health.

The need for diversification of crops at the present is different among developed and developing countries. In the developed countries, diversification towards horticulture and vegetables crops is still missing as they focus on creating varieties of products from a single crop. Developed world has the resource and dedicated infrastructure such as advanced machinery, well connected roads, available markets, etc. to practice crop diversification out of passion. They have opportunities to cultivate various sites in the form of window gardening, track farming, green house tent, lake farming, etc.

In developing countries like India, Brazil, Sri Lanka, Pakistan, Nigeria, etc., the craze of crop diversification has come to light in the 1990s after the introduction of LPG (Liberalization, Globalization, and Privatization), allowing foreign companies to invest directly in the various sectors. These countries have overcome the challenges of self-sufficiency in food and an increase in agricultural production recently. Now the focus has shifted towards other issues like income, employment, health, and nutrition security (Rahaman 2021). Ample evidence from the works of the literature shows that the scope of crop diversification is multi-folded, i.e., it augments income and employment opportunities as well as improves food and nutritional security (Kasem and Thapa 2011, Chand 1996, Shiyani and Pandya 1998, Weinberger and Lumpkin 2007, Mango et al. 2018, Rajendran et al. 2017, Bamji 2000, Satyasai and Viswanathan 1996). Intensive subsistence farming creates severe environmental problems, like depletion of groundwater resources, soil erosion and loss of fertility. Diversification through rotation and alternation of crops helps to reduce these problems (Chhatre et al. 2016). Opportunities from crop

diversification are multiple but growth in same is not identical even within similar geophysical environment. Last twenty years' trends reveals stunting to de-stunting growth pattern at different cropping level hence crop diversification in India (Rahaman 2020). In his situation, setting up of policy-based evidences, follow up best practice approach and access achievable policy target arising as viable diversification avenue to promote the same at both level, i.e., horizontal and vertical and reach the goal of doubling farmer income.

Study area:

According to 2011 Census, West Bengal is the home of 91.28 million population spreading over an area of 88752 sq. km. Out of which, 68.13 per cent live in rural area. Agriculture Census of 2015-16 shows that the total net sown area of the state is 5.17 million hectares. Marginal farmers account 82.71 per cent of the total farmers and their share in total net sown area is 53.67 per cent. About 13.40 percent farmers are belong to small land size class and they contribute 28.68 percent of the total net sown area. The share of semi-medium, medium, and large farmers in the total cultivators remain 3.53, 0.24, and 0.01 per cent respectively but their representations in net sown area are 13.26, 1.57, and 2.81 percent consecutively. Nearly 44.03 per cent of the total workforce in the state is engaged in agriculture sector alone and out of which 78.09 per cent inhabits male. Different types of crops are grown in both Rabi and Kharif seasons but the presence of heterogeneous geo-physical condition and agro climatic environment do not allow major Rabi and Kharif crops to grow in different districts evenly throughout the state (Fig. 1). Although the state is suffering from different constraints like low land productivity, unorganized markets, deterioration of soil health, inadequate farm mechanization, still the state has ample opportunities to tackle these challenges. The state of West Bengal has potential favorable climatic conditions, physiographic advantages, fertile alluvial soil and human resources to practice agriculture in a better manageable way.

The state government has adopted Rashtriya Krishi Vikas Yojana- - Remunerative Approaches for Agriculture and Allied Sector Rejuvenation (RKVY-RAAFTAR) to boost up agricultural development in general and increasing crop productivity through multiple cropping in particular through preparation of District Agriculture Plan (DAPs) and State Agriculture Plan (SAPs). On the other hand, the central government has taken several steps such as soil health card scheme to improve soil fertility, Pradhan Mantri Krishi Sinchai Yojana (PMKSY) for access and efficiency of irrigation, Pradhan Mantri Fasal Bima Yojana (PMFBY) to alleviate risk in agriculture which target to developed diversified cropping system. In spite of the immense effort by the central and state government, the share of agriculture in the state and central GDP is falling down rapidly; the share of agriculture in GDP has declined from 51.9 per cent in 1950-51 to 17.8 per cent in 2019-20 (Economic Survey 2019-20). Moreover, the workforce participation in agriculture is also decreasing. The negative growth rate of the agriculture workforce, especially out-migration of productive adult population is really a matter of concern. Horizontal crop diversification, though increased at cropping level but expansion of such is limited and requires short and long terms policy impetus. The present study is arranged to answer such critical concerns.

Objective

The specific aim of the study is to examine the trends of crop diversification under different land size classes in West Bengal during the period of 1995-96 to 2015-16. And suggest, required policy intervention in favor of de-stunting diversification index.

Hypothesis

There is no significant difference in change of crop diversification across land size categories.

Data & Methodology

The present work is entirely based on secondary data sources. The required data has been obtained from Agriculture Census of India.

There are a number of statistical methods available in the literature to measure the magnitude of diversification. Each and every method has their own advantages and limitations due to nature of data each formula deals with and specific purpose of interpretation. Gibbs and Martin's technique is employed for this study because it is best suited on continuous data of areal extent of crops. Gibbs and Martin's technique is defined as-

$$\text{Crop Diversification Technique} = 1 - \frac{\sum X^2}{(\sum X)^2}$$

Here, X is the percentage of total cropped area occupied by an individual crop at a point of time. The index value of this technique ranges from 0 to 1. It is directly related to the magnitude of diversification, i.e., higher the index value, higher would be the diversity and vice-versa.

To check the significance level of the framed hypothesis, the one-way ANOVA technique has been used.

Result & Discussion

Marginal Land-size Class

Fig-2 shows that the district average in diversification records a positive index in eight districts with the highest index in Darjeeling (0.754). This higher index is basically induced from horticulture and floriculture (Kumar et al. 2012). Contrary to this, Purulia (0.200) district stands at the bottom due to cultivation of single or two cereal crops only. Although ten districts are located at a lower diversification index than state average, some districts like North 24 Parganas and others are located at the same as the state average. With the same number of districts in 2015-16, the least diversified district is East Midnapore (0.164) due to no addition of crops in major cropping systems like vegetables, fruits, oilseeds, and others. In the same year, Nadia district (0.795) arises as the maximum diversified district in the state. Overall change of index value of the state although positive (0.057) but it's not that much significant due to the least share from major districts. This positive gain is attributed from vegetables, fruits, oilseeds and floriculture space into overall diversification.

Small Land-size Class

Fig-2 reveals that in 1995-96, a total of five districts recorded the diversification index more than the state average (0.524), among which Darjeeling (0.794) ranks at the top. On the other hand, the least index value is recorded in South 24 Parganas (0.192). The higher concentration of only a few major crops is the reason for such a lower index (Mithiya et al. 2018). In 2015-16, the number of districts with a diversification index higher than the state average is increased to eight, where Nadia (0.787) emerges out to be the most diversified district. Jalpaiguri (0.238) scores the minimum index value in the same year caused by single crop domination, i.e., paddy in the entire district. The changes in diversification index value of the state as a whole are positive (0.063) and are being substantiated by the shifting of food crops towards non-food crops such as vegetables, fruits, and others.

Semi-Medium Land-size Class

Under this class, the state has witnessed a negative growth (-0.060) during 1995-96 to 2015-16 (fig-2). Eight districts stand above the state average of the diversification index in each time period. Darjeeling (0.795) posits the maximum index value at the district level, while South 24 Parganas (0.123) locates at the lowest position during 1995-96. In the latter district, farmers choose not to diversify their farms in favor of horticultural crops as it required additional labor employment. In 2015-16, the state's lowest and highest diversification index values are secured by East Midnapore (0.038) and Nadia (0.737) districts, respectively.

Medium Land-size Class

Fig. 2 represents that in 1995-96, seven districts come under the positive diversification index compared to the state average with the maximum index value in Nadia (0.736). The reason being this higher index is the proportionate distribution of the area under different crop categories. Conversely, South 24 Parganas (0.170) stays at last because of the prevailing monoculture of paddy. In 2015-16, again, Nadia (0.703) appears to be the most progressive district in terms of diversification index. In the same year, Howrah (0.000) shows the complete crop specialization of rice due to the subtraction of other crop groups of vegetables, oilseeds, and fibres. On the whole, the diversification index of the state has fallen (-0.133) as big farmers choose to commercialize their farms to cereal crops rather than diversified towards non-food crops.

Large Land-size Class

An exciting picture has been noticed under the large land-size class category (Fig. 2). North Dinajpur which was the most diversified district in 1995-96 is placed at the bottom during 2015-16. Over the years, fragmentation of land reduces the area under this land class category, which further affects the diversification index. In 1995-96, Darjeeling (0.025) displays the lowest diversification index by reason of cultivation of tea crop in the almost entire region. Nadia (0.711) turns out to be the maximum diversified district in 2015-16. Altogether, the state indicates a surprising positive (0.321) increase in diversification index during 1995-96 to 2015-16. This significant increase is mainly caused by the introduction of other crops such as vegetables, fibres, plantation crops, etc. in the existing paddy cultivation system.

All Land-size Classes

It is clear from Fig. 2 that as many as eight districts obtain higher index value than the state's average in 1995-96 as well as in 2015-16. Darjeeling (0.792) ranks as the most diversified district in 1995-96, while in 2015-16, the top position is acquired by Nadia (0.786). These higher index values result from switching of cropping patterns from cereal crops towards high-value crops such as vegetables, fruits, oilseeds, spices, etc. Purulia (0.201) witnesses the minimal index values in 1995-96 and East Midnapore (0.185) in 2015-16. Although the state manages to gain a slight increase (0.036) in diversification index over the past 20 years, it is inconsequential because paddy crop still dominates the entire cropping system of the state.

Comparative analyses

From aforesaid analyses on crop diversification, it is clear that the amount and intensity of changes in cropping pattern across land size class categories is significantly different from one another. However, semi-medium and medium land group posits negative change but remaining other groups add positively in crop diversification basket. Within positive groups, large land size class category witness maximum change and marginal land size category witness the least. This change has been statistically measured through analysis of variance.

It is seen in Table 1 that the significant change in cropping pattern across land size class category (95 per cent confidence level at 2.29) is not the same. Hence, the proposed hypothesis fails to accept at 0.5 per cent significant level. It means each land size category exhibits different amount of diversification at different pace and intensity.

Moving Towards Policy Options

Overall analyses from two periods of data reveal that the stunting change in diversification is noted in marginal, small, large and all land classes. The significant reasons for such change remain the same as the introduction of horticulture crops, oilseed, spices and cash crops in existing cropping patterns. However, the amount of diversification at large land size class category posits higher due to agricultural innovation but the extent of such is significant under marginal land size class as this group shares more than 85 per cent of total states cultivator. In such lights, small farmers have to play an important role as their share sites next to marginal groups and combine both to 91 per cent. The cause of such variable and visible growth in the diversification index remains similar but not the same as geographic conditions differ significantly across districts of state. To boost up diversification across districts of West Bengal, no doubt more props needed to be introduced through

different agencies. Apart from that stunted districts must be taken into considerations by respective district agencies to carry forward the diversification program into rural areas.

Over changes also represent another picture from semi medium and medium land size classes. These noted groups represent negative change in the index. The introduction of new crops would not be viable at present to those districts because infrastructure development is the most needed specially to develop irrigation infrastructure and increase farmer incentive on a timely basis. Along with agricultural development measures, district administration should conduct and arrange capacity building programmes and other exercises in full spirit. In developing countries like India, it is only possible if a dedicated diversification centre comes up as an independent agency.

One of the serious concerns of diversification towards vegetables is that the seasonal farmers start growing vegetable crops in their backyard, garden, and other small vacant places around their habitat for the purpose of feeding their own households. This creates hindrance for the professional marginal and small vegetables growers whose main target of market is the locality and thus pushing them backward. Besides, fruits and vegetables record the maximum amount of post-harvest losses among the crop commodities. In these circumstances, government need to examine the situation carefully by either creating facilities for them to export that production in the bigger market by improving the connectivity and storage infrastructure at the lower regional units or implementing schemes and programmes relating to the benefits of crops groups other than vegetables so that they can eliminate their risk by shifting their diversification to other crop groups such as oilseed, pulses and plantation crops. The immense pressure of population hampers the scope of converting more area for agriculture purposes. Therefore, the only option to increase agricultural productivity is through vertical expansion of crops. The government need to identify the main pockets of vegetable cultivation from various parts of the country and then set up processing industries in those zones to expand the diversification into vertical level from which the marginal and small farmers will get benefit as this will not only reduce the post-harvest losses but also help to augment their income. To do so the mere excuse of government is that it would create a lengthy and massive budget. In this situation, the government have to allow the involvement of private sectors. One serious backdrop of this is that privatization will lead to exploitation of farmers. So, a careful attention to that will be much needed. The government should allow the investment process in the hands of private sectors but in control, manage farms and price policy which should be inspected and checked up by public agencies. At the end, stunting growth in crop diversification is just a situation not a permanent practice but its continuity is a hindrance in the way of farmer's doubling income.

Declarations

Competing interests:

The authors declare no competing interests.

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Tables

Table 1: ANOVA result

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	0.3775215	5	0.0755043	0.035383261	2.298431
Within Groups	3.2712946	108	0.0302898		
Total	3.6488161	113			

Source: Calculated by authors

Annexures 1: Land size class-wise crop diversification index under all crops in West Bengal, 1995–1996 and 2015–2016

District Name	1995-96						2015-16					
	Marginal	Small	Semi-Medium	Medium	Large	All Classes	Marginal	Small	Semi-Medium	Medium	Large	All Classes
24 Parganas (North)	0.521	0.488	0.486	0.370	0.322	0.501	0.705	0.725	0.611	0.584	0.268	0.704
24 Parganas (South)	0.244	0.192	0.123	0.170	0.090	0.205	0.396	0.439	0.250	0.063	0.039	0.402
Bankura	0.453	0.417	0.422	0.374	0.375	0.427	0.589	0.461	0.326	0.377	0.283	0.477
Birbhum	0.490	0.429	0.422	0.382	0.159	0.448	0.384	0.381	0.261	0.247	0.180	0.355
Burdwan	0.399	0.350	0.347	0.335	0.226	0.365	0.485	0.419	0.292	0.250	0.052	0.414
Coochbehar	0.653	0.620	0.609	0.572	0.528	0.630	0.687	0.659	0.574	0.602	0.327	0.663
Darjeeling	0.754	0.794	0.795	0.734	0.025	0.792	0.731	0.636	0.645	0.659	0.278	0.775
Dinajpur (North)	0.654	0.640	0.632	0.656	0.560	0.646	0.698	0.690	0.619	0.575	0.001	0.670
Dinajpur (South)	0.515	0.456	0.436	0.429	0.160	0.476	0.459	0.393	0.288	0.403	0.281	0.413
Hooghly	0.606	0.547	0.528	0.490	0.235	0.575	0.687	0.655	0.551	0.490	0.664	0.670
Howrah	0.347	0.362	0.381	0.445	0.362	0.354	0.234	0.334	0.389	0.000	0.117	0.255
Jalpaiguri	0.666	0.633	0.623	0.547	0.026	0.734	0.259	0.238	0.173	0.296	0.477	0.416
Malda	0.632	0.560	0.566	0.607	0.196	0.596	0.735	0.743	0.691	0.550	0.211	0.725
Midnapore (East)	0.277	0.307	0.361	0.340	0.090	0.289	0.164	0.286	0.038	0.043	0.132	0.185
Midnapore (West)	0.345	0.321	0.291	0.293	0.105	0.327	0.460	0.474	0.363	0.373	0.360	0.455
Murshidabad	0.715	0.688	0.676	0.656	0.177	0.698	0.715	0.703	0.585	0.459	0.496	0.686
Nadia	0.688	0.719	0.725	0.736	0.077	0.706	0.795	0.787	0.737	0.703	0.711	0.786
Purulia	0.200	0.206	0.200	0.191	0.091	0.201	0.349	0.299	0.085	0.057	N.C	0.289
All Districts	0.535	0.524	0.511	0.492	0.181	0.543	0.592	0.588	0.452	0.359	0.503	0.578

Source: Computed by authors (data from Agriculture Census)

Note: N.C= No Crops

Figures

Figure 1

Location of West Bengal. (Source: base map obtained from Census of India 2011)

Figure 2

See image above for figure legend

Source: based on annexure 1