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Supply response of coconut cultivation in Kerala

N. Karunakaran[1]✉ and K. Gangadharan[2]

[1]PG Department of Economics, EKNM Government College Elerithattu, Elerithattu – Post, Nilishwar – Via, Kasaragod – Dist, Kerala-671314, India.

[2]Department of Applied Economics, Kannur University, Thalasserry Campus, Palayad, Kerala, India.

✉Corresponding author: narankarun@gmail.com

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Abstract

Kerala's agriculture development experience 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. The analysis of the growth trends of area of principal crops in Kerala clearly revealed that the cropping pattern in the state made a significant change from food crops to non-food crops. Coconut came to the first position by pushing rice to the third. There must be certain determinants that motivated the farmers to make such a shift. Supply response in terms of area response and yield response models were used to analyse the determinants. The determinants estimated are lagged area, expected price of the crop, lagged yield, expected yield risk and price risk, average annual rainfall, irrigated area, etc. The analysis revealed that the irrigated area, rainfall and price risk factors are the significant variables affecting the area allocation of coconut in Kerala and the crop's yield response, irrigated area, rainfall and expected price risk are the strong variables.

Keywords: Coconut; growth trend; supply response; area response; yield response.

Agriculture continues to be the core sector in the rural economy of Kerala, providing livelihood security for vast majority of the population. The state which accounts for only 1.18% of the geographical area of the country supports nearly 3.10% of the population. Kerala is one of the states in India, where land resources are put to more intensive use than anywhere else mainly because of the low percapita availability of land. Out of a geographical area of 38.85 lakh hectare, land devoted to agriculture is about 58%. Even after five decades of development planning, over half of the population in Kerala still subsists on the income generated from the relatively small agricultural holdings.

In the crop production sub sector, a mixed trend has been observed indicating fluctuations in production of coconut, pepper, ginger, arecanut, banana and coffee with declining trend in cashew and tapioca. The production of rubber has shown consistent increase over the years. Although the growth performance of the sector as a whole is encouraging since 1990 – 91, it is noteworthy that the engine of growth is fuelled by the two principal crops namely coconut and rubber that too on account of the large scale area expansion through the shift in cropping pattern. Food crops in general have suffered severe setback in production mainly on account of the reduction in area under rice and tapioca.

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. 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 coconut in Kerala by analysing the supply response.

Materials and Methods

Supply response models give valuable information regarding farmer's decision behaviour in response to price and non-price factors. The model helps one to know how the farmers react to changes in the price of the crop that they produce (Ramesha. Y.S., et.al, 1988; 9-13). It also helps one to ascertain how farmers reallocate resources among various crops in response to changes in relative price levels. Various studies pointed out that an important methodology to discuss the determinants is the supply response models; where the farmer's decisions are discussed from two angles, area response and yield response (Mani. K.P., 2009; 80-83).

The popular theoretical framework which the agricultural economists used to analyse the determinants of changes in cropping pattern is the Nerlovian supply response models (Usha Tuteja, 2006; 218-237). 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 coconut on the basis of Nerlovian lagged adjustment model.

(i) Area Response Model for Coconut:

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

(ii) Yield Response Model for Coconut:

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

Where,

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 (The expected price of the crop in period t was calculated as the average prices prevailing in the preceding three years),

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

YRt^e = Expected yield risk in the current year (The yield risk in period t was represented by the standard deviation of yield in the past three years from period t),

PRt^e = Expected price risk in the current year (The price risk in period t was represented by the standard deviation of price in the past three years from period t),

It-i = Irrigated area lagged by i years,

It = Irrigated area in the current year,

RFt = Average annual rainfall in mm,

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.

Compound Growth Rates of area, production and productivity of coconut for the period 1960-61 to 2009-10 were estimated with the following 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.

The study was carried out mainly by collecting secondary data. The secondary data were collected from various publications of the Government of Kerala like Economic Review, Statistics for Planning, Agricultural Statistics, Season and Crop Reports. The study period is 1960-61 to 2009-10 and is split up into different sub- periods.

Results and Discussion

Cropping pattern towards Coconut in Kerala

Kerala is endowed with diverse climatic, edaphic and socio-economic conditions and this has given rise to many location-specific cropping systems. Major cropping systems followed in the state includes paddy based cropping systems, coconut based cropping systems, arecanut based systems, plantation crops based cropping systems and other convenient based specific regional cropping systems.

During 1960-61 the order of the first five crops was rice, coconut, tapioca, rubber and pepper, in the descending order of shares to the total cropped area. Table 1 reveals that in 2009-10, the first five crops were coconut, rubber, rice, pepper and arecanut. Coconut came to the first position by pushing rice to the third.

Table 1. Cropping Pattern according to Land use statistics in Kerala (1960-61 to 2009-10).

Sl. No.	Crops	1960-61	1970-71	1980-81	1990-91	2000-01	2009-10
1	Rice	33.16 (1)	29.83 (1)	27.79 (1)	18.53 (2)	11.50 (3)	8.77 (3)
2	Coconut	21.32 (2)	24.52 (2)	22.56 (2)	26.72 (1)	30.63 (1)	29.18 (1)
3	Arecanut	2.31 (6)	2.93 (7)	2.12 (7)	2.15 (10)	2.89 (8)	3.72 (5)
4	Rubber	5.23 (4)	6.11 (4)	8.24 (4)	13.63 (3)	15.70 (2)	19.65 (2)
5	Pepper	4.25 (5)	4.03 (5)	3.75 (6)	5.58 (4)	6.69 (4)	6.43 (4)
6	Cashewnut	2.31 (6)	3.50 (6)	4.90 (5)	3.83 (6)	3.05 (7)	1.84 (9)
7	Tapioca	10.31 (3)	10.01 (3)	8.49 (3)	4.85 (5)	3.79 (5)	2.80 (7)
8	Coffee	0.72 (10)	1.08 (11)	2.02 (8)	2.49 (7)	2.80 (9)	3.18 (8)
9	Tea	1.60 (8)	1.28 (10)	1.25 (11)	1.15 (11)	1.22 (11)	1.35 (11)
10	Cardamom	1.22 (9)	1.62 (9)	1.87 (9)	2.21 (8)	1.37 (10)	1.56 (10)
11	Ginger	0.51 (11)	0.41 (12)	0.44 (12)	0.47 (12)	0.38 (12)	0.20 (12)
12	Banana and other plantains	1.89 (7)	1.66 (8)	1.72 (10)	2.17 (9)	3.29 (6)	3.71 (6)
13	Other crops	15.17	13.02	14.87	16.22	16.69	17.27
14	T C A	100.00	100.00	100.00	100.00	100.00	100.00

Figures shows percentage to Total Cropped Area (TCA) and in bracket shows rank.

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. Percentage Change in the Cultivation of Coconut in Kerala in Different Periods (1960-61 to 2009-10).

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	38.33	-3.11	16.01	3.60	-18.26	31.68
2	Kollam	41.75	-10.87	-4.76	2.36	-26.51	-9.48
3	Pathanamthitta	-	-	-	-17.13	-21.46	-34.91
4	Kottayam	28.76	-32.48	-76.26	-11.89	-15.33	-40.09
5	Alappuzha	8.75	-23.47	5.62	-10.33	-26.43	-42.01
6	Ernakulam	44.34	-4.51	8.84	1.72	-26.69	11.86
7	Idukki	-	-	-10.55	60.19	-16.32	19.91
8	Trissur	40.23	7.09	49.65	10.66	-8.69	127.08
9	Palakkad	84.24	-32.61	66.22	21.59	30.18	226.66
10	Malappuram	-	-	71.33	7.95	-5.12	75.49
11	Kozhikkode	39.52	-31.84	29.21	5.47	-4.51	23.74
12	Wayanad	-	-	-	143.79	11.79	172.55
13	Kannur	94.06	-22.32	25.92	5.53	-15.21	69.83
14	Kasaragod	-	-	-	33.25	-3.41	28.69
15	State	43.61	-9.42	23.89	14.72	-15.69	55.86

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. Compound Growth Rates of Area, Production and Productivity of Coconut in Kerala (1960-61 to 2009-10).

Sl. No.	Item	1960-61 to 1969-70	1970-71 to 1979-80	1980-81 to 1989-90	1990-91 to 1999-00	2000-01 to 2009-10	1960-61 to 2009-10
1	Area	4.013	-1.229	2.742	**0.910	***-1.202	1.072
2	Production	2.197	-3.403	4.034	2.113	1.009	1.386
3	Productivity	-1.439	-2.202	1.259	1.193	2.662	0.366

** - Significant at probability level 0.03
*** - Significant at probability level 0.05

Kerala was traditionally a coconut growing area along with the coastal states of Karnataka, Tamilnadu and Andhra Pradesh. The area under coconut has been increasing over the years since 1960-61 in Kerala. From 1960-61 to 2009-10 there has been an increase of 55.86%. The percentage changes in the area under coconut cultivation in different decades are presented in Table.2. The table shows that between 1960-61 and 2009-10, the largest area increase was happened in the northern districts and many of the southern districts recorded decrease in the area under coconut.

Time series analysis of acreage, production and productivity data shows that the growth rate of coconut production was determined more by increase in area. Table.3 revealed that coconut depicted fluctuating trend in productivity growth rate during different decades. It is also worthwhile noting that among the non-food categories, the growth of area expansion index is tremendous in the case of coconut.

Supply Response of Coconut in Kerala

The important determinants included are prices, yields, irrigation, rainfall, acreage and the risk factors. In estimating yield response and area response functions for coconut during the three periods these variables are incorporated in the form of lagged area, expected price, average rainfall, lagged yield, expected yield risk, expected price risk and lagged irrigated area. The significance of the R-square value indicated that these variables are capable of explaining area response and yield response of coconut in Kerala in different periods.

Area response of Coconut

Considering the area response function (Table 4), by far the most important variable determining area

Table 4. Regression Coefficients of the Area response of Coconut in Kerala in Different periods.

Sl. 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 shows standard error
*- Significant at 0.01 level of significance
***- Significant at 0.05 level of significance

allocation during period one for coconut seems to be irrigated area 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, previous years yield and irrigated area seems to be negative during the period.

The area response function tried for coconut during the period 1960-61 to 2009-10 for the state presented in Table. 4 revealed negative influence of yield risk and previous years 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. 4 shows that irrigated area is the most 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.

Yield response of Coconut

With regard to the yield equations presented in Table. 5, irrigated area is the most important factor determining the yield response of coconut during the first period. The influence of rainfall and expected yield risk are weak for coconut during that period. The expected price risk variable has positive influence on the yield of crop whereas the expected price has significant negative influence on the yield response of coconut during the first period in Kerala. The results of the second period presented a different picture like that of area response. Rainfall and irrigated area has significant negative influence on the yield response. Yield risk is insignificant and expected price have to be interpreted as a significant factor (0.0777) in the yield response of coconut.

Considering the entire period from 1960-61 to 2009-10, the variable irrigated area turns out to be an important factor determining the yield response of coconut. Rainfall and expected price risk also has strong positive influence on the yield of coconut. While the expected price of coconut has strong negative influence (-0.0863) associated to the yield influencing variables. From the analysis, it is derived that the variables like irrigated area, expected price risk, rainfall, etc, in the model are the most determining area influencing factors of coconut. These variables are estimated to have significant influence on the yield response of coconut also, except expected price, in Kerala over the years from 1960-61 to 2009-10.

Table 5. Regression Coefficients of the Yield response of Coconut in Kerala in Different periods.

Sl. No.	Variables	1960-61 to 1989-90	1990-91 to 2009-10	1960-61 to 2009-10
1	b0	3.0233	2.8204	0.3091
2	Yt-i	0.2696 (0.193)	0.9445 (0.176)	0.7408 (0.106)
3	Pte	-0.2364 (0.057)	0.0777 (0.082)	*** -0.0863 (0.042)
4	RFt	0.009 (0.065)	-0.0744 (0.090)	0.0403 (0.056)
5	YRte	0.0008 (0.010)	0.0011 (0.014)	-0.0002 (0.009)
6	PRte	** 0.0434 (0.019)	-0.0046 (0.012)	0.0261 (0.014)
7	It	* 0.3687 (0.136)	-0.1825 (0.097)	*** 0.1727 (0.088)
8	R Square	0.7753	0.9018	0.8271
9	Durbin-Watson statistic	2.0888	2.7128	2.4349

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

Conclusion

From the analysis of the growth trends of area of important crops in Kerala over different decades, it is clearly established that the cropping pattern in the state made a significant change from food crops to non-food crops, particularly to coconut and 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. Supply response models in terms of area response and yield response were used to analyse the determinants. The determinants estimated are lagged area, expected price of the crop, lagged yield, expected yield risk and price risk, average annual rainfall, irrigated area, etc.

The analysis which covered fifty years time period divided into two sub-periods and estimated area responses and yield responses of coconut revealed that 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. For the crop's yield response, irrigated area, rainfall and expected price risk are the strong variables.

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