An Empirical Analysis on Relationship between Crop Diversification and Doubling the Farmers Income

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ABSTRACT

In the past seven decades, the Indian government has given more importance to agricultural production and food security than the income of farmers. Most significantly, during the last half-century, India's production of food crops multiplied 4.7 fold. However, the strategies could not identify the need to increase the farmers' income, and there was no direct relation to support farmers' welfare. The cropping pattern is also monotonically biased towards limited crops, especially rice and wheat in the green revolution period. Of the Indian total cultivated area, more than 30 percent of the area was under wheat and rice. Demand for high-value foodstuffs is on the rise in the 1990s due to increasing population, high-income growth, changing food consumption habits, awareness of the high nutritional value, and great emphasis on value addition and change in export policy. In this problem of background, the central government set an objective to double farmers' income by 2022-23 to promote farmers' livelihood, reduce farming distress and fetch parity between farmers' income and non-agricultural professions. According to *Niti Aayog*, doubling real farmers' income till 2022-23 as the base year of 2015-16 requires a 10.41% annual growth rate in farmers' income. Therefore, strong methods are needed to harness all potential sources of growth in farmers' income. To attain doubling the farmers' income, there are three possible ways available (i) new development initiatives, (ii) new technology adoption, and (iii) policy reforms in agriculture. This research study is one of the possible ways to examine the divers of crop diversification and its impact on farmers' income

HIGHLIGHTS

⊙ Crop diversification driver provides a scope of untapped farmers' income capacity.
⊙ Growth rate analysis gives a way to reallocate production to more productive uses.
⊙ Herfindahl index indicates the area of crop diversification and doubling farmers' income.
⊙ Econometric analysis of this research provides the factors responsible for doubling farmers' income by 2022.

The forecasts are that by 2030, the urban population in India will account for 41 percent of the total population (UN, 2015). To meet the demand for High-value crops in the urban areas, agriculture is transforming from a food grain-based system to high-value agriculture and the chance to double the farmers' income. Further, economic liberalization policies as well as the globalization process, exerted strong pressures on the area allocation decision of the farmers essentially through the impact on the relative prices of inputs and outputs (Selvaraj *et al.* 2016). Such transformation in the economy leads to changes in

production portfolio from cereals- based systems to high-value commodities, such as fruits and vegetables and livestock products, to double income. Diversification of agriculture in favor of more competitive and high-value enterprises is reckoned as an essential strategy to get more income and overcome the emerging challenges of globalization (Bhalla *et al.* 2012). Although the objective of diversification may vary depending on the level of agricultural development, overall diversification is a strategy for doubling the farmers' income through better use of available resources (Satyasai and Vishwanath, 2013; Ryan and Spencer, 2011). This research examines the pattern and trends in area shifts across the crops, trends in crop and livestock sectors, and economic and non-economic factors influencing the farmers' income.

There is a substantial area shift from cereals to non-cereals. The area under cereals declined from 61 percent to 53 percent, while the area share of oilseeds increased to 13 percent from 9 percent between the 1990-91s and 2019-the 20s. The area under fruits and vegetables increased over the last three decades, particularly during the 2010s. Share of the area under fruits and vegetables jumped to 5 percent in the 1990s from 2 percent in the 1970s. Higher income elasticity of demand for these high-value commodities pushed up the demand; as a result, these sectors grew faster than the other sectors (Pingali, *et al.* 2014). The crop sector grew at the rate of 3 percent during the 1990s, while livestock and fruits and vegetable sectors grew faster than the crop sector and recorded 4 and 6 percent growth respectively during the same period. To meet the growing demand during the nineties, the livestock sector grew faster than the crop sector in most south Asian countries. This is reflected in an increase in the share of the livestock sector in the agricultural sector (Barghouti, 2013). The promotion of Operation Flood to boost milk production and augment the income of small rural holders uniformly promoted the dairy sector irrespective of their proximity to the urban center (Pandey *et al.* 2015).

MATERIALS AND METHODS

Secondary data of GDP for agriculture, fisheries, livestock, fruits and vegetables, other non-agriculture sectors were collected from the National Accounts Statistics of India. 30 years of economic data were collected. Herfindahl Index economic analysis was worked out to find out the crop diversification will be measured across the states. When the value of the Herfindahl Index declines, crop diversification occurs, and when the value of the Herfindahl Index increases, crop concentration occurs. The average least square method will calculate the household diversification index as the dependent variable and various explanatory variables.

Herfindahl index is defined as

$$H = \sum_{i=1}^{n} P_i^2$$

p_i = Proportion of area under i^{th} crop

The value of the H-index varies from zero to one. It is one in the case of perfect specialization and zero in case of perfect diversification.

Crop concentration

Crop concentration means the "variation in the density of crops in an area or region at a given point/period of time." The concentration of a crop in an area largely depends on its terrain, temperature, moisture, price and income, social factors, government policy, type of soil, and many others. The most common method to study crop concentration is the Location Quotient method.

Location Quotient Method of Crop Concentration algebraically defined as:

$$LQ = \frac{\dfrac{A_{ij}}{A_j}}{\dfrac{\sum_{i=j}^{n} A_{ij}}{\sum_{j} A_j}}$$

A_{ij} = Gross cropped area under i^{th} crop in j^{th} state

A_j = Gross cropped area in j^{th} state.

$\sum_{j} A_j$ = Gross cropped area in the country

RESULTS AND DISCUSSION

Trend in GDP growth rate for agriculture, fishing, livestock and fruits sectors

The GDP growth rate of the Indian economy, agriculture, and allied sectors are given in Table 1. It could be seen from the table that farmers can get more income through high-value crops.

States crop diversification and concentration

State-wise analysis shows that area under rice, which was 11 percent of the gross cropped area in Punjab during the 1990s increased to 29 percent during 2018-19s. Similarly, most irrigated areas except the Tamil Nadu area under rice registered a positive growth rate. However, in the rainfed rice ecosystems, the share of the rice area in the gross cropped area declined during the 2010s compared to the 2000s. Herfindahl Index for irrigated environment particularly for Punjab and Haryana, was 0.27 and 0.15 respectively during the 2000s. This shows a gradual diversification of the crop sector in favor of high-value commodities, especially fruits and vegetables (Tables 2 and 3). Estimates of Location Quotient method of Crop Concentration Index imply that crop concentration is shifting towards maize, sunflower, and banana from most of the States (Table 4).

Table 1: Growth rate in GDP of the economy and agriculture sub sectors at 1993-94 prices

Period	GDP Total	GDP Non-agriculture	GDP Agriculture	GDP Fishing	Value of Output		
					Crop sector	Livestock	Fruit/Veg
1990-91 to 1999-2000	3.45	4.72	1.94	2.9	1.79	3.92	2.88
2000-01 to 2009-10	5.38	6.78	3.13	5.82	2.47	4.99	2.36
2010-11 to 2019-20	6.19	7.4	3.28	5.46	2.99	3.82	5.97

Source: National Accounts Statistics of India.

Table 2: Crop Diversification in Selected States (Herfindahl Index)

Zone / State	2000's	2010's	2018-19's
South Zone			
Tamil Nadu	0.14	0.12	0.13
Andhra Pradesh	0.10	0.11	0.13
Karnataka	0.03	0.03	0.03
North Zone			
Punjab	0.19	0.25	0.27
Haryana	0.07	0.15	0.15
Uttar Pradesh	0.13	0.20	0.18
East Zone			
West Bengal	0.46	0.55	0.43
West Zone			
Madhya Pradesh	0.07	0.08	0.10
Maharashtra	0.02	0.03	0.03
India	0.07	0.08	0.08

Table 3: Extent of Diversification among the states

High diversified states	Medium diversified states	Low diversified states
Karnataka	Madhya Pradesh	Punjab
Maharashtra	Andhra Pradesh	West Bengal
	Tamil Nadu	Haryana
		Uttar Pradesh

HI<0.09 - highly diversified states, HI = 0.10 to 0.1499 - medium diversified states, if HI > 0.150 - low diversified states.

Table 4: Crop Concentration in the Pre and Post Reform Periods

	Rice		Groundnut		Cotton		Maize	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Andhra Pradesh	1.30	1.26	4.26	4.11	1.10	1.77	0.77	4.40
Karnataka	0.42	0.47	0.14	0.14	0.61	1.27	6.01	8.92
West Bengal	2.75	2.66	0.26	0.28	0.20	0.11	1.17	1.52
Maharastra	1.09	1.50	2.42	3.05	1.18	3.09	0.01	0.08
Punjab	1.24	1.22	3.17	2.78	0.91	0.59	1.76	1.63
Uttar Pradesh	0.90	0.91	2.47	2.36	1.35	1.30	5.98	10.15
Tamil Nadu	1.29	1.40	3.72	4.24	1.48	1.61	3.87	3.08
Haryana	0.50	0.66	2.46	2.40	1.61	2.06	1.01	1.03

Pre Reform Period: 2000-01 to 2009-10; Post Reform Period: 2010-11 to 2018-19.

Table 5: Factors Determining Crop Diversification (Auto Correlation Adjusted Linear Estimates)

Dependent Variable = Herfindahl Index

States	Intercept	GIA/GCA	Fertilizer (kg/ha)	Productivity Index	Rainfall (mm)	WSPI	Size of Holding (ha)
South Zone							
Tamil Nadu	5.191	0.0917**	-0.0001	0.0070	0.0004	0.0029***	-0.4343
Andhra Pradesh	-2.759	-0.1301	-0.0027	0.0649***	0.0022***	0.0060***	-0.7547
Karnataka	0.9534	0.0063	0.0019	0.0007	0.0002	0.0004	0.2554
North Zone							
Punjab	-1.9668	0.3578**	0.0255	0.0374	0.0032	0.0022	-0.0448
Haryana	4.861	0.1087	0.0247	-0.6719**	0.0027	-0.0014	6.277*
Uttar Pradesh	9.2183	-0.2602	-0.2252	-0.0168	0.0019	0.0305**	0.1723*
East Zone							
West Bengal	-17.0199	3.9874	-0.2942	0.4112	0.0261	0.0258	0.4416
West Zone							
Madhya Pradesh	3.653	0.1919***	-0.0355**	-0.0075	0.00004	0.0014	0.7342*
Maharashtra	3.566	0.0547**	-0.0047***	-0.0081	-0.0002***	0.0006***	-0.2194***

*** significant at 1 percent level; ** significant at 5 percent level; * significant at 10 percent level; GIA/GCA: Ratio of Gross Irrigated Area to Gross Cropped Area expressed in percentage; WSPI: Whole Sale Price Index.

Table 6: Determinants of Crop Diversification of High Value Crops– Log linear Estimates

Ratio of value of production to AgGDP	GIA/GCA	Fertilizer consumption (kg/ha)	Productivity Index	Rainfall (mm)	Wholesale Price Index	Average size of land holding (ha)	Intercept	Adj R²
Vegetables	0.10	0.0055	-0.0014*	-0.0068	0.0026	0.13**	-0.008	0.73
	(1.363)	(0.826)	(-2.202)	(-1.142)	(1.200)	(2.535)	(-.076)	
Fruits	-0.18	-0.015	0.025	0.0036	0.0026	-0.057	0.28	0.36
	(-1.279)	(-1.220)	(0.198)	(.316)	(.626)	(-0.545)	(1.291)	
Sugar	0.11	0.00076	-0.0036	-0.0011	-0.0037	-0.10	0.38	0.71
	(1.361)	(0.010)	(-0.479)	(-1.707)	(-1.505)	(-1.758)	(2.936)	
Oilseeds	0.13*	-0.0083	-0.030***	-0.0030	-0.0025	0.027	0.53***	0.98
	(1.814)	(-1.309)	(-4.827)	(-0.526)	(-1.213)	(0.531)	(4.878)	
Total of High Value Crops	0.16	-0.018	-0.046***	-0.0017	-0.0010	-0.0018	1.18***	0.95
	(1.175)	(-1.473)	(-3.736)	(-1.596)	(-0.252)	(-0.002)	(5.567)	

Figures in parenthesis are t values; *** significant at 1 percent level; ** significant at 5 percent level; * significant at 10 percent level; GIA/GCA: Ratio of Gross Irrigated Area to Gross Cropped Area expressed in percentage.

Table 7: Determinants of Crop Diversification-Log Linear Estimates

	Pre-Liberalization	Post-Liberalization
	(1980-81 to1990-91)	(1991-92 to2002-03)
Constant	-17.40* (-1.66)	-6.49** (-2.46)
Cropping Intensity	-3.09* (-1.66)	-0.05** (-2.21)
Yield Index	0.12** (2.20)	0.88* (1.61)
R^2	0.69	

*Figures in parentheses denote t values; * Significant at 1 per cent level of probability; ** Significant at 5 per cent level of probability.*

Diversification of cropping pattern particularly from high water consuming crops like paddy to other lower water consuming crops is not much reflected as the Herfindhal index found almost same in the rainfed areas.

Factors influencing crop diversification

Econometric results showed that rainfall had a positive effect, thought not significant for many states, on crop acreage diversification except Maharashtra revealing that good rainfall is expected to encourage diversification (Table 5, 6, and 7). The results further indicate that if the yield level increases, crop specialization also increases. Higher the yield level more is the incentive to cultivate the crop. There is no incentive to diversify when the output from the crop is increasing. Cropping intensity has a negative sign. This shows that when cropping intensity increases, the value of the Herfindahl index goes down, which means that crop diversification is taking place (Table 6).

CONCLUSION AND POLICY IMPLICATIONS

Further, in the era of globalization, agriculture and horticulture produce must be of international quality and globally competitive. Without discounting post-harvest losses total demand of about 130 million tonnes of vegetables has been projected for the country in the coming years showing ample scope for vegetable farming to double the farmers' income. To secure the future of agriculture and improve the livelihood of half of India's population, adequate attention needs to be given to improve the welfare of farmers and raise agricultural income.

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