Short Communication

Determinants of crop diversification in Kerala- a temporal analysis

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Abstract

The magnitude of crop diversification shows the impact of physical, socio-economic and technological influence on cropping pattern of an area. The present study was aimed at assessing crop diversification over a period of 30 years (1987-88 to 2016-17) along with the trends and growth in area of major crops of Kerala. The data were collected from periodic documents such as 'Economic Review' published by the Kerala State Planning Board, and 'Agricultural Statistics' by the Department of Economics & Statistics, Government of Kerala. The study revealed that the area under food crops in Kerala has been dwindling over the years while the area under most commercial crops, especially, rubber, arecanut and banana has been increasing. In the process, crop diversity suffered as farmers have shifted from diversified to specialized farming. It is also evident that when wage rate increases, crop diversification decreases as farmers shift to less labour-intensive perennial crops like rubber and coconut. Higher literacy rate prevalent in Kerala also contributes to decline of crop diversification. However, as increased population density leads to fragmentation of land holdings, homestead-based farming, which encourages crop diversification is widely prevalent among small holders.

Key words: Commercial crops, Crop diversification, Homestead farming, Kerala, Modified Entropy Index.

The cropping pattern plays a vital role in determining the level of agricultural production and reflects the agricultural economy of an area. A change in cropping pattern implies a change in proportion of area under different crops (Manwar and Nagpure, 2017). The cropping pattern of Kerala is quite different from other Indian states because of tropical climate and undulating topography. Kerala has congenial agro-climatic conditions for growing many perennial crops such as plantation crops and spices. Still, being the staple food, rice occupied almost 31 per cent of the gross cropped area of the state in the sixties (Andrews, 2013). However, in the later years, commercial crops started to dominate the agricultural scenario of the state pushing back food crops such as rice. In fact, the trend of crop diversification in Kerala had started tilting in favour of non-food crops since mid-1970s (Mahesh, 1999). Unlike the rest of India, where the shift was among annual crops, in Kerala, the shift has been from annual crops such as rice and cassava to perennial crops such as coconut and rubber (Kannan and Pushpangadan, 1988).

It is well known that imbalance in land utilization leads to food insecurity and ecological instability in any region. Declining cultivable area, predominance of tiny and fragmented holdings, and decline in work force in terms of reduction in agricultural labour have made farming more vulnerable in Kerala (Sanitha and Singla, 2016). These situations warranted the study of the changing trends of cropping pattern in Kerala state, especially for formulating appropriate farm policies. The study would provide a comprehensive analysis of cultivation of cash crops and the subsequent decline

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of food crops in the State, and its effect on crop diversification and contributing factors. The study would also suggest implications for policy changes related to shift in crop diversification in the state.

The present study was based on time series secondary data collected from various published sources such as 'Economic Review' published by the Kerala State Planning Board, Thiruvanthapuram and 'Agricultural Statistics' published by the Department of Economics and Statistics, Thiruvanthapuram, Government of Kerala, and 'Agricultural census', published by the Government of India.

The data were collected for major agricultural crops for a period of 30 years from 1987-88 to 2016-17. Ten major crops contributing to more than 70 per cent of the gross cropped area in Kerala (2016-17) were purposively selected for the purpose of analysis (Table 1). The data on annual rainfall, gross irrigated area, per capita domestic income, wage rate of agricultural workers, literacy rate, population density, farm credit per year, fertilizers used per hectare, average size of holdings and crop intensity were also collected for identifying factors affecting crop diversification.

To minimise the effect of annual fluctuations in variables, the triennium averages of the first three years were considered as the base year and those of the last three years as the current year. The analytical tools, *viz.,* absolute change, relative change, standard deviation, coefficient of variation, simple and compound growth rate were considered to draw conclusions.

Table 1. Cropping pattern of Kerala (2016-17)

Crop	Area (ha)	Percentage of gross cropped area
Coconut	781496	30.24
Rubber	551050	21.33
Paddy	171398	6.63
Arecanut	97696	3.78
Pepper	85207	3.3
Coffee	84976	3.29
Tapioca	68664	2.66
Banana	57158	2.21
Cashew	41661	1.61
Tea	30205	1.17
Total major crops	1969511	76.22
Other crops	614496	23.78
Gross cropped area	2584007	100

Source: Agricultural Statistics, 2016-17. Department of Economics & Statistics, Government of Kerala, Thiruvananthapuram

Modified Entropy Index (MEI) was used to analyse the extent of crop diversification as it overcomes the limitations of the Entropy Index by using a variable base of logarithm instead of a fixed base of logarithm. The MEI lies between zero (complete specialization) and one (perfect diversification) (Singh et al., 2013). It can be computed as follows

$$MEI = \sum_{i=1}^{n} P_i \log_n \left(\frac{1}{P_i}\right)$$

Where, n is the total number of crops and

$P_i = \frac{A_i}{\Sigma A_i}$ is the proportion of i^{th} crop in an area

and A_i is the i^{th} activity.

A multiple linear regression model of the following form was also used to identify the important factors affecting crop diversification (Joshi et al., 2003; Acharya et al., 2011).

$$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + \ldots\ldots\ldots + b_8X_8$$

Where, Y is the crop diversification index (dependent variable), X_1 to X_8 are factors affecting crop diversification (independent or explanatory variables), and b_1 to b_8 representing the regression coefficients of X_1 to X_8.

The crop diversification factors include: X_1 = Annual rainfall (mm), X_2 = Gross irrigated area (ha), X_3 = Per capita domestic income (Rs/year), X_4 = Wage rate of agricultural workers (Rs/day), X_5 = Literacy rate (%), X_6 = Population density(persons/sq.km), X_7 = farm credit (Rs/year), X_8 = Fertilizers used (kg/ha), X_9 = average size of holdings (ha) and X_{10} = Crop intensity (%).

The trends and growth in area of major crops, extent of crop diversification and the contributing factors were analysed in the study.

Trends and growth

A comprehensive analysis of area under the major crops showed the changing scenario throughout the period. The percentage share in area of major crops to gross cropped area during the base year and the current year of period were analysed and presented in Fig 1. It was obvious from the figures that the crop with the highest increase in percentage share in area from the base year to the current year was rubber (8%) followed by coconut (3%), areca nut (2%), coffee (1%) and banana (1%). The area under other crops also increased by 5 per cent in the current year (24%) as compared to the base year (19%) to the gross cropped area of the State. The crops that showed a decrease in percentage share in area to the gross cropped area from the base year to the current year were paddy (-13 %), tapioca (-3 %), pepper (-2%) and cashew (-2%). The area under tea was stagnant in the base (1%) as well as in the current year (1%) of the study.

The relative changes in the current year compared to the base year and fluctuation in the area during the period under study of major crops were also observed (Table 2). The area under banana increased by 196.11 per cent in the current year (259.64 thousand ha) as compared to the base year (20.14

Table 2. Fluctuation in area of major crops in Kerala

Crops	BaseYear(1000 ha)	CurrentYear(1000 ha)	Absolute change	Relative change(%)	SD	CV (%)
Coconut	808.14	788.53	-19.61	-2.43	52.38	6.14
Rubber	367.42	550.62	183.2	49.86	56.63	11.91
Paddy	588.34	188.81	-399.5	-67.91	142.17	40.28
Arecanut	62.06	97.84	35.77	57.64	16.51	19.12
Pepper	156.73	85.53	-71.20	-45.43	46.88	28.04
Coffee	68.78	85.11	16.33	23.74	5.19	6.3
Tapioca	167.51	71.19	-96.32	-57.50	31.08	29.28
Banana	20.14	59.64	39.50	196.11	16.56	37.99
Cashew	123.32	43.40	-79.92	-64.81	27.23	33.08
Tea	34.63	30.21	-4.42	-12.78	2.35	6.75
Other crops	563.71	611.22	47.50	8.43	37.18	6.25
GCA	2960.80	2612.10	-348.70	-11.78	173.08	6.01

Note: SD-Standard deviation, CV-Coefficient of variation

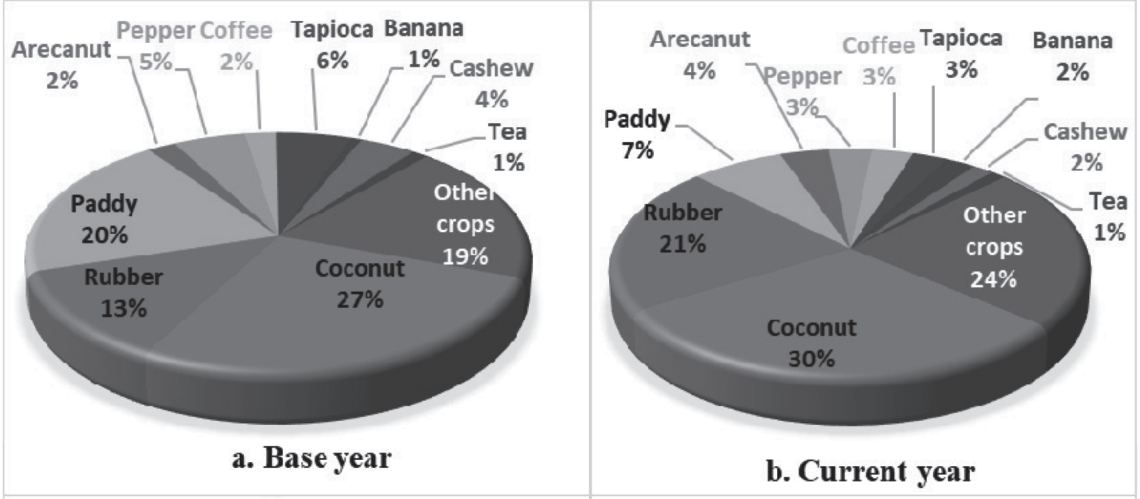

Figure 1. Percentage contribution of area of major crops to gross cropped area

thousand ha) with the fluctuation of 37.99 per cent during the period under study. The area under arecanut, rubber and coffee also increased in the state by 57.64, 49.86 and 23.74 per cent respectively in the current year as compared to the base year with the fluctuation of 6.3 per cent (coffee) to 19.12 per cent (arecanut) during the study period.

The major crops that had a decrease in area from the base year to the current year based on relative change were paddy, tapioca, cashew, pepper, coconut and tea. The highest reduction in area was observed for paddy (-67.91 %), cashew (-64.81%), tapioca (-57.50%), pepper (-45.43%), tea (-12.78%) and coconut (-2.43%).

With regard to the annual percentage growth of area of different crops in the State, the area of banana (4.68 % /year), arecanut (2.07 % /year), rubber (1.36 % /year) and coffee (0.51 % /year) increased with highly significant compound growth rate, while the area of paddy (-4.45% /year), cashew (-3.90% / year), tapioca (-3.15% /year), coconut (-0.32 % / year) and tea (-0.29 % /year) decreased with non-significant compound growth rate during the period under study (Table 3).

Extent of crop diversification

The data on Modified Entropy Index (MEI) indicated that Kerala had high crop diversification as the MEIs were between 0.67 and 1.0. MEI takes zero for complete specialization and a value close to one indicates complete diversification, that is, with increase in diversification, these values would increase. It could be observed that the highest diversification was in 2002-03 (0.8201). Higher MEI values were observed in years from 2000-01 to 2005-06. The lowest diversification was observed during 2016-17 (0.7759). Out of the 30-year study period, the years from 2011-12 to 2016-17 showed lower diversification indices signifying that crop diversification decreased at the magnitude of 0.0001 unit per year in the state and farmers shifted from diversified farming to specialized farming.

Table 3. Trend and growth in area of major crops of Kerala

Crops	Coefficient b* (ha)	SGR(%)	CGR(%)
Coconut	-2716.4	-0.32	-0.32
Rubber	6279.68**	1.32	1.36
Paddy	-15746	-4.46	-4.45
Arecanut	1671.46**	1.94	2.07
Pepper	-2567.6	-1.54	-2.11
Coffee	396.34**	0.48	0.51
Tapioca	-3404.3	-3.21	-3.15
Banana	1747.35**	4.01	4.68
Cashew	-3035.2	-3.69	-3.9
Tea	-91.88	-0.26	-0.29
Other crops	1178.09	0.2	0.21
GCA	-16288	-0.57	-0.58

Note: ** shows level of significance at 1%, SGR -Simple Growth Rate, CGR-Compound Growth Rate

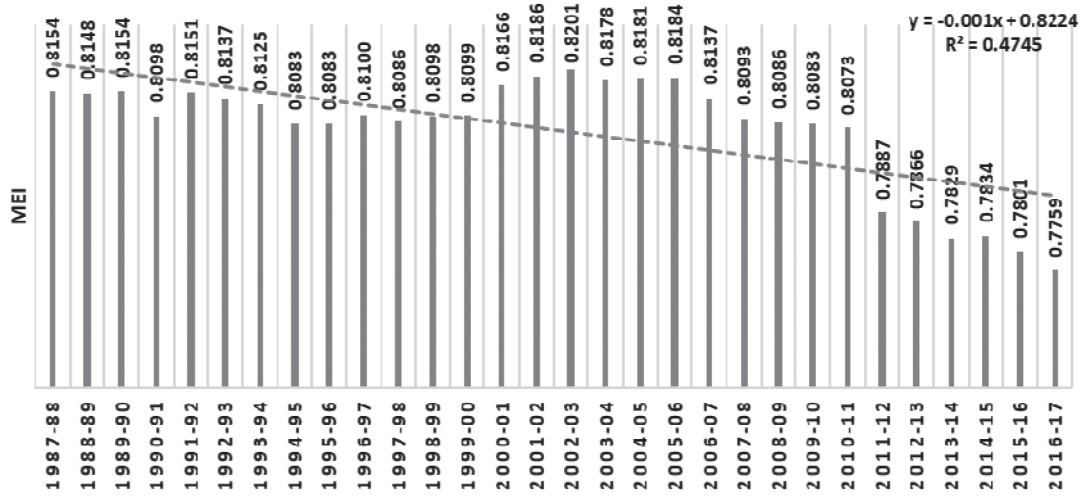

Figure 2. Crop diversification indices from 1987-88 to 2016-17

Factors affecting crop diversification

The factors influencing crop diversification were also analysed by using multiple regression model as it showed good fit and explained 95 per cent (R^2) of the effect of selected independent variables on crop diversification. Rainfall, gross irrigated area, per capita state income, wage rate of agricultural workers, literacy rate, population density, farm credit per year, fertilizer consumption, average size of land holding and crop intensity were taken as the independent variables and Modified Entropy Index was taken as the dependent variable and these were regressed together and data presented in Table 4.

The multiple regression analysis with MEI and factors influencing crop diversification showed that among all the factors, only wage rate of agricultural labourers, literacy rate and population density were significant. The coefficient of population density (0.00012769) was positive and significant, implying that crop diversification increased with increase in population density. Both wage rate of labourers and literacy rate had negative effects on crop diversification. The negative coefficient for wage rate of labourers (-0.00006815) and literacy rate (-0.00138226) indicated that when literacy rate and wage rate of agricultural workers increased, crop diversification decreased, signifying that the state was moving towards crop specialization. However, the coefficient of population density (0.00012769) was positive and significant, implying that crop diversification increased with increase in population density.

The independent variables that exerted insignificant effects on crop diversification were rainfall, gross irrigated area, farm credit issued, fertilisers consumed, average size of land holdings, per capita state income and crop intensity. Among these, positive values were shown by per capita state income and crop intensity.

There was a drastic decline in paddy and tapioca, the main food crops of Kerala, during the study period. Although coconut still occupied the highest position in area, the second position went to rubber, replacing paddy, showing the switchover of the state from food crops to commercial crops. Paddy showed a major drop in area of 67.91 per cent, which was the highest among all the major crops cultivated in Kerala. From the relative changes, the crop which showed pronounced positive change in area was rubber, with an increase of 49.86 per cent. Even though more changes could be seen in banana (196.11%), the overall area was far less compared to rubber (550.62 thousand ha for rubber and 59.64 thousand ha for banana). The crops that had moderate increase in area were arecanut and coffee. All the other crops suffered a decline echoing the decrease in gross cropped area in the State (-11.78%). It could be concluded that rubber, with

Table 4. Multiple regression analysis between Modified Entropy Index (Y) and factors affecting crop diversification

Particulars	Coefficients	Standard Error	P-value
Intercept(a)	0.85206308	0.05335	1.82E-12
Rainfall[1](mm) (X_1)	-0.00000034	2.00E-06	0.87117
Gross irrigated area[2](ha) (X_2)	-0.00003916	3.50E-05	0.2722
Per capita State income[3] (Rs. Crores/year) (X_3)	0.00000008	1.40E-07	0.58675
Wage rate of agricultural workers[4] (Rs/day) (X_4)	-0.00006815**	2.60E-05	0.01595
Literacy rate[5] (%) (X_5)	-0.00138226**	0.00055	0.02063
Population density[6] (persons/km^2) (X_6)	0.00012769**	5.70E-05	0.03628
Farm credit[7] (Crores/year) (X_7)	-0.00000012	1.20E-07	0.33668
Fertilizers[8] (kg/ha) (X_8)	-0.00008769	9.20E-05	0.35316
Average size of land holdings[9] (ha) (X_9)	-0.05008287	0.0313	0.12611
Crop intensity[10] (%) (X_{10})	0.00023883	0.00037	0.52592
R^2	0.947894326		

Source:[1,2,3,4,7,8,10] Department of Economics and Statistics (GOK),[6,5] Office of Registrar General of India and Census Commissioner (GOI),[9]Agricultural Census, GOI

Note: ** shows 5 % level of significance

the increase from 367.42 thousand ha in the base year to 550.62 ha in the current year, had replaced paddy and tapioca, the major food crops of Kerala. This showed that the state was clearly moving away from food crops to commercial crops like rubber, coconut and export-oriented cash crops.

The decrease in area of cashew, a cash crop, was attributed to many setbacks in cashew industry like insufficient demand of domestic raw nuts because of severe competition from imported nuts from Brazil and Vietnam and problems related to processing and marketing (Kumar, 2018). Another reason was the existing land ceiling laws in Kerala and the continued denial of plantation status to cashew by the state. Because of this constraint, many big farmers had shifted away from cashew towards more profitable crops like rubber (Sisli, 2017). The decrease in area of crops like cashew and pepper was also due to the slump in prices (GOK, 2017). As commented by Joseph and Joseph (2005), the expansion of rubber area could also be attributed to higher prices offered to farmers and the policy followed by the government to keep the domestic prices at levels significantly higher than international prices. A shift in commercial crops towards less labour-intensive ones was also visible as a structural adaptation of the regional economy to cope with the rising cost of cultivation on account of rising wages (Joseph and Joseph, 2005).

According to Agricultural Development Policy, Govt of Kerala (GOK, 2015), the reasons behind the decrease in cultivation of paddy were indiscriminate reclammation of paddy fields, allegedly under the disguise of developmental activities. Earth brought from other dry land regions was used to fill these wetlands. Some of the converted areas were subsequently used for construction of houses and roads and were transformed into land put to non-agricultural purposes. Decline in rice production in Kerala was visible from the latter part of 1970s owing to the increased availability of rice grains at a comparatively cheaper price. Consequently, investment in rice production decreased and a major portion of the land was converted for the cultivation of more lucrative commercial crops.

A general trend of loss of interest in agriculture was evident. The possible reasons for people shying away from agriculture could be reduced profitability of crops due to high wages for farm labourers, high price of land and the uneconomic size of operational holding areas. The population pressure on land was also very high in Kerala and as a result there was high demand for land for purposes other than farming (GOK, 2015).

The investigation revealed the significance of three factors as determinants of crop diversification in Kerala. They were high wage rate of labour, high literacy rate, and high population density. When the wage rate increased, crop diversification decreased. This could be explained by the fact that mean wage rate in Kerala was Rs 624.70 per day which was the highest in the country (GOI, 2017). The proportion of area covered by major crops during the last 30 years threw light on the fact that paddy had undergone a major area shift and was replaced by more remunerative and less labour utilising crops like rubber, coconut and banana (Table 2). This led to a skewed distribution in area. In the current year, rubber and coconut together occupied 51 per cent in the gross cropped area, further cementing the fact that cultivators were opting for less labour-intensive crops. The major reason attributed to the increase in labour wages was shortage of labour force in Kerala. According to Nair and Dhanuraj (2016), this shortage was due to an aversion among the young generation towards working in the agriculture sector, poor profitability of farming and high social prestige attached to government and private jobs.

The second factor responsible for crop diversification was literacy rate, as high literacy tends to decrease crop diversification. The literacy rate of Kerala is the highest in the country, standing at 93.91 per cent in the current year. Increased educational facilities extended the period of

schooling and delayed the entry of younger generation to the work force. Further, a greater percentage of highly educated youth prefered white collar jobs over the agricultural sector, (Saleena, 2017). The spread of education and increasing contact with the outside world made rural labour aware of their rights and privileges. Unionism (formal or informal) grew among the rural workers enabling them to bargain for higher wages prompting many farmers to cultivate less labour-intensive crops (Mahesh, 1999). For the development of such crops, the Government of India provided support through Commodity Boards such as the Rubber Board, the Coconut Development Board, and Spices Board, giving a boost to the cultivation of commercial crops.

The third factor influencing crop diversification in Kerala was the population density. Compared to other factors, this had a positive influence on crop diversification. When population density increased, crop diversification increased. Increase in population and partitioning of households caused fragmentation of holdings and rise in the demand for new dwelling units. Moreover, the average household size was also decreasing due primarily to adoption of family planning and high literacy. Each household, of four to five members, chose to have an independent house of its own with a small homestead around it (Mahesh, 1999). A typical homestead in Kerala consisted of a dwelling house with a small ornamental garden in the front and a variety of annual and perennial crops grown in mixture. The integrated farming system combining livestock, backyard poultry and inland fishery concentrating around the home is popularly known as the 'homestead farming', which was unique to Kerala. Therefore, it can be stated that when population density increased, adoption of homestead farming increased and crop diversification also increased in the process.

Based on the results of the study, the followings recommendations have been suggested for policy implications.

1. Cultivation of rice needs to be encouraged as it is a socially and politically important crop of Kerala. It can be done by giving profitable procurement price, production bonus, ecological incentives for conserving wetlands, group farming, popularization of appropriate high yielding varieties for each region, soil health management based on soil test data, integrated pest management, and organizing frontline demonstrations for maximizing profitability as recommended by Kumari (2012).
2. The law prohibiting permanent conversion of paddy fields for cultivation of perennial crops or commercial purposes shall be strictly enforced.
3. Farmers should be encouraged to cultivate suitable crops in between the interspaces of commercial crops, which enhances crop diversification.
4. As most of the gross cropped area in Kerala is covered by notified plantation crops, steps must take to conserve such plantations. In Kerala, estates cultivated with rubber, tea, coffee, cocoa, cardamom, and cinnamon are exempted from the land ceiling as they are given a special status. It should be insisted that in all the lands belonging to such estates, the notified plantation crops alone be planted.
5. When commercial crops are grown, it must be as special crops by creating specialized zones along with better technological advancements for production, processing and trade related facilities to survive the competition from imported products.
6. As wage rate is high due to the shortage of labour force in Kerala, schemes such as "agriculture labour banks" started by many Panchayaths may be encouraged to address this issue.
7. With the increasing population density and decreasing average size of land holdings, special schemes to encourage homestead farming shall be started.
8. The areas where food crops are cultivated

should be protected through various incentives to the cultivators. Seeds of improved varieties need to be made available to the farmers along with better opportunities for storage, processing, value addition, export, etc.

The trend in area under crops in Kerala from 1987-88 to 2016-17 shows that non-food crops have fared comparatively better than food crops. The major setback is for paddy (-15745.55 ha/year) followed by tapioca (-3404.29 ha/year). Rubber showed the maximum impact on area expansion with 6279.68 ha/year during the period of 30 years. Area under arecanut and banana also increased during this period. It can be concluded that crop diversification has been decreasing in recent years. The study showed that the highest crop diversification index was in 2002-03 and the lowest diversification in 2016-17. The investigation revealed the significance of three factors as determinants of crop diversification in Kerala: high wage rate high literacy rate, and high population density. Wage rate and literacy rate exerted negative effect on crop diversification whereas population density exerted positive effect on crop diversification.

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