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DETERMINANTS OF CHANGES IN CROPPING PATTERN IN KERALA

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ABSTRACT

Agriculture development experience of Kerala since the last few decades has been characterised by sharp decline in the area under food crops and the substantial expansion in the area under non-food crops. From the analysis of the growth trends of area of principal crops in Kerala, it is clearly established that the cropping pattern in the State made a significant change from food crops to non-food crops and recently towards rubber. This change in cropping pattern is mainly due to farmers' decisions. There must be certain determinants that motivated the farmers to make such a shift in the cropping pattern. Area response models were used to analyse the determinants. Three crops – paddy, coconut and rubber, which covered 57 per cent of the total cropped area are considered for the analysis. Knowledge about the decision behaviour is crucial and the analysis revealed that non-price factors such as yield risk variables, rainfall, irrigated area, etc., are the significant determinants of farmers' behaviour and price played only a nominal role in the case of paddy indicating frequent shift to other crops like coconut and rubber; in the case of rubber, price is the dominant governing determinant. Farmers' decision behaviour is more sensitive in the case of rubber.

Introduction

Statistical data show that agricultural income in Kerala which achieved a steady growth up to the mid-seventies began to decline thereafter and showed a vacillating trend at present. During 1960-61 to 1995-96, the share of agricultural income in State Domestic Product (SDP) at constant prices decreased from 56 to 25.78 per cent. It has been stagnating around 34 per cent during the decade 1980-90. Then from 1995-96, it declined continuously and touched the level of 9.20 per cent in 2009-10. During 2009-10, the share of agriculture stood at 11.47 per cent at current prices. The SDP share of

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secondary sector was 23.14 per cent and tertiary sector was 61.50 per cent at current prices during 2009-10. An examination of sectoral contributions over the years shows that the shares of tertiary and secondary sectors are increasing. The only sector which showed declining share to SDP was the primary sector. Since agriculture which accounts more than 90 per cent of the primary sector of Kerala and as its contribution to SDP is declining over the years, this sector needs special attention.

According to the data available from the Directorate of Economics and Statistics, Government of Kerala, Thiruvananthapuram, the land put to agriculture in Kerala almost reached a saturation point. Together with forests, land devoted for agriculture stood at as high as 82.29 per cent of the total geographical area which is perhaps the highest for any State in the country. The State is very keen in making use of every bit of land which has potential for any kind of use. Another peculiarity is that where population density is very high, agricultural land is getting diversified and put to non-agricultural purpose.

Agriculture development experience of the State since the last seventies has been characterised by sharp decline in the area under food crops and the substantial expansion in the area under non-food crops. Area under food crops decreased from 66.63 per cent of the total cropped area during 1960-61 to 12.05 per cent of the total cropped area during 2009-10. But the situation is just the reverse in the case of non-food crops, which went up from 33.37 per cent of the total cropped area in 1960-61 to 87.95 per cent of the total cropped area in 2009-10.

The agriculture scenario of Kerala thus indicates a heavy concentration of non-food crops. The two main characteristics of the cropping pattern of agriculture in Kerala are the predominance of crops, which are dependent on world market conditions, and the dominance of perennial crops as against annual or seasonal crops. The emergence of cash crops as a dominant sector over the last four decades is the most notable feature of Kerala's agricultural development.

The changes in cropping pattern are mainly due to farmers' decisions. Based on price expectations, labour availability, impact of government strategies, agro-climatic conditions, irrigation facilities, expected yield, cost of cultivation, soil fertility and so on, farmers decide whether to allocate their land for agricultural purposes, viz, which of the crops to cultivate, how much area to allocate, etc., or for non-agricultural purposes (Mythili G, 2006).

The most important decisions therefore, are what crops to grow and on how much land. These decisions are taken in an uncertain future environment of rain and harvest prices (Parikh KS and Narayana NSS, 1980). In Kerala, changes in cropping pattern thus take place due to different reasons. It may be due to expected price of the crop, price of the competing crop, expected yield, variations in the climatic conditions, soil fertility, irrigation facilities, labour availability, cost of cultivation, etc (Mani KP, 2009).

The statistical profile of Kerala agriculture since 1960-61, clearly established that the cropping pattern in the State made a significant change from food crops, particularly paddy to non-food crops like coconut and rubber. In recent years, rubber seems to be replacing other crops. Naturally, there must be certain determinants which motivated the farmers to make such a change in the cropping pattern. Hence in this

paper an attempt is made to examine the determinants causing this change with regard to three important crops (paddy, coconut and rubber) in Kerala.

Methodology and Materials

The study used secondary data collected from various publications of the Government of Kerala like Economic Review, Statistics for Planning and Agricultural Statistics. The universe of the study is the State as a whole and the study period is 1960-61 to 2009-10 and is split up into sub-periods; period I (1960-61 to 1989-90), period II (1990-91 to 2009-10) and overall period (1960-61 to 2009-10).

Compound Growth Rates of area, production and productivity of twelve principal crops for the period were estimated using the exponential model:

$$Y = ab^t$$

The growth rate (GR) has been computed using the formula:

$$GR = (\text{Antilog } b\text{-}1) * 100$$

The F test has been applied to test the significance of b.

The popular methodology which the agricultural economists used to discuss the determinants of changes in cropping pattern is the area response models (Usha Tuteja, 2006) and this is used for three crops, viz, paddy, coconut and rubber.

(i) AREA RESPONSE MODEL FOR PADDY:

$$At = a0+a1At\text{-}i+a2Pte+a3RFt+a4Yt\text{-}i+a5YRte+a6PRte+a7It\text{-}i+vt$$

(ii) AREA RESPONSE MODEL FOR COCONUT:

$$At = a0+a1At\text{-}i+a2Pte+a3RFt+a4Yt\text{-}i+a5YRte+a6PRte+a7It\text{-}i+vt$$

(iii) AREA RESPONSE MODEL FOR RUBBER:

$$At = a0+a1Pte+a2Ptce+a3Yte+a4TAt+a5PRte+a6RFt+vt$$

Where,

At = Area under the crop in the current year,

At-i = Area under the crop lagged by i years,

Pte = Expected price of the crop,

Yt-i = Yield of the crop lagged by i years,

YRte = Expected yield risk in the current year,

PRte = Expected price risk in the current year,

It-i = Irrigated area lagged by i years,

RFt = Average annual rainfall in mm,

Ptce = Expected price of the competing crop (that is, coconut),

Yte = Expected yield of the crop,

TAt = Tappable area in the current year,

The expected price of the crop in period was measured as the average prices prevailing in the preceding three years for rice, rubber and coconut, respectively. The yield risk in period t was represented by the standard deviation of yield in the past three years from period t and is measured for coconut and rice. The price risk in period t was also represented by the standard deviation of price in the past three years from period t and is measured for these three crops. The expected yield of the crop in

period t was calculated as the average yield prevailing in the preceding three years for rubber. The regression coefficients were estimated by the method of OLS. The regression coefficients were tested for their significance using t test. Durbin-Watson statistic was also computed for testing the incidence of auto-correlation.

Results and Discussion

The trends in area, production and productivity of paddy in Kerala analysed in Table 1 present a very interesting behaviour while comparison is made among different crops during 1960-61 to 2009-10. Until 1970, the area remained almost stagnant, but since

Table 1: Compound Growth Rates of Area, Production and Productivity of Principal Crops in Kerala During 1960 – 61 to 2009 – 10

S. No.	Crops	Area	Production	Productivity
1	Rice	-2.683	-1.418	-1.245
2	Coconut	1.072	1.386	0.366
3	Arecanut	0.691	5.575	4.835
4	Rubber	3.292	7.065	3.903
5	Pepper	1.889	2.589	0.786
6	Cashewnut	-0.151	-1.238 **	-1.098
7	Tapioca	-2.634	-0.729	2.067
8	Coffee	3.403	4.649	1.127
9	Tea	-0.215	0.999	1.189
10	Cardamom	0.415	4.528	4.213
11	Ginger	-0.429 *	2.945	3.348
12	Banana and other plantains	2.101	2.351	* 0.236

* Significant at probability level 0.01.

**Significant at probability level 0.03.

1975, the Kerala farmers made a slow shift from paddy cultivation to cash and plantation crops and this shift became tremendous since 1980. In 2009-10, it has just 8.77 per cent of the total cropped area compared to 33.16 per cent in 1960-61, while the State is 84 per cent short of the required rice production. Hence it is appropriate to examine the area response of Kerala farmers to the cultivation of paddy.

Area Response of Paddy : Various price and non-price factors influence the farmers' decisions regarding land allocation to various crops. The first segment includes input and output prices. These range from last year's harvest price of the crop, availability of minimum support price, last year's harvest price of the competing crop, prices of inputs like fertilisers, power, water, insecticides, etc., and availability of credit. Similarly, a lot of non-price factors also play an important role. The major factors are the last year's acreage and yield, availability of improved seeds and irrigation facilities, rainfall, procurement prices, extension services, etc. Due to lack of information on all these variables, the findings of area response models of rice in Kerala are based on a few variables for which data are available. The results are given in Table 2 and the estimated regression coefficients are given for three periods.

The variables included in the model are capable of explaining sizable proportion of the variations in the area in different periods since the R square value is significant. The area response function tried for paddy during three periods; 1960-61 to 1989-90, 1990-91 to 2009-10 and 1960-61 to 2009-10 are presented in Table 2. The estimated

Table 2: Regression Coefficients of the Determinants of Area of Rice in Kerala in Different Periods

S. No.	Variables	1960-61 to 1989-90	1990-91 to 2009-10	1960-61 to 2009-10
1	a0	1.3713	8.6149	1.7990
2	At-i	0.9723 (0.075)	0.8825 (0.160)	0.9471 (0.031)
3	Pte	0.0202 (0.032)	-0.3059 (0.103) *	-0.0007 (0.026)
4	RFt	0.0140 (0.032)	-0.3643 (0.120)	-0.0003 (0.032) *
5	Yt-i	-0.2294 (0.148)	-0.0908 (0.220)	-0.2172 (0.117) ***
6	YRte	0.0061 (0.012)	0.0444 (0.018) **	0.0045 (0.007)

(Contd...)

Table 2: *(Contd...)*

S. No.	Variables	1960-61 to 1989-90	1990-91 to 2009-10	1960-61 to 2009-10
7	PRte	-0.01 (0.012)	* 0.0475 (0.017)	-0.0015 (0.009)
8	It-i	0.0219 (0.019)	-0.2265 (0.163)	0.01 (0.021)
9	R Square	0.9498	0.9916	0.9939
10	Durbin-Watson statistic	2.2326	1.9882	2.0228

Figures in bracket show standard error.
*Significant at 0.01 level of significance.
**Significant at 0.03 level of significance.
***Significant at 0.05 level of significance.

parameters of expected price, rainfall and irrigated area of previous year were positive and significant during the initial period and after 1990-91 it becomes negative. The yield risk factor during the three periods under study was found to be positive and significant; whereas the price risk factor was negative during the first period and after that it becomes positive. During the overall period from 1960-61 to 2009-10, the price risk factor was found to be negative indicating farmers' risk aversion behaviour for paddy.

The coefficients of yield in all the periods were negative indicating very little influence on the area decision behaviour of farmers. The area response function presented in Table 2 illustrated that irrigated area under paddy in the previous year and yield risk are the major significant factors influencing the acreage decision behaviour of paddy farmers in Kerala during the period 1960-61 to 2009-10.

Area Response of Coconut: The important determinants included are prices, yields, irrigation, rainfall and the risk factors. In estimating area response function for coconut during the three periods, these variables are incorporated. The significance of the R-square value indicated that these variables are capable of explaining area response of coconut in Kerala in different periods.

Considering the area response (Table 3) function, by far the most important variable determining area allocation during period one for coconut seems to be irrigated area under coconut and it has a very strong positive influence on the area planted under coconut during the period. The area response results of the second period are entirely different from that of the first period. The estimated results of price and yield risks, rainfall, yield and irrigated area seem to be negative during the period.

Table 3: Regression Coefficients of the Determinants of Area of Coconut in Kerala in Different Periods

S. No.	Variables	1960-61 to 1989-90	1990-91 to 2009-10	1960-61 to 2009-10
1	a0	1.4185	4.5022	3.7708
2	At-i	0.2025 (0.210)	* 0.8047 (0.311)	*** 0.3051. (0.153)
3	Pte	-0.0001 (0.131)	0.0264 (0.057)	0.0196 (0.054)
4	RFt	0.0412 (0.119)	-0.112 (0.060)	0.0528 (0.073)
5	Yt-i	0.0061 (0.355)	-0.1753 (0.190)	-0.1394 (0.144)
6	YRte	-0.0222 (0.017)	-0.00003 (0.011)	-0.0179 (0.012)
7	PRte	0.0129 (0.034)	-0.0069 (0.009)	0.0113 (0.018)
8	It-i	0.3188 (0.320)	-0.0744 (0.067)	0.139 (0.118)
9	R Square	0.6075	0.8817	0.8088
10	Durbin-Watson statistic	2.2276	1.7799	2.2226

Figures in bracket show standard error.

*Significant at 0.01 level of significance.

***Significant at 0.05 level of significance.

The area response function tried for coconut during the period 1960-61 to 2009-10 for the State presented in Table 3 revealed negative influence of yield risk and previous year's yield on the area response of coconut. The expected price variable is positive but is statistically insignificant in the case of coconut. The estimated parameters of price risk showed positive significant value (0.0113) indicating the farmer's perceptions of risks for area adjustments. The results of Table 3 show that irrigated area is the significant determinant affecting the area response of coconut. In addition to that, rainfall and price risk factor also have significant value in the case of the area allocation decision of coconut farmers.

Area Response of Rubber: Originally rubber was introduced into areas with degraded forests. From there it spread all over. It replaced natural vegetation, tapioca, cashewnut, fruit trees and coconut (Srikumar Chattopadhyay, et.al, 2006). The area under rubber cultivation had tremendously increased and now it ranked second behind coconut. Factors like expected price and yield of the crop, price of the competing crops (like coconut), average annual rainfall, tapable area, previous years yield of the crop, etc., are conceived to be of great importance

Table 4: Regression Coefficients of the Determinants of Area of Rubber in Kerala in Different Periods

S. No.	Variables	1960-61 to 1989-90	1990-91 to 2009-10	1960-61 to 2009-10
1	a0	3.3996	3.7358	2.1703
2	Pte	0.0119 (0.081)	0.0957 (0.026)	0.1383 (0.025)
3	Ptce	0.405 (0.099)	0.0254 (0.023)	0.2158 (0.036)
4	Yte	-0.1747 (0.050)	-0.0407 (0.074)	-0.2183 (0.041)
5	Tat	0.1648 (0.112)	0.3623 (0.718)	0.4756 (0.073)
6	PRte	* -0.020 (0.008)	* -0.012 (0.004)	-0.0237 (0.006)
7	RFt	0.0606 (0.036)	-0.0366 (0.034)	0.0527 (0.034)
8	R Square	0.9901	0.9842	0.9942
9	Durbin-Watson statistic	2.290	1.4631	1.4479

Figures in bracket show standard error.

*Significant at 0.01 level of significance.

in determining the area allocation of rubber in Kerala.

The estimated results of the area response of rubber in Kerala for three periods are given in Table 4. The expected price of the crop, expected price of the competing crop coconut, tapable area of rubber and rainfall are the most significant factors that influenced the area response of rubber in Kerala during the sub-period one. Among these four factors, expected price of coconut is the strong determinant (0.405) in the area expansion of rubber in the initial period. This revealed the fact that the low expected price of coconut is the main determinant of planted area decision of rubber in Kerala up to the year 1989-90. Expected yield and expected price risk of rubber were shown negative influence in area adjustments. In the second period, the tapable area of rubber is the major governing factor of farmer's decisions. In addition to that, the expected price of rubber and coconut are the next two factors working behind the farmer's area adjustment decisions on rubber. All other variables were found to have negative significant influence.

From the estimation results of the area response of rubber in Table 4 during 1960-61 to 2009-10, it is revealed that price variable (expected price of rubber, 0.1383 and expected price of competing crop, 0.2158) turns out to be an important factor in determining the area response in addition

to tapable area of rubber (0.4756). The expected yield and expected price risk seem to have negative influence on area.

Conclusion

From the analysis of the growth trends of area of principal crops in Kerala, it is clearly established that the cropping pattern in the State made a significant change from food crops to non-food crops and recently (since 2000-01) the shift is towards rubber. This change in cropping pattern is mainly due to farmers' decisions. There must be certain determinants that motivated the farmers to make such a shift in the cropping pattern. Area response model is used to analyse the determinants. The determinants estimated are expected price of the crop, past year's yield, expected yield risk and price risk, average annual rainfall, irrigated area, etc. Three crops – paddy, coconut and rubber- which covered 57 per cent of the total cropped area are considered for analysis.

The analysis which covered fifty years time period is divided into two sub-periods and estimated area response of paddy, coconut and rubber revealed the following results:

(1) In area adjustments, irrigated area and yield risk were found to be the most significant factors influencing the acreage decision behaviour of paddy farmers.

(2) For coconut, the irrigated area, rainfall and price risk factors are the significant variables affecting the area allocation of the crop in Kerala during the period 1960-61 to 2009-10.

(3) In the case of rubber, the price variable (expected price and expected price of competing crop) is the major determining factor in addition to tapped area for area decision. The area response of rubber shows that area under rubber was price responsive. Future expectations about price is the dominating factor governing the acreage decision of rubber in Kerala.

(4) Knowledge about the decision behaviour is crucial and the analysis revealed that non-price factors such as yield risk variables, rainfall, irrigated area etc., are the significant determinants of farmers' behaviour and price played only a nominal role in the case of paddy indicating frequent shift to other crops like coconut and rubber; in the case of rubber, price is the dominant governing determinant. Farmers' decision behaviour is more sensitive in the case of rubber.

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