Intra-regional disparities in Kerala's agricultural development

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ABSTRACT

Disparities in agricultural development in all the fourteen districts of Kerala were studied for the period 2015 to 2020. The standardised developmental indicators were used to find out the overall composite index. The districts were classified into homogenous groups based on the composite indices. For identifying the most contributing variables in agricultural development, principal component regression was carried out. A biplot was employed to identify major contributing variables. District Palakkad with a composite index of 0.617 was ranked first and Pathanamthitta with the highest composite index of 0.877 received the least rank. The variables such as the area under pepper, productivity of rubber, the productivity of rice, area under rubber, productivity of tubers and fertilizer consumption contributed higher to the first principal component. In contrast, the variables area under paddy, net sown area and area under irrigation contributed more to the second principal component. A district-level intervention for the improvement and increase in these indicators can help the districts to progress their position in the development of the agricultural sector of that particular district and, hence, the overall socio-economic development of the district and the state.

Keywords: Composite index; developmental indicators; principal component; regression; contributing variables

INTRODUCTION

India is a large federal nation and it is well known that there are widespread disparities in the levels of economic and social development among the different states of the Indian nation. It is generally recognized that inter-regional economic disparities increase at least in the initial stages of national economic development. Regional imbalances in a country may be natural due to unequal distribution of natural resources and or man-made in the sense of neglect of some regions and preference for others for investment and infrastructural facilities (Paul and Sheeja 2016). Agriculture plays a strategic role in the development and it has helped the economy to transform significantly. However, due to risks and uncertainties brought on by climate variability, variations in commodity prices and difficulty in marketing the produce, Kerala's agriculture sector has recently faced growth challenges. Agriculture's contribution to the Gross State Value Added (GSVA) fell from 12.37 per cent in 2013-14 to 9.44 per cent in 2020-21. Kerala differs from other states in land use pattern and how it cultivates its crops (https://dairydevelopment.kerala.gov.in/images/pdf/2022-23/Cattle_feed.pdf).

Increased productivity from cultivable land must be achieved through modernised agriculture. Low agricultural output is a result of a variety of environmental issues, including an unfavourable climate and a propensity for flooding. These problems also contribute to the state's poor economic development in different regions. As a result, different parts of India have grown at different rates. Development is a dynamic concept and has different meaning for different people. It is used in many disciplines at present. The development processes of a growing economy are significantly influenced by geographic considerations (Tanwar et al 2016). Locational advantages are a major factor in deciding a region's development plan. There are considerable geographical differences in the pace of agricultural development in Kerala because of the wealth of natural resources, farming practices and other variables (Ayyoob et al 2013). The regional disparities in the agricultural sector are a threat to balanced and uniform growth of the rural areas of state, the economic growth and hence the overall development of the state. Despite the fact that there are regional differences in the state of agricultural development between the districts, it is difficult to precisely quantify these variations. Development is a continuous process of raising the standard of living and progress of the state (Ohlan 2013). One indicator alone cannot properly convey the impact of progress but the contribution of each variable is vital in the process of development. In the current study, a composite index of development has been constructed to quantify the agricultural development of various districts across the state; classification of homogenous groups was carried out based on the development and an attempt has been made to identify major contributing variables to agricultural development.

METHODOLOGY

For the study, secondary data pertaining to the agricultural sector, for a period of five years from 2015 to 2020, were collected from various published sources of the Government of Kerala. Thirty six indicators that contributed to the development of the agricultural sector in each district were included in the data. Based on these indicators, composite developmental indices were developed for several districts viz rainfall (mm), percentage of forest area, percentage of net sown area, percentage of area under irrigation, productivity of rice (kg/ha), productivity of ginger (kg/ha), productivity of black pepper (kg/ha), productivity of areca nut (kg/ha), productivity of tubers (kg/ha), productivity of rubber (ha), productivity of mango (kg/ha), productivity of banana (kg/ha), productivity of plantain (kg/ha), productivity of pineapple (kg/ha), productivity of raw cashew nut (kg/ha), productivity of green chillies (kg/ha), productivity of coconut (kg/ha), productivity of tobacco (kg/ha), productivity of tea (kg/ha), productivity of cocoa (kg/ha), percentage share of marine fishing, percentage share of inland fishing, number of indigenous cattle, number of crossbred cattle, livestock population, number of indigenous cattle milk yield (kg), fertilizer consumption of N (kg/ha), fertilizer consumption of P (kg/ha), fertilizer consumption of K (kg/ha), area under paddy (ha), area under black pepper (ha), area under coconut (ha), area under rubber (ha), area under pulses (ha), area under vegetables (ha) and area under tubers (ha).

Composite index: As the variables selected for the analysis were measured in different units of measurement, the values of these variables were not nearly appropriate for combined analysis. Hence, at the first step the variables were transformed and standardised for developing a composite index as follows:

Let [Xj] be a data matrix that contains the values of the variables for the i^{th} district i = 1, 2,…n (number of districts) and the j^{th} indicator j = 1, 2,..., k (number of indicators).

For combined analysis $[X_{ij}]$ was transformed to $[Z_{ij}]$ as:

$$[Z_{ij}] = \frac{X_{ij} - \overline{X_j}}{S_j}$$

where $\overline{X_j}$ = Mean of j^{th} indicator, S_j = Standard deviation of j^{th} indicator

For each indicator, the best value of the transformed variable was determined which was either maximum or minimum based on the indicator's impact on development.

C_i was calculated by using the formula:

$$C_i = \left(\sum_{j=1}^{k} \frac{p_{ij}}{cv_j}\right)^{1/2}$$

where C_i = Pattern of development, CV_j = Coefficient of variation in X_{ij} for j^{th} indicator, $P_{ij} = (Z_{ij} - Z_{oj})^2$

Composite index of development is given by:

$D_i = C_i/C$

where C = C + 3SDi, C = Mean of C_i, SD_i = Standard deviation of C_i

The districts were classified into different homogeneous groups namely high, medium and low developed districts based on the level of development by using mean ± 0.5 SD of the indices.

Principal component analysis: To reduce the selected thirty six variables into a new set of fewer number of mutually orthogonal components, principal component analysis was employed. The principal components are the linear combination of original variables obtained by extracting maximum variability within the original data. Principal component analysis can be used to examine how many variables interact with one another so that the information contained in many original variables can be condensed into a smaller set of variables or factors with the least amount of information loss (Mishra 2019).

Multiple linear regression: Multiple regression analysis was employed taking agricultural development indices as the dependent variable and selected principal components as independent variables, to obtain the major contributing indicators to the development of each district; factor loadings obtained from the principal components were analysed:

$$Y = \beta_0 + \beta_1 PC_1 + \beta_2 PC_2 + \ldots + \beta_n X_n + \varepsilon_i$$

where Y = Composite index of socio-economic development, β_0 = Intercept, β1, β2, β3,…..βn = Coefficients of principal components, PC1, PC2, PC3, PC4, PC5 = Principal components, ε_i = Error term

RESULTS and DISCUSSION

Level of development: Composite indices of development were constructed for each district based on the combination of thirty six developmental indicators and the districts were ranked based on the obtained indices (Table 1). The district with the smallest value of the composite index received the first rank and the one with the highest value the least rank. The composite indices had wide range of disparity ranging from 0.671 to 0.877. District Palakkad with a composite index of 0.617 was ranked first followed by Kasaragod (0.738) and Idukki (0.760). District Pathanamthitta with the highest composite index of 0.877 received the least rank followed by Kozhikode (0.857) and Thiruvananthapuram (0.853). Districts Kannur (0.793), Thrissur (0.800), Ernakulam (0.809), Malappuram (0.823), Kottayam (0.825), Kollam (0.827), Wayanad (0.829) and Alappuzha (0.834) were ranked fourth to eleventh in the order.

The results show that the present study is almost on par with the study of Narain et al (2007). Similar results were obtained by Ayyoob et al (2013). For highly developed districts, the indicators like the productivity of ginger, the productivity of black pepper, the productivity of coconut, the productivity of rubber, the productivity of rice, the area under black pepper and area under coconut were common variables that might have contributed more to the development of the agricultural sector. Similar method was also used by Kumar et al (2018), Narain et al (2005) and Narain et al (2011) for the construction of composite index.

Different stages of development: The districts were classified into different homogeneous groups, based on the development considering a benchmark of mean ± 0.5 standard deviation. The districts with a composite index of less than 0.771 (CI $\leq$0.771) were considered as highly developed districts, whereas, the districts with the composite index of more than 0.836 (CI $\geq$0.836) were categorised as low developed districts. The districts whose composite index fell in between 0.771 to 0.836 (0.771 <CI <0.836) were grouped as medium developed.

Data in Table 2 depict that the districts with a composite index of higher than 0.836 (CI $\geq$0.836) were classified as low developed districts viz Thiruvananthapuram, Pathanamthitta and Kozhikode. The districts Palakkad, Kasaragod and Idukki were categorised as highly developed districts (CI $\leq$0.771). The districts Kollam, Alappuzha, Ernakulam, Thrissur, Malappuram, Wayanad, Kannur and Kottayam were medium developed districts (0.771 <CI <0.836).

Fig 1 shows that highly developed districts were distributed in the different geographical locations of Kerala. Palakkad from central Kerala, Kasaragod from northern Kerala and Idukki from high ranges were classified in highly developed districts. The districts such as Kannur, Wayanad and Malappuram belong to northern Kerala, the districts Thrissur, Ernakulam and Kottayam belong to central Kerala and the districts Alappuzha and Kollam belong to southern Kerala and were classified as medium developed districts. In contrast, Kozhikode in northern Kerala, Pathanamthitta and Thiruvananthapuram in southern Kerala were classified as low developed districts.

Principal component analysis: Principal component analysis was employed to identify major contributing indicators for the development.

The data given in Table 3 show that the first five principal components extracted 74 per cent of explained variation. The first principal component extracted the maximum variance of 22.7 per cent followed by PC_2 (18.6%), PC_3 (13.2%), PC_4 (10.5%) and PC_5 (8.7%).

From the scree plot (Fig 2), it is observed that the first five principal components extracted around 74 per cent of the total variability in the data set. Hence, these five components were considered for the regression analysis.

Regression analysis was performed by taking indices as the dependent variable and the first five principal components as independent variables (Table 4). From regression analysis, the first two principal components were found to be significant and hence contributed significantly to agricultural development.

Fig 3 shows the biplot of principal components in which there are two axes; the horizontal axis depicts the first principal component and the vertical axis portrays the second principal component. From the biplot, it can be see that the variables such as the area under pepper, productivity of rubber, the productivity of rice, area under rubber, productivity of tubers and fertilizer consumption contributed higher to the first principal component. In contrast, the variables area under paddy, net sown area and area under irrigation contributed more to the second principal component.

As the first two principal components were highly significant in the regression, it is clear that the improvement in these variables contributed significantly and positively to the level of development of the agricultural sector of the particular districts. Hence, a district level intervention for the improvement and increase in these indicators can help the districts to progress their position in the development of the agricultural sector of that particular district and, hence, the overall socio-economic development of the district and the state.

Earlier, Narain et al (2005) obtained the level of development of different districts of Kerala with the help of composite index based on optimum combination of thirty nine socio-economic indicators. District Thrissur was ranked first and Wayanad was ranked last in the socio-economic development. Wide disparities were observed in the level of development among different districts.

Ayyoob et al (2013) observed wide range of disparities in the level of agricultural development among different districts of Kerala. District Palakkad was ranked first and the district of Pathanamthitta was ranked last in agricultural development. Categorising the districts into three groups based on mean and standard deviation of composite index, it was found that six districts namely Pathanamthitta, Alappuzha, Kottayam, Idukki, Kozhikode and Kasaragod were low developed, whereas, Thiruvananthapuram, Kollam, Wayanad and Kannur were moderately developed. Four districts namely Ernakulam, Thrissur, Palakkad and Malappuram were classified as highly developed districts.

Kumar et al (2018) captured latest dynamics of development of districts of western Uttar Pradesh. The composite indices (CI) of development in respect of 18 developmental indicators for the total 26 districts of weastern Uttar Pradesh were estimated for the year 2011-12. The district Muzzfarnagar showed a higher level of development (CI = 0.81) in agricultural development as compared to social development in district Hathrus (CI = 1.32) and infrastructural development in GB Nagar (CI = 0.17).

Tanwar et al (2016) studied the dynamics of development of districts of eastern Uttar Pradesh. District Barabanki showed a higher level of development (CI = 0.10) in agricultural development compared to social development (CI = 1.12) and infrastructural development (CI = 0.89) followed by Ambedkar Nagar in agricultural (CI = 0.52), social (CI = 1.12) and infrastructural (CI = 0.89) development.

They observed that Allahabad secured first position in the social development (CI = 0.81) and second in infrastructural development (CI = 0 .34) as compared to agriculture (CI = 0.93). Varanasi was the most developed district in infrastructure (CI = 0.10) as compared to agriculture (CI = 0.96) and social (CI = 0.96).

Narain et al (2011) studied the level of development of eighteen districts of West Bengal with the help of composite index based on optimum combination of forty five developmental indicators for the year 2001-02 and observed wide disparities in the level of development among the districts. Infrastructural facilities and agricultural development were found to be positively associated with socio-economic development.

Table 1. Composite index of agriculture

District	Agricultural development		District	Agricultural development	
	Composite index	Rank		Composite index	Rank
Palakkad	0.617	01	Kottayam	0.825	08
Kasaragod	0.738	02	Kollam	0.827	09
Idukki	0.760	03	Wayanad	0.829	10
Kannur	0.793	04	Alappuzha	0.834	11
Thrissur	0.800	05	Thiruvananthapuram	0.853	12
Ernakulam	0.809	06	Kozhikode	0.857	13
Malappuram	0.823	07	Pathanamthitta	0.877	14

Table 2. Stages of development of the agricultural sector

Stage	Districts
High (CI $\leq$0.771)	Palakkad, Kasaragod, Idukki
Medium (0.771 <CI <0.836)	Thrissur, Kannur, Ernakulam, Wayanad, Malappuram, Kollam, Kottayam, Alappuzha
Low (CI $\geq$0.836)	Pathanamthitta, Kozhikode, Thiruvananthapuram

Table 3. Extraction of variability

Component	PC_1	PC_2	PC_3	PC_4	PC_5
Eigen value	8.2	6.7	4.7	3.8	3.1
Standard deviation	2.8	2.7	2.1	1.9	1.7
Proportion of variance	22.7	18.6	13.2	10.5	8.7
Cumulative proportion	22.7	41.3	54.5	65.1	73.8

PC = Principal component

Table 4. Regression analysis

	Coefficient	Standard error	t-stat	P-value
Intercept	0.79	0.01	67.72	2.5×10^{-12}
PC_1	0.01	0.01	3.18	0.012
PC_2	–0.01	0.01	–2.24	0.49
PC_3	0.01	0.01	0.37	0.71
PC_4	0.006	0.006	1.08	0.31
PC_5	–0.015	0.007	–2.07	0.07

In a study conducted in Himachal Pradesh, Tripathi and Tanwar (2017) observed that the districts Kangra, Mandi, Sirmaur and Shimla were found to be most developed, whereas, the districts Lahaul and Spiti, Kinnaur, Bilaspur and Hamirpur were found to be low developed districts in the overall development.

Narain et al (2007) obtained the level of development of different states of India with the help of composite index based on optimum combination of a number of socio-economic indicators. They reported that the state of Punjab was ranked first and Bihar was ranked last in overall socio-economic development. Wide disparities were observed in the level of development among different states. The overall socio-economic development was positively associated with the development in agricultural sector. The infrastructural facilities and literacy status were

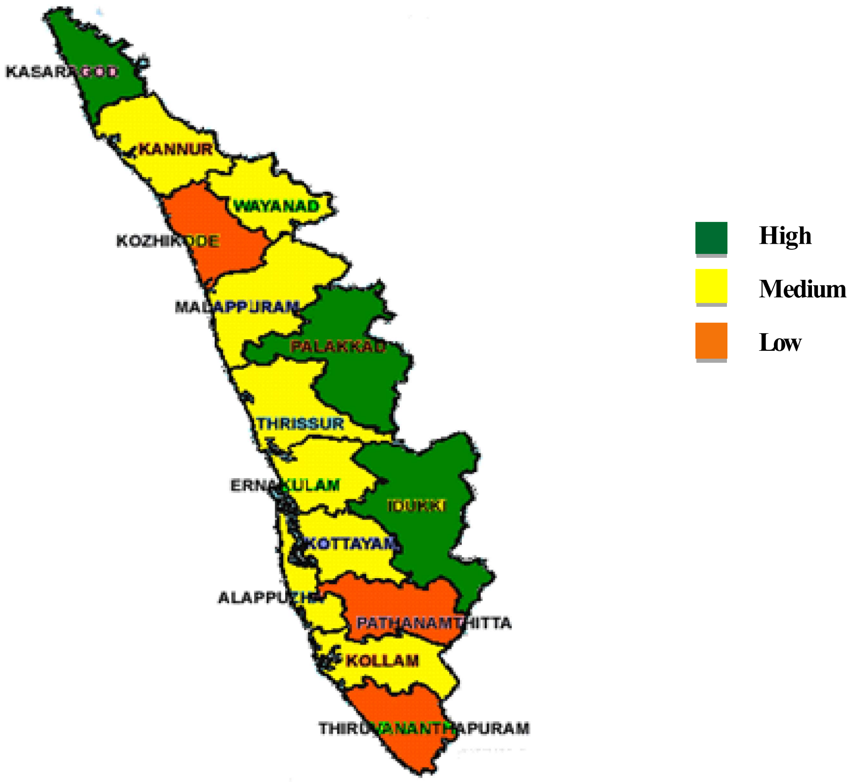


Fig 1. Graphical representation of high, medium and low developed districts in the agricultural sect

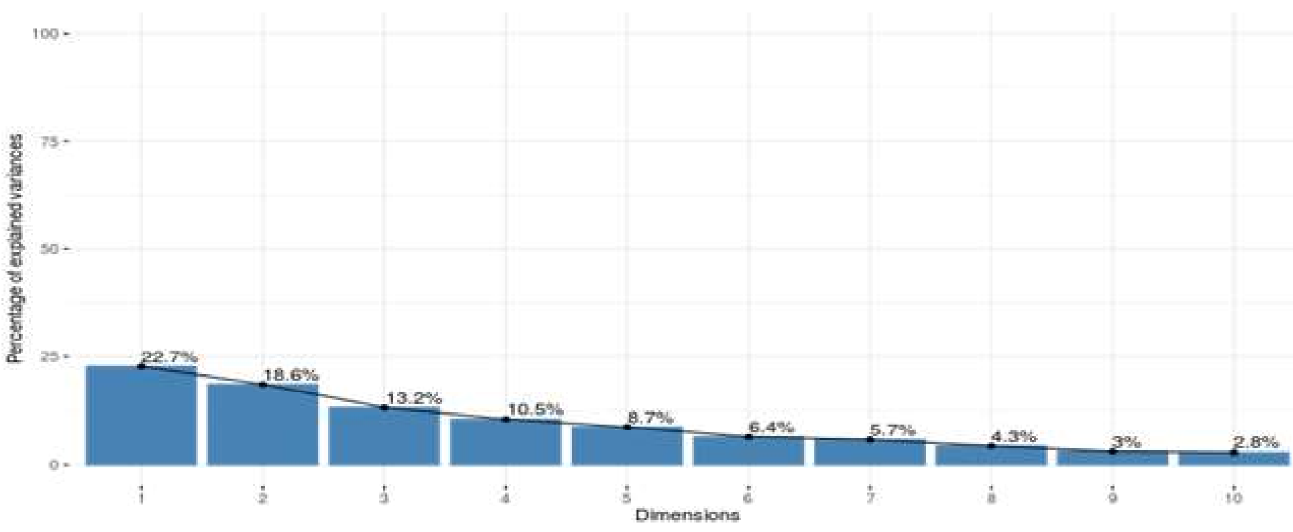
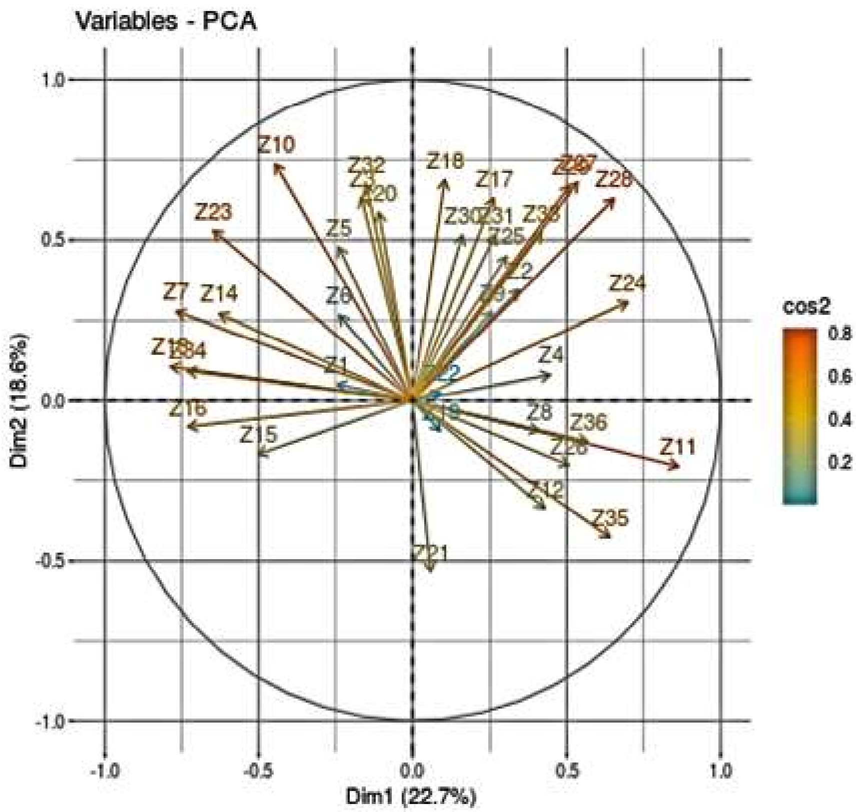


Fig 2. Scree plot

influencing the socio-economic development in the positive direction.

Ohlan (2013) assessed the pattern of disparities in socio-economic development at the district level in India and reported that southern region was far more and symmetrically developed in comparison of central and northern regions. Wide disparities in the level of socio-economic development existed among different districts within and between different regions of India. The level of development in infrastructural service sector was found to be positively and statistically significantly associated with the overall socio-economic development



Z1: Rainfall, Z2: Forest area, Z3: Net sown area, Z4: Productivity of rice, Z5: Productivity of ginger, Z6: Productivity of pepper, Z7: Productivity of areca nut, Z8: Productivity of tubers, Z9: Productivity of mango, Z10: Productivity of banana, Z11: Productivity of pineapple, Z12: Productivity of plantain, Z13: Productivity of cashew nut, Z14: Productivity of cashew nut, Z15: Productivity of coconut, Z16: Productivity of rubber, Z17: Productivity of tobacco, Z18: Productivity of tea, Z19: Productivity of cocoa, Z20: Area under irrigation, Z21: Marine fishing, Z22: Inland fishing, Z23: Indigenous cattle, Z24: Crossbred cattle, Z25: Livestock population, Z26: Indigenous cattle milk yield, Z27: Fertilizer consumption of N, Z28: Fertilizer consumption of P, Z29: Fertilizer consumption of K, Z30: Area under coconut, Z31: Area under paddy, Z32: Area under pulses, Z33: Area under vegetable cultivation, Z34: Area under pepper, Z35: Area under tubers, Z36: Area under rubber

Fig 3. Biplot of principal components

indicating that the growth and progress of the sectors had been going hand in hand in the country. In northern and central regions of India, the level of industrial development did not influence the agricultural and overall socio-economic development while agricultural development influenced overall socio-economic development.

CONCLUSION

It can be concluded that in the state of Kerala, district Palakkad was highly developed in agriculture followed by Kasaragod and Idukki. The district Pathanamthitta was low developed followed by Kozhikode and Thiruvananthapuram. Among the thirty-six variables, area under pepper, productivity of rubber, productivity of rice, area under rubber, productivity of tubers, fertilizer consumption, area under paddy, net sown area and area under irrigation were identified as the major contributing variables to the development of the agricultural sector of the state. Hence a district-level intervention for the improvement and increase in the identified indicators can help the districts to progress their position in the development of the agricultural sector.

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