Artha *J Soc Sci*, **13**, 4 (2014), 21-35
ISSN 0975-329X | doi.org/10.12724/ajss.31.2

Paddy Cultivation in Kerala – Trends, Determinants and Effects on Food Security

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Abstract

The statistical profile of Kerala agriculture since 1960, clearly established the decrease in the area under paddy cultivation in the state. Time series analysis of acreage, production and productivity data of rice in Kerala during the five decades from 1960-61 to 2009-10 revealed the performance of this crop in terms of growth of area, production and productivity. The production of major food crop, rice, reached negative growth rates due to the declining trend of their area. The diversification of crops in terms of variation in acreage allocation has taken place due to price and non-price factors like agro-climatic conditions, labour availability, irrigation facilities, soil fertility, cost of cultivation, price levels, profitability, mechanisation etc. The change has taken place largely in favour of non-food crops and recently it is towards rubber. The real growth of agricultural crop output has declined continuously since 1960-61 compared to monetary growth, i. e, the growth in the value of agricultural crop output. Food security, particularly rice security is the vital issue for Kerala today. The data reveals that during 1960-61 Kerala had a shortage of rice of about 40.12 percent, which increased to 83.45 percent in 2009-10. The study clearly revealed the increasing demand for rice in Kerala in the coming years compared to the existing supply. This will enlarge the supply demand gap of rice in Kerala in the future years

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indicating a threat to food security bringing out a need for further increase in rice production in a sustainable way.

Keywords: Kerala, Paddy cultivation, Growth trend, Overall growth, Determinants.

Introduction

Agricultural crops in Kerala are broadly divided into two classes – food crops and non-food crops. The ratio of food crop area to non-food crop area in the state in 1968-69 was 64:36. But in 1995-96 the ratio was 47:53 and in 2004-05 it was 44: 56. Present trend reveals that Kerala is being converted to non-food crop area and the ratio of food crop to non-food crop area is 12: 88. The main food crop in Kerala is rice. The area under Paddy during 1967-68 was 48 percent of the total food crop area. But in 1995-96 it was15 percent and in 2004-05 it was 10 percent. The area under rice was at its maximum in 1980-81; after which decline set in and reached 8.77 percent in 2009-10.

During the span of fifty years from1960-61 to 2009-10, the state witnessed a decrease of 69.92 percent in the area under paddy cultivation. In general there is an overall decrease of paddy grown area in Kerala. The districts level decrease of paddy field area in the state was also very high. This change in the area under cultivation was 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 and which of the crops to cultivate, how much area to allocate, etc, or for non-agricultural purposes (Mythili, 2006).

During 1960-61 to 2009-10, among the major crops analysed, rice and tapioca exhibited highest negative growth rates in area under cultivation. In Kerala this phenomenon takes 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, 2009).

The traditional rice growing areas like Palakkad and Alappuzha have 49.93 percent and 56.97 percent decline in area during the time period from 1960-61 and 2009-10. The total rice production during the year 2009-10 also decreased tremendously and widened the supply demand gap of rice in Kerala. In this context, an analysis of trends and determinants of paddy cultivation in Kerala and the effects on food security was attempted in this study.

Methodology and Materials

The study used secondary data which was collected from various publications of the Government of Kerala like Economic Review, Statistics for Planning and Agricultural Statistics.

Compound Growth Rates of area, production and productivity of paddy for the period from 1960-61 to 2009-10 were estimated with the exponential model: $Y = ab^t$ [The growth rate (GR) has been computed using the formula: GR = (Antilog b-1)*100; The F test has been applied to test the significance of b].

To measure the relative contribution of different elements (real and monetary) to the growth of output of paddy during different periods from 1960-61 to 2009-10 in Kerala, the model used by Kurian & Joseph (1979) and Kaushik (1993) is applied in this study. Observing the value of output in period zero (V_0) and in period t (V_t), the difference between the two is decomposed into eight component elements, viz, (i) change in area, (ii) change in yield per hectare, (iii) change in cropping pattern, (iv) the interaction between yield and cropping pattern, (v) the price change effect, (vi) the interaction between price and yield, (vii) interaction between price and cropping pattern effect and (viii) interaction between price, cropping pattern and yield. In equation form these eight component elements were worked out in schemes 1 and 2.

$$(Vt - V0) = (At - A0)\ \Sigma iwi0\ ci0\ yi0 + At\ \Sigma iwi0\ ci0\ (yit - yi0)$$

$$+ At\ \Sigma iwi0\ yi0\ (cit - ci0) + At\ \Sigma iwi0\ (yit - yi0)\ (cit - ci0) \qquad (1)$$

(In the decomposition scheme (1), the first term on the right hand side is the area effect, the second the yield effect, the third the cropping pattern effect and the fourth interaction effect,

representing the interaction between yield and changes in cropping pattern).

A decomposition of the monetary component is shown in scheme (2).

$$V_t - P_t (w_t - w_0) = A_t \Sigma_i ci_0 yi_0 (wi_t - wi_0)$$

$$+ A_t \Sigma_i ci_0 (wi_t - wi_0) (yi_t - yi_0)$$

$$+ A_t \Sigma_i yi_0 (wi_t - wi_0) (ci_t - ci_0)$$

$$+ A_t \Sigma_i (wi_t - wi_0) (ci_t - ci_0) (yi_t - yi_0) \quad (2)$$

(The first component in the scheme (2) is the 'pure price effect', the second and third terms are respectively the first order interactions between price and yield rate and price and cropping pattern effect, under constant cropping pattern and constant yields. The last term is the second order interaction term between the three variables considered, viz, changes in prices, cropping pattern and yields and may be called the 'total interaction effect').

The popular methodology which the agricultural economists used to discuss the determinants is the supply response models (Usha, 2006). This model has been used in this study and the farmers' decisions are discussed in terms of area response and yield response and the following models were developed and estimated for paddy. The regression coefficients were estimated by the method of OLS. The regression coefficients were tested for their significance using t test.

(i) Area Response Model for Paddy:

$$At = a_0+a_1At\text{-}i+a_2Pt^e+a_3RFt+a_4Yt\text{-}i+a_5YRt^e+a_6PRt^e+a_7It\text{-}i+vt$$

(ii) Yield Response Model for Paddy:

$$Yt = b_0+b_1Yt\text{-}i+b_2Pt^e+b_3RFt+b_4YRt^e+b_5PRt^e+b_6It+ut$$

(At = Area under the crop in the current year, Yt = Yield per hectare of the crop in the current year, At-i = Area under the crop lagged by i years, Pt^e = Expected price of the crop, Yt-i = Yield of the crop lagged by i years, YRt^e = Expected yield risk in the current year, PRt^e = Expected price risk in the current year, It-i = Irrigated area lagged by i years, It = Irrigated area in the current year, RFt = Average annual rainfall in mm).

The expected price of the crop in period t was calculated as the weighted average of the weighted distributed lagged prices prevailing in the preceding three years. The yield risk in period t was represented by the standard deviation of yield in the past three years from period t and the price risk in period t was represented by the standard deviation of price in the past three years from period t.

The demand projections for rice for the year 2026 were obtained by using the formulae developed by Sekhon, Rangi & Dhaliwal (2008).

$$D_t = d_o * N_t (1+ y*e)^t$$

(D_t = individual demand of rice in the year t, that is, 2026, d_o = percapita demand of rice in the base year, that is, 2001, N_t = projected population in year t, that is, 2026, y = growth in percapita income (5 percent to 10 percent), e = expenditure elasticity of demand for rice).

Trends and Overall Growth of Paddy Cultivation in Kerala

Out of the total area, the area under rice cultivation had declined from 778.91 thousand hectare in 1960-61 to 234.26 thousand hectare in 2009-10 (a decline of 69.96 percent). Disaggregating the data at the district level, it was observed that, the traditional rice growing districts like Palakkad and Alappuzha showed 49.93 percent and 56.97 percent decline in area during the time period from 1960-61 to 2009-10. All the districts except Alappuzha, Palakkad, Wayanad and Kasaragod observed higher level of decrease in the area under rice cultivation compared to the state level decline. Decade wise, the decline started after 1970-71 and was severe after 1990-91. Hence from Table 1 the picture emerges that the relative contribution of rice to the total cropped area consistently declined in all the districts in the state.

Table 1. Percentage Change in the Cultivation of Rice in Kerala in Different Periods

Sl. No.	Districts	1970-71 over 1960-61	1980-81 over 1970-71	1990-91 over 1980-81	2000-01 over 1990-91	2009-10 over 2000-01	2009-10 over 1960-61
1	Thiruvananthapuram	5.54	-17.49	-33.47	-67.73	-57.18	-91.99
2	Kollam	12.44	-3.53	-39.04	-51.04	-74.17	-91.64
3	Pathanamthitta	-	-	-	-55.89	-57.30	-81.16
4	Kottayam	25.31	-36.21	-17.81	-36.49	-34.33	-72.60
5	Alappuzha	7.44	-3.25	-26.42	-37.79	-9.53	-56.97
6	Ernakulam	20.28	9.40	-38.46	-40.66	-65.36	-83.35
7	Idukki	-	-	-45.17	-31.61	-39.10	-77.16
8	Trissur	10.88	-2.64	-32.88	-20.71	-52.42	-72.67
9	Palakkad	10.00	-13.10	-20.66	-18.52	-18.96	-49.93
10	Malappuram	-	-	-35.10	-55.43	-52.42	-86.24
11	Kozhikkode	26.45	-65.14	-73.46	-44.15	-40.99	-96.08
12	Wayanad	-	-	-	-26.26	-15.03	-37.34
13	Kannur	3.09	-25.53	-73.35	-39.79	-35.13	-92.01
14	Kasaragod	-	-	-	-35.92	-45.50	-65.08
15	State	12.33	-8.37	-30.21	-37.89	-32.58	-69.96

Source: - Computed from (i) Statistics for planning (various issues), Department of Economics and Statistics, Govt. of Kerala, Thiruvananthapuram. (ii) Economic Review (various issues), State Planning Board, Govt. of Kerala, Thiruvananthapuram.

Table 2. Compound Growth Rates of Area, Production and Productivity of Rice in Kerala in Different Periods.

Sl. No.	Item	Period I (1960-61 To 1969-70)	Period II (1970-71 To 1979-80)	Period III (1980-81 To 1989-90)	Period IV (1990-91 to 1999-2000)	Period V (2000- 01 To 2009- 10)	Overall Period (1960- 61 to 2009- 10)
1	Area	1.284	-1.073	-4.077	-5.555	-4.835	-2.683
2	Production	** 1.583	-0.375	-2.612	-4.694	* -3.062	-1.418
3	Productivity	0.353	0.704	1.524	* 0.910	* 1.866	-1.245

* - Significant at probability level 0.01
** - Significant at probability level 0.05

Table 2 shows that rice registered negative growth rate in area, production and productivity during the overall period from 1960-61 to 2009-10 in Kerala. The table also shows that, decade wise, the crop's growth rate was positive only in the case of productivity during the fifty years considered for study.

Table 3. Decomposition of output growth of Rice in Kerala.

Period	c_0	y_0	w_0	c_t	y_t	w_t	A_0 (' 000 hectare)	A_t (' 000 hectare)
1960-61 to 1969-70	33.16	1371	40.51	29.97	1403	100.31	2349	2916
1970-71 to 1979-80	29.83	1484	90.25	27.79	1638	133.24	2933	2854
1980-81 to 1989-90	27.79	1587	152.06	19.32	1956	290.47	2885	3019
1990-91 to 1999-00	18.53	1942	289.61	11.59	2203	684.43	3020	3017
2000-01 to 2009-10	11.50	2162	646.36	8.67	2520	915.87	3022	2669
1960-61 to 2009-10	33.16	1371	40.51	8.67	2520	915.87	2349	2669

c_0, c_t - Share of area (percent) of the total cropped area, y_0, y_t - Output in Kg per hectare, w_0, w_t - Price per quintal (In Rupees).

Source: - Computed from (i) Statistics for planning (various issues), Department of Economics and Statistics, Govt. of Kerala, Thiruvananthapuram. (ii) Economic Review (various issues), State Planning Board, Govt. of Kerala, Thiruvananthapuram.

Table 3 gives the decomposition of output growth of Rice in Kerala for Periods I to V and overall period and Table 4 to that of the relative contribution of real and monetary elements to the growth of crop output. From the analysis, it is revealed that the increase in the value of output of the crop analysed in the overall period from 1960-61 to 2009-10 is monetary growth in nature rather than real growth.

Table 4. Relative contribution of different elements to the growth of output of Rice in Kerala in different periods. (In percentages)

Sl. No.	Elements	Period					
		I (1960-61 To 1969-70)	II (1970-71 To 1979-80)	III (1980-81 To 1989-90)	IV (1990-91 To 1999-2000)	V (2000-01 To 2009-10)	OP (1960-61 To 2009-10)
1	Increase in value of output	157.01	37.64	109.11	1.33	-16.05	226.78
2	Area effect	69.29	-24.80	-105.60	56.26	203.00	-30.83
3	Yield effect	14.85	25.00	65.62	12.61	-69.57	11.11
4	Cropping pattern effect	-6.10	-16.47	-86.02	-35.14	103.39	-9.79
5	Interaction effect	-1.43	-1.71	-20.00	-4.72	17.12	-8.21
6	Real Growth (2+3+4+5)	76.61	-17.98	-146.00	29.01	253.94	-37.72
7	Pure price effect	93.96	114.73	256.89	120.50	-175.18	286.57
8	Price Yield effect	21.93	11.91	64.11	1.69	-29.01	240.16
9	Price cropping pattern effect	-90.41	-7.85	-73.21	-45.13	43.11	-211.64
10	Total Interaction effect	-2.11	-0.81	-1.79	-6.07	7.14	-177.37
11	Monetary Growth (7+8+9+10)	23.39	117.98	246.00	70.99	-153.94	137.72
12	Total (6 +11)	100.00	100.00	100.00	100.00	100.00	100.00

Source: - Computed from Table. 3

Determinants of Paddy Cultivation in Kerala

Until 1970, the area under paddy remained almost stagnant, but since 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 was just 8.77 percent of the total cropped area compared to 33.16 percent in 1960-61. Hence it is appropriate to examine the area response and yield response of Kerala farmers to the cultivation of paddy with the help of supply response models.

(a) 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 ranges 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 5 and the estimated regression coefficients were 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 5. The estimated 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.

Table 5. Regression Coefficients of the Area response of Rice in Kerala in Different periods.

Sl. No.	Variables	1960-61 to 1989-90	1990-91 to 2009-10	1960-61 to 2009-10
1	a_0	1.3713	8.6149	1.7990
2	At-i	0.9723 (0.075)	0.8825 (0.160)	0.9471 (0.031)
3	Pt^e	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	YRt^e	0.0061 (0.012)	** 0.0444 (0.018)	0.0045 (0.007)
7	PRt^e	-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 shows standard error
*- Significant at 0.01 level of significance; **- Significant at 0.03 level of significance
***- Significant at 0.05 level of significance

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 5 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.

(b) Yield Response of Paddy

The estimated yield response functions for paddy are presented in Table 6. From the table, it is seen that the determinant, expected price of paddy are positive and significant during the first period. Other variables like rainfall, expected price risk, expected yield risk and irrigated area showed negative significance during the period. In the second period all the variables except irrigated area were

positive. The risk factors turned out to be positive in the second period implies that paddy farmers since 1990-91 in Kerala were willing to adopt modern technologies to improve their yields. During the second period all the determinants found to be significantly affecting the yield response of paddy.

Table 6. Regression Coefficients of the Yield response of Rice in Kerala in Different periods.

Sl. No.	Variables	1960-61 to 1989-90	1990-91 to 2009-10	1960-61 to 2009-10
1	b_0	4.8490	5.5259	3.538
2	Yt-i	0.3425 (0.198)	0.3578 (0.299)	0.5165 (0.135)
3	Pt^e	0.1358 (0.046)	0.0540 (0.121)	0.0959 (0.034)
4	RFt	-0.0244 (0.051)	0.0322 (0.188)	0.0292 (0.044)
5	YRt^e	-0.0063 (0.015)	0.0305 (0.028)	0.0031 (0.010)
6	PRt^e	*** -0.0378 (0.017)	0.0284 (0.027)	-0.0176 (0.012)
7	It	-0.0286 (0.030)	-0.1151 (0.166)	-0.0504 (0.029)
8	R Square	0.8656	0.7498	0.945
9	Durbin-Watson statistic	2.0152	2.5247	2.4007

Figures in bracket shows standard error
***- Significant at 0.05 level of significance

An analysis of the overall period reveals that the expected price risk and irrigated area had negative significant value. The Table 6 shows that the expected price factor is not playing a major role in deciding the yield of paddy. The price risk factor was negative during the overall period implies the farmers risk aversion behaviour in the case of yield response also like that of area response.

A comparison of the regression coefficients of the area and yield response of rice in Kerala revealed that the coefficient of area adjustment values were higher than the values of yield adjustment. This shows that area adjustments were comparatively quicker than yield adjustments. The broad inference of the analysis of area

response and yield response of paddy leads to the conclusion like that of the earlier studies (Sunilkumar, 2004; Mythili, 2006) that non-price factors determine area and yield response of paddy than the price factors in Kerala.

Paddy Cultivation and Food Security in Kerala

Reduction in rice production, decline in the availability of feeds to livestock, decline in the food availability, change in the employment pattern in the rural areas, decline in the income of the rural households, etc, are the important economic effects of reduction in area under paddy cultivation.

Self sufficiency of food grains has been one of the objectives of planning in Kerala (Venkiteswaran, 1984). Among the food items, rice is the staple food of Kerala. The immediate effect of the shortage in area under paddy cultivation in Kerala is the reduction in rice production. The annual production came down to 598.34 thousand tonnes in 2009-10 from 1067.53 thousand tonnes in 1960-61. As indicated, the area under rice cultivation has declined continuously over the last 50 years. The conversion of rice lands decreased the supply of rice in Kerala over the years. Table 7 shows that during 1960-61 to 2009-10, the decrease in the rice supply in Kerala was 43.95 percent, showing continuous decrease over the decades since 1970-71.

Table 7. Demand and Supply Gap of Rice in Kerala in different years (1960-61 to 2009-10)

Year	Demand for Rice (In'000 tonnes)	Supply of Rice (In'000 tonnes)	Demand and Supply Gap (In'000 tonnes)
1960-61	1782.93	1067.53	-715.40 (40.12)
1970-71	2248.86	1298.01	-950.85 (42.28)
1980-81	2674.29	1271.96	-1402.34 (52.44)
1990-91	3032.43	1086.58	-1945.85 (64.17)
2000-01	3319.82	751.33	-2568.49 (77.37)
2009-10	3615.98	598.34	-3022.64 (83.45)

Figures in bracket shows percentage to total demand.

Table 7 also shows the estimated demand for rice in Kerala for different years from 1960-61 to 2009-10. The data reveals the

continuous increase in the demand for rice in Kerala over the decades. A comparison of the data in Table 7 clearly reveals that during 1960-61, Kerala had a shortage of rice about 40.12 percent, increased to 42.28 percent in 1970-71, 52.44 percent in 1980-81, 64.17 percent in 1990-91 and 77.37 percent in 2000-01. In 2009-10 the rice shortage in Kerala was 3022.64 thousand tonnes of the total demand (that is, 83.45 percent shortage).

Table 8. Projected Demand for Rice in Kerala in the Year 2026

Growth rate (in percent)	Rural (In'000 tonnes)	Urban (In'000 tonnes)	Total (In'000 tonnes)
5	4673.28	1761.27	6434.55
6	5190.75	1925.16	7115.91
7	5762.98	2103.63	7866.61
9	7095.05	2509.66	9604.71
10	7866.60	2739.95	10606.55

In view of the increasing demand for rice, it is felt that the radical transformation of paddy fields into gardens or orchards of rubber and other crops will accentuate the food problem of the state in the long run. Therefore an attempt has been made to calculate the demand for rice in Kerala up to the year 2026 under different scenarios of growth in income (5 percent to 10 percent). The results of the projected household demand for rice in Kerala are presented in Table 8. It is estimated that the household demand for rice in Kerala in the coming years compared to the existing supply as shown in Table 7 will enlarge the supply demand gap of rice in Kerala in the future years indicating a threat to food security and revealing further increase in rice production in a sustainable way.

Conclusion

The major food crop rice in Kerala shows negative growth rate in area in all the decades except 1960's and the decline was highest in the fourth period. The decline in area is due to the large scale conversion of area to other crops like coconut and rubber. During the overall period the compound growth rates of area, production and productivity of rice were negative. The production of rice also reached at a negative growth rates in Kerala due to the declining trend of area.

From the analysis of the decomposition of output growth into real and monetary components of rice in Kerala studied during different periods in the reference period, the general conclusions derived are: there are fluctuations in the overall growth of crop output in Kerala over different periods, there is a perceptible increase in the monetary growth and decline in the real growth of crop output in Kerala from period I to period V and price factor is the major element in determining the relative contribution of different elements to the growth of crop output.

In area adjustments, past year's area, irrigated area and yield risk were found to be the most significant factors influencing the acreage decision behaviour of paddy farmers. Past years yield and expected price were the significant factors influencing the yield response of paddy during the first period. In the second period the risk factors also turned out to be positively significant, indicating farmers' decision to adopt modern technologies to improve the yield of paddy.

Over the 50 years from 1960-61 to 2009-10, the area under rice was at its peak in 1980-81 and then continuous decline set in. Rice lost the maximum area during the period. The substitution of other crops at the cost of rice has far reaching implications for food and price policies. The continuous increases in the price of food grains, particularly rice recently, affect the poor population adversely than before.

The conversion of rice lands decreased the supply of rice in Kerala and widened the supply demand gap of rice. During 1960-61, the shortage of rice was only 40.12 percent of the total demand increased to 83.45 percent in 2009-10. In the coming years, the total demand for rice will again increase and it is estimated that in 2026 AD it will be 10606.55 thousand tonnes in Kerala. The situation of rice production in the state can be augmented only through increase in yield. Yield can be improved by adopting better technology involving adequate, efficient, effective right type of inputs. In the paddy sector strict enforcement of various existing laws relating to land use pattern should be followed by the revenue authorities. Keeping in view the sustainability and ecological problems created by crops like rubber in the form of land degradation, ground water depletion, chemical pollution, etc, there

is a need to introduce various strategies for diverting areas from these crops to rice.

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