Risk in agriculture: A spatio-temporal analysis of agricultural income of Kerala

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Abstract

Agriculture and allied sectors are the crucial sectors of Kerala economy as they provide livelihood to approximately 40 per cent of the rural households. But over the past two decades its relative importance in the state economy has been dwindling. The present study discusses the trends and patterns in agricultural income of the state over a period of 15 years from 1999-00 to 2015-16. The analysis shows the nominal income as increasing steadily over the period, while the real income as stagnating. The rate of growth in nominal income is 10.6 per cent and that of real income is -0.8 per cent. The price trend of agricultural commodities of Kerala shows adverse terms of trade in price received and price paid by the farmers. The index of agricultural production of prominent crops of Kerala halved from 107.85 (1999-00) to 48.05 (2015-16) highlighting the severe set-back in agricultural production. Palakkad, Idukki and Kottayam were the districts that contributed highest to state agricultural income (2015-16) while Idukki, Kottayam, Malappuram in that order were the ones that showed consistent share over a span of 15 years. The level of agricultural risk in the state, estimated as the instability index was found to be 0.086 at current prices and 0.067 at constant prices. Kasaragod, Alappuzha and Wayanad were the high risk districts. The paper recommends that the policy instruments are to be designed taking into consideration the relative importance of districts in the state's agricultural performance and risk factors.

Keywords: Agricultural income, Compound growth rate, District, Instability, Kerala, Nominal price, Real price, Risk.

Introduction

Though agricultural sector has made large strides in achieving the development goals of food security, availability and accessibility, it remains constrained by low productivity, excessive dependence on monsoon and weather conditions, price fluctuations and fragmented markets that has led to episodes of agrarian crisis (GoI, 2017). Most of the studies highlight growing levels of instability in agricultural income (Vaidyanathan, 1992; Backua et al., 1997) which is attributed to technology (Mariconda, 2014; Kohansla and Aliabadi, 2014), climate (Munansinghe, 1997; 1997; Anton et al., 2012) and market forces (Mishra, 2008). The estimates of farmers income in India from agriculture over the past three decades show that the income earned by farmers from agricultural activities after paying input costs and the wages for hired labour has seen low to high growth in different periods during the last three decades (Chand et al., 2015). A low growth rate in farm income is associated with an increase in agrarian distress as the number of farmers' suicides increased during the phase of low growth and decreased when farm income increased at a higher rate. Instability in farm income was found to be higher compared to yield and area in all important crops at both national and

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state level (Chand and Raju, 2008).

Kerala agriculture is characterized by high share of marginal farmers, diverse agro-ecosystems, multiplicity of crops and many social and economic factors that deter the importance of farm sector. The average income of an agricultural household in Kerala is reported as Rs.5872 per month from crop production, which is the highest in India (All India Debt and Investment Survey, 2013). But the expenditure levels are also on the higher side, making it as high as 97 per cent of the income. Agricultural income in Kerala showed declining trend with 1.43 per cent growth rate in 2012-13 compared to the previous agricultural year, to a negative growth rate of 2.9 per cent in 2015-16 (Economic Review, 2016).

Kerala agriculture has been showing structural changes over the past several decades. One of the most influential factors contributing to the structural change in state domestic product and employment is the changes in cropping pattern triggered by market opportunities and demand factors (Kannan, 2011). Ramakumar (2004) observed the inherently vulnerable, predominantly commodity market dependent agriculture of Kerala as undergoing an unprecedented crisis since the 1990's consequent to the price crash in most of the commodities. Since then agricultural prices plummeted to unforeseen levels. In this background this paper analyses the growth and instability in agricultural income in Kerala over a span of 15 years and attempts to understand the relative position of the districts.

Materials and Methods

The present study is based on time series data on agricultural income from 1999-00 to 2015-2016. Data on agricultural income (real and nominal terms) at state and district level (14 districts) were compiled from various publications and institutions like Directorate of Economics and Planning, and State Planning Board. Real agricultural income series were rebased to a fixed base year (1999-00) to remove the effects of changes in general price level over time.

To understand the trend in agricultural income over a period of time (15 years), Compound Annual Growth Rate (CAGR) was estimated. It is expressed in annual percentage terms and gives a general trend in growth of agricultural income over specified time period (Prabakaran and Sivapragasam, 2013)

CAGR is worked out by fitting exponential function in the form of,

$$Yt = ab^t e^u$$

Where,

Yt: Agricultural income in Kerala
a : Intercept
b : Regression coefficient
t : Number of years
u : Error term

Taking logarithms on both sides to transform this equation to log linear form,

$\log Yt = \log a + t \log b + u$

$Yt' = A + B\,t + u$

Where,

Yt′ : log Yt
A : log a
B : log b

CAGR of a variable is the rate of change per unit time, usually a year. The method of ordinary least squares was adopted to estimate the co-efficient (b). Compound growth rate in percentage is calculated using the relationship:

Compound Growth Rate (CGR) =
(Antilog B – 1) X 100

The significance of the regression coefficient was tested using the student's t- test as

$$t = bi / SE(bi)$$

Where,

(bi) = regression co-efficient
SE (bi) = standard error of regression co-efficient bi
t = calculated t- value

For measurement of risk, instability index as

estimated by Raju et al. (2014) was employed. They used the method to analyse the inter-state instability in Indian agriculture by covering the entire post-independence period since 1950-51. It is measured as the standard deviations of natural logarithms of agricultural income of the current year to that of the succeeding year. A low value of this index indicates low instability in agricultural income and vice-versa.

Instability index = Standard deviation of natural logarithm (Y_{t+1}/ Yt)

where, Yt is the agricultural income in the current year and, Y_{t+1} is for the next year. This index is unit free and very robust, and it measures deviations from the underlying trend. When there are no deviations from the trend, the ratio of Y_{t+1}/ Yt is constant and thus standard deviation is zero. As the series fluctuates more, the ratio of $Y_{t+1}$and Yt also fluctuates more, and standard deviation increases (Ray, 1983).

Results and Discussion

Agricultural income in Kerala: status and trends

Indian economy is characterized by the predominance of agriculture sector, by way of dependence of the population on the sector. Nearly 58 per cent of rural households in India depend on this sector. In Kerala, the proportion of farm households are rather low (40 per cent) (NSSO, 2013) and its relative importance in the state's economy has been dwindling. The share of agriculture and allied sectors in the Gross State Domestic Product (GSDP) of the state was 14.38 per cent in 2011-12, which reduced to 10.38 per cent in 2015-16. The sector recorded a positive growth of 1.8 per cent during X^{th} plan period but a negative growth rate of 1.3 per cent during XI^{th} five year plan period (Economic Review, 2016).

The GSDP from agriculture and allied sectors include sub sectors like agriculture (including livestock and dairying), forestry and logging and fishing and aquaculture. The agricultural income in Kerala was reported at Rs. 44,12,673 lakhs in 2015-16 at constant prices of which the share of agriculture was 81.97 per cent, forestry and logging at 8.05 per cent and fishing, and aquaculture constituted 9.97 per cent. This, on an average formed 9.44 per cent of the state's income. The analysis of the agricultural income from 1960s showed an increasing trend (current price) though it stagnated during some phases (Lalitha, 1993). She reported the agricultural income of the state as growing since the mid-eighties but as stagnating during the period between mid-seventies to mid-eighties. Thereafter, the revival of growth in agriculture was mainly due to the increase in yield and shift in cropping pattern to high valued crops, she argues. In our study the agricultural income in current prices showed an increasing trend, after a stagnation phase during 99-00 to 2002-03. The real income had been declining over the period under study while the movement of the two trend lines was on par till 2003-04. Since then, the real income showed continuous decline while the nominal income grew (Figure 1).

The agricultural income being a function of prices and output, we analyzed the price trend of agricultural inputs and products, looking at the index of prices. The index of prices received by the farmers showed an increase over the years at current prices, which contributed to a positive growth in nominal income. But the movement of the price realized by

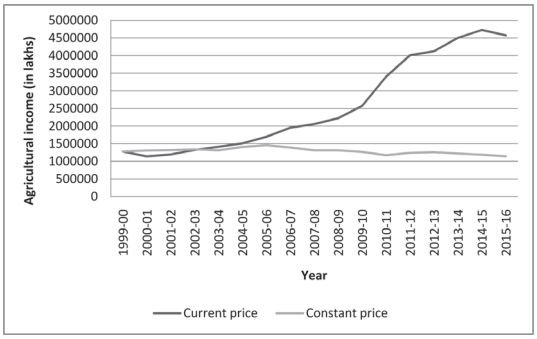

Figure 1. Trend in agricultural income of Kerala (1999-00 to 2015-16) at current and constant prices

Source: Economic Review, 2000-2016

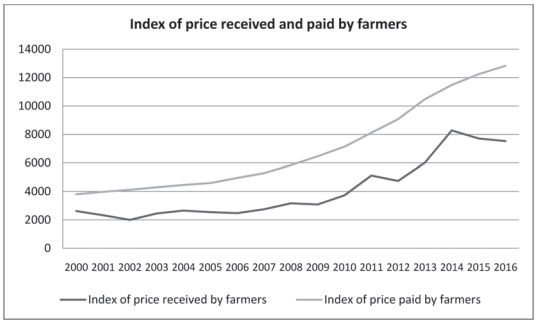

Figure 2**.** Yearly average index of prices received and prices paid by farmers (2000 to 2016)
Source: Economic Review, 2000-2016

the farmers had been to the disadvantage of the farmers, the price paid being at higher level than price received and the gap getting widened (Economic Review, 2016). The trend reflected the unfavorable terms of trade to the farming community (Figure 2).

Agricultural output, the second determinant of agricultural income was analyzed by taking the index of agricultural production of prominent crops of Kerala, both food crops and non-food crops (1999-00 to 2015-16). The index represented each year's crop production relative to the base period (1993-94). The index halved from 107.85 (1999-00) to 48.05 over these years, highlighting the severe set-back in agricultural production (Table 1). The reasons could be the changes in area under cultivation, productivity and relative allocation of area of major crops, which needs further in depth analysis. However, it could be concluded that the prices received by the farmers, could offset the decline in production so that the agricultural income is on the rise. But, in real terms it was not enough to offset the decline in production as evidenced by the decline in real income.

Table 1. Yearly index of agricultural production of prominent crops in Kerala

Year	Index of agricultural production of prominent crops in Kerala
1999-00	107.85
2000-01	108.12
2001-02	105.30
2002-03	97.80
2003-04	108.75
2004-05	96.28
2005-06	102.15
2006-07	109.70
2007-08	105.40
2008-09	109.04
2009-10	97.73
2010-11	95.60
2011-12	51.89
2012-13	50.60
2013-14	49.30
2014-15	49.10
2015-16	48.05

Source: Economic Review, 2000-2016

The districts were categorized based on contribution to the state income into three groups' viz., low (below Mean-SD), medium (between Mean+SD and Mean-SD) and high (above Mean+SD) (Table 2). There were two districts in the high share category (nominal terms) and three in terms of real income. Palakkad and Idukki were the two districts that contributed the maximum to the agricultural income, this combined contributions (23.81%) accounting to nearly a quarter of the total. Palakkad district is an agriculturally important district with a GCA of 30,3461 ha (11.46 per cent of GCA of the state). The agricultural production is mainly food crops (rice and vegetables). Idukki district is characterized by the cultivation of high value spice crops (pepper and cardamom) and plantation crops which are traded in the international and domestic markets. On analyzing the performance of districts with respect to their contribution to state income over 15 years, Idukki was found to be better performing followed by Kottayam and Malappuram.

Alappuzha followed by Pathanamthitta and Wayanad contributed lowest to the nominal income of the state. It was Alappuzha followed by Wayanad in real terms. Share of agricultural income was the lowest in Alappuzha district at both current and constant prices. Though Alappuzha is considered as the rice bowl of Kerala, the proportion of gross cropped area to total geographical area of the district was only 14.92 per cent. The agricultural activity of the district was mainly confined to paddy and

Table 2. District –wise distribution of agricultural income (2015-16) and CAGR in agricultural income (1999-00 to 2015-16)

Districts	Current price		Constant price	
	Agricultural income (2015-16) (Rs. in lakhs)	Growth rate (1999-00 to 2015-16)	Agricultural income (2015-16)(Rs. in lakhs)	Growth rate (1999-00 to 2015-16)
TVM	332320 (7.26)	9.5	260189 (7.19)	-1.2
KLM	341011 (7.45)	11.1	274278 (7.58)	-3.2
PTA	197537 (4.31)	11.0	188401 (5.20)	-0.8
ALP	178170 (3.89)	8.3	121391 (3.35)	-6.7
KTM	281366 (6.14)	11.0	302504 (8.36)	1.2
IDK	517585 (11.31)	11.7	404364 (11.17)	-0.6
EKM	349311 (7.63)	11.4	302623 (8.36)	-1.2
TSR	337915 (7.38)	8.1	247274 (6.83)	-1.6
PLK	572475 (12.50)	12.6	402633 (11.13)	2.7
MLP	385856 (8.43)	9.4	298711 (8.25)	-4.2
KKD	281914 (6.16)	8.5	212323 (5.87)	-2.8
WYD	226245 (4.94)	9.1	154875 (4.28)	-0.09
KNR	297639 (6.50)	10.7	239266 (6.61)	-0.2
KSD	276845 (6.04)	11.6	208275 (5.75)	2.6
KERALA	**4576189 (100)**	**10.6**	**3617077 (100)**	**-0.8**

(Figures in brackets are percentage to total income of the state)

the other crops cultivated were coconut, tapioca, jack, mango and plantain. The geographical peculiarities limited the scope of other crops in the district.

To quantify the changes in agricultural income during the period, and to understand the performance of districts, the Compound Annual Growth Rate (CAGR) was estimated at the state level and district level. The growth rate of the state income was estimated as 10.6 per cent at current prices and -0.8 per cent at constant prices during the year 1999-00 to 2015-16. The growth rate in current prices was obviously high due to the price factors and their inflationary trends. All the districts in Kerala showed positive growth in agricultural income at current prices but recorded a negative growth at constant prices except for Palakkad, Kasargod and Kottayam. (Table.2). These districts registered positive growth in real and nominal terms, though the magnitude varied.

The districts that contributed most to the state income were the ones that showed highest growth rate. The growth rate was high in Palakkad (12.6 per cent) followed by Idukki (11.7 per cent) and Kasargod (11.6 per cent). While Palakkad district is prominent with food crops the non food crops find major share in Idukki district. At constant prices, majority of the districts showed negative growth rate except Palakkad, Kasargod and Kottayam, in that order. Kasargod district showed positive growth rate compared to others because over the past 15 years, net sown area of the district had increased by 8 per cent (2015-16). Major crops cultivated in the district are paddy, pepper, arecanut, cashew, coconut and rubber.

Risks in agriculture; Measurement of instability in income

Agricultural activities are subjected to a wide range of risks due to various factors causing wide swings in agricultural income. An attempt to study the instability in agricultural income of the state and its districts was done to understand the level of risks on the farming community of Kerala.

Agricultural income is a function of production and price and hence influenced by biotic and abiotic factors. Because of variations in climatic conditions, natural resource endowments, institutions, infrastructure and several other factors, pattern of agricultural growth and development vary across

districts. Accordingly, instability in agriculture is expected to show varying patterns across the districts of Kerala.

Instability index was worked out to assess the extent of variability in agricultural income over the past 15 years. At state level, the index is estimated as 0.086 (current prices), and 0.067 (constant prices), showing comparatively reasonable stability. The instability in agricultural production has a cascading effect on the farm economy and has serious implications for food security. So the estimation of instabilities in farm income at district level will be helpful to devise strategies for more vulnerable districts. In this context district wise instability index was also worked out from 1999-00 to 2015-16 to examine whether they are significantly different between districts. The index at current prices is observed to be higher than that at constant prices in all the districts except four. For Thrissur, Palakkad and Wayanad district, it was on the reverse and in the case of Kollam both were equal (Table 3).

The districts were grouped into three based on the value of index i.e., high, medium and low. The agricultural income (current prices and constant prices) in Kasaragod (0.288), Alappuzha (0.225) and Wayanad (0.210) is found to be highly unstable and hence they are the most risky districts (Table 4).

Table 3. District wise instability index in agricultural income during the years 1999-00 to 2015-16

Districts	Instability index at current price		Instability index at constant price
TVM	0.121	>	0.068
KLM	0.133	=	0.133
PTA	0.124	>	0.094
ALP	0.225	>	0.165
KTM	0.166	>	0.116
IDK	0.163	>	0.157
EKM	0.134	>	0.082
TSR	0.120	<	0.132
PLK	0.116	<	0.152
MLP	0.182	>	0.154
KKD	0.186	>	0.123
WYD	0.210	<	0.221
KNR	0.145	>	0.133
KSD	0.288	>	0.177
KERALA	0.086	>	0.067

Table 4. Distribution of districts based on instability index for agricultural income

Instability index class	No of districts (current price)	No of districts (constant price)
High (Above Mean + SD)	3	2
Medium (Between Mean + SD and Mean – SD)	11	10
Low (Below Mean – SD)	0	2

Kasargod district, with the highest index, is known for the cultivation of crops like paddy, pepper, arecanut, cashew, coconut and rubber. Over the years the agricultural land use in the district is shifting towards plantation crops. Area under paddy, pepper and cashew shows a declining trend and area of arecanut, coconut and rubber are on the increase. The land-use pattern in the district has undergone considerable diversification in the past few decades, especially in favour of rubber and coconut. This change has caused a severe challenge to sustainability of the agricultural production in the area and has also led to overuse of chemical fertilizers. Given these changes in the cropping pattern and input use, a negative growth has been found in total factor productivity in the crop sector of Kasaragod district (Karunakaran, 2014). The Government of Kerala had taken the decision to convert the district to a fully organic one, owing to the reported health damages due to Endosulfan spray in the cashew plantations. In the transition to organic agriculture, several small and marginal farmers have turned away from agriculture due to losses caused by uncontrolled pests and diseases, reduction in production during initial years of transition and lack of proper institutional support during the transition phase (Seenu, 2016). These factors along with the adverse price factors of planation products (especially rubber) might have caused the income fluctuations. At the same time, the district registers as one among those with the highest growth in income.

Alappuzha district which houses a major part of the Kuttanad ecosystem is known as the rice bowl of Kerala. The below sea level ecosystem is highly prone to risks, both biotic and abiotic. For instance, the summer rains of 2008 resulted in a direct loss

of Rs.4309.06. The total area equivalent affected was 32 per cent of total cropped area under paddy in Kuttanad during the season, amounting to 72 per cent of total paddy production in Alappuzha. The maximum temperature and rainfall during the initial growth phase (first two months) of the crop in Kuttanad region was found to have significant positive impact on farm income while higher levels of temperature and rainfall during second phase cause a decline in income (Susha, 2011). The breach of bunds and salinity intrusions are also very common in these systems. The agricultural production in Alappuzha, though it contributes substantially to the food security of the state, is low in its share of agricultural income and is highly risky in nature.

Wayanad district occupies the third position with respect to severity of risk .The prosperity of Wayanad is highly dependent on weather, the major sources of income being agriculture and tourism. Rainfall pattern of the district over the years demonstrate a declining trend. Variation and erratic nature in the rainfall pattern along with the increase in temperature has affected agriculture adversely. It is believed that the summer showers determine the corresponding year's yield, and failure of summer showers has a deleterious effect on pepper and coffee yield, the major crops of the district, and thereby the economy of the district.

A comparison between the Vulnerability Index and water scarcity of Wayanad for the years 2010 and 2005 showed that the proportion of farmers in the highly vulnerable category has increased during the period. It is mainly due to the increased dependence on irrigation coupled with decreased cropping intensity. Diversity index, cropping intensity, percentage of irrigated area to total cropped area, net cropped area and education level of the farmers have significant influence on the probability of an agricultural household being vulnerable, of which the diversity index and cropping diversity are the most influential factors. Wayanad is the only aspirational district in the state, owing to the ecological, social and demographic peculiarities.

Kollam, Pathanamthitta, Kottayam, Idukki, Thrissur, Palakkad, Malappuram, Kozhikode and Kannur are the districts categorized under the medium risk group. Two districts i.e. Thiruvanathapuram (0.068) and Ernakulam (0.082) are the low risk ones. Thiruvananthapuram and Ernakulam are not agriculturally important districts. In 2015-16, the agricultural income of Thiruvananthapuram district was estimated to be Rs.332320 lakhs, with 7.26 per cent share in the state income. Major crops grown in the district were coconut, rice, tapioca, tuber crops, plantains and vegetables. The GCA of the district accounted for 70.4 per cent to the total geographical area. In Ernakulam district, agricultural income contributed to 7.63 per cent share to the state income. Rice is the principal crop cultivated in the wet lands and its area has been decreasing steadily over the past three decades. Though Ernakulam district is the largest producer of nutmeg and pineapple in the state, industries occupy a prominent activity and the district is known as the industrial capital of the state.

Despite the predominance of the service sector in the state's economy, the agricultural sector of Kerala is significant due to its social, ecological and economic importance. Over the years, the share of the sector to the states income has been declining. But the agricultural income growth was estimated at 10.6 per cent at current prices and -0.8 per cent at constant prices during the years 1999-00 to 2015-16. The growth rate in current prices was obviously high due to the price factors and its inflationary trends. The prices received by the farmers could offset the decline in production so that the agricultural income could be on the rise. But in real terms it was not enough to offset the decline in production, as evidenced by the decline in real income. In tune with the macro level behavior, all the districts in Kerala showed positive growth in agricultural income at current prices but recorded a negative growth at constant prices, except for a few.

The districts that registered positive growth in real and nominal terms, varied with respect to magnitude of the same. The districts that contributed most to the state's income were the ones that registered the maximum growth (Palakkad and Idukki).The instability index of agriculture income was highest in Kasaragod, Alppuzha and Wayanad districts making them the most risky ones. It is important that the resources are allocated and policy instruments are designed taking into account the relative significance and vulnerability of the districts.

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