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Determinants of Land use and Cropping Pattern Changes in Kerala

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ABSTRACT

Land is one of the most limited natural resources and land use dynamics is a complex process The present study examined the causes of land use and cropping pattern changes in Kerala from 1985-2019. The time series data were collected from various published sources and the analysis was done at the state level. Population pressure, increase in number of factories, emigration, literacy rate, rainfall *etc.,* were identified as the major causes of land use change in Kerala. The analysis of determinants of cropping pattern was done for paddy using the area response model and it was observed that the previous year's area under the crop, expected price of paddy, and average annual rainfall positively influenced the farmer's acreage response.

Key Words: Agriculture, Cropping Pattern, Determinants, Land Use, Population Density.

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INTRODUCTION

In the 21st Century, Kerala has witnessed a structural transformation in the agricultural sector in terms of land utilisation pattern and cropping pattern. Land is one of the most limited natural resources in the world that supports life. Agricultural land use change is the fundamental driver of societal structure and natural resource dynamics. The land utilisation pattern of a region is determined by various socio-economic, agro-climatic, institutional, and technological factors (Ramaswamy *et al,* 2005; Gairhe, 2011). Decisions about land use considerably impact biodiversity, supply of agricultural commodities, ecosystem services and environmental conditions. The philosophy and methods of land use in Kerala have changed over the past fifty years. According to Karunakaran (2014), Kerala is noted for its extensive use of land responses due to the low per capita land availability. The per capita availability of land in Kerala is only 0.12 ha (GOK, 2019). The land put to non-agricultural uses increased substantially from 7.12% in 1970-71 to 11.73% in 2019-20 of the state's total geographical area. Population pressure and urbanisation have significantly favoured the conversion of land for non-agricultural purposes.

In 1971, the urban population was 16% in Kerala, whereas in 2011, it was noted to be 92.72% (Kumar and Abraham, 2021). According to Zachariah and Rajan (2004), migration and remittances from abroad are the major causes of land use change in the state. Kerala's agricultural growth experience from the late 1970s has been characterised by a steep drop in the area under food crops, primarily rice and a significant expansion in the area under commercial agriculture dominated by plantation crops. The factors like exemption of plantation crops from land reforms, their relatively high profitability, favourable export price, and promotional activities by the government emboldened the farmers in Kerala to opt for high valued cash crops rather than seasonal crops (Geetha, 2006). Thus, a shift from food crops to non-food crops has been prevalent in the agrarian economy of Kerala for the past

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five decades. Similar results are also reported by Jayakumar and Velayudham (2002), Mani (2004), Thomas (2004) and Johnson (2014). In 2019-20, the area under paddy in the state was 191051 ha, whereas the area under coconut and rubber was 760776 ha and 551030 ha (GOK, 2019). That is the percentage share of area under paddy to the gross cropped area was only 7.38%. The percentage share of coconut (29.41%) and rubber (21.30%) was remarkably higher than paddy (7.38%). Land use and cropping pattern changes affected the food security of the state, in addition, it has aggravated adverse ecological consequences. The conversion of paddy land for non-agricultural purposes has resulted in the reduction in area under wetlands.

The climatic changes and water deficit in Kerala are the repercussions of declining wetlands in Kerala. The farmer's decision to follow a particular cropping pattern is governed by factors such as price expectation, labour availability, agro-climatic condition, irrigation facilities, expected yield, cost of cultivation, price of competing crops *etc* (Mythili, 2008; Karunakaran, 2014). Thomas (2004) opined that the shortage of farm labourers coupled with the rapid increase in wages diverted the farmers from cultivating labour-intensive food crops to commercial crops. Even the increase in absentee land owners, and attainment of higher crop profitability from cash crops favoured the farmers to enhance the area under cash crops. Thus, there are several determinants for land use and cropping pattern changes in Kerala. In this backdrop, an attempt has been made to examine the causes of land use and cropping pattern changes in the state from 1985-2019.

MATERIALS AND METHODS

The analysis of the present study is exclusively based on secondary data. The time series data of area under various land use classes, area under paddy and the data regarding explanatory variables used in the study were collected from statistics for planning, Agricultural Statistics at a Glance published by the Government of Kerala for the period 1985-86 to 2019-20. The analysis was done in STATA software. The explanatory variables were selected based on the literature review of the studies related to the research, as well as their data availability.

Causes for changes in land use pattern in Kerala

The multiple regression of double log form was fitted for analysing the factors causing land use changes in the state. The independent variables were regressed with each of the nine land use categories. The functional form of the regression equation of double log form is given below

$$\ln Y = b_0 + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + \ldots + b_7 \ln X_7 + u_i$$

where,

Y= Area under a specific land use category (ha)

X_1 =Average annual rainfall (mm)

X_2 = Population density (no. of persons per.sq.km)

X_3 = Road length (km)

X_4 = Railway route length (km)

X_5 = Number of factories

X_6 = Literacy rate (%)

X_7 = Number of emigrants from Kerala

u_i = Error term

The double log model was selected based on R^2 fit. The coefficients were estimated using Ordinary Least Square Technique (OLS).

Determinants of changes in cropping pattern in Kerala

The popular theoretical framework used to analyse the determinants of changes in cropping pattern is the Nerlovian lagged adjustment model (Usha Tuteja, 2006; Karunakaran and Gangadharan, 2014). The following model was developed on the basis of Nerlovian lagged adjustment model, and the farmer's decisions are discussed in terms of Area response. As the Nerlovian lagged adjustment model is used in the case of annual crops, the determinants of changes in cropping

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Table 1. Causes for land use change in Kerala (1985-2019).

Explanatory variables	Land put to non-agricultural uses	Barren & uncultivable land	Permanent pastures	Land under misc. tree crops	Cultivable wastes	Current fallow	Net area sown
Annual rainfall(mm)	-0.07 (0.04)	-0.02 (0.13)	0.79 (0.83)	0.07 (0.20)	-0.00 (0.09)	-0.14 (0.08)	0.007 (0.01)
Population density (No. of persons per sq. km)	7.54*** (1.73)	-27.37*** (5.20)	-209.78*** (33.15)	-44.22*** (8.02)	6.51 (3.58)	-10.55*** (3.26)	-1.57*** (0.43)
Road length (km)	-0.01 (0.04)	-0.07 (0.12)	0.92 (0.79)	-0.11 (0.19)	0.11 (0.08)	0.20** (0.08)	-0.02** (0.01)
Railway route length (km)	-0.08 (0.19)	-1.65*** (0.56)	-3.73 (3.56)	-2.45*** (0.86)	1.13*** (0.38)	0.08 (0.35)	-0.14*** (0.05)
No. of factories	0.20 (0.21)	1.46 (0.62)**	6.49 (3.95)	8.80*** (0.96)	-4.96*** (0.43)	0.81** (0.39)	0.58*** (0.05)
Literacy rate (%)	-5.40*** (1.63)	20.09*** (4.88)	155.92*** (31.11)	34.62*** (7.52)	-6.19 (3.36)	6.05** (3.06)	1.45*** (0.41)
No of emigrants from Kerala	-0.37 (0.09)	1.19*** (0.28)	10.37*** (1.77)	0.04 (0.43)	0.42** (0.19)	0.69*** (0.17)	-0.04 (0.02)
Intercept	-8.77** (3.53)	84.43*** (10.59)	506.52*** (67.48)	80.93*** (16.32)	28.83*** (7.29)	35.21*** (6.64)	14.73*** (0.88)
F value	89.6***	154.32	55.39***	198.6***	36.16***	47.85***	97.32***
Adj. R^2	0.95	0.96	0.92	0.97	0.88	0.91	0.95

*Note: *** denotes significant at 1% level; ** denotes significant at 5% level*

pattern is analysed particularly for paddy, which is the traditional and staple food crop of Kerala. The regression coefficients were estimated by the method of OLS. The presence of auto correlation was tested using Durbin-Watson test.

Area response model for paddy

$A_t = a_0 + a1\ A_{t-i} + a2\ Pt_e + a3\ RFt + a4\ Y_{t-i} + a5\ YRt_e + a6\ PRt_e + a7\ I_{t-i} + u_t$

The natural log of the variables are taken on both sides and the equation becomes

$\ln A_t = \ln a_0 + \ln a1\ A_{t-i} + \ln a2\ Pt_e + \ln a3\ RFt + \ln a4\ Y_{t-i} + \ln a5\ YRt_e + \ln a6\ PRt_e + \ln a7\ I_{t-I} + u_t$

Where,

A_t = Area under the crop in the current year

A_{t-i} = Area under the crop lagged by i years

Pt_e = Expected price of the crop

RF_t = Average annual rainfall in mm

Y_{t-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

I_{t-i} = Irrigated area lagged by i years

u_t = error term

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

RESULTS AND DISCUSSION

The results of the multiple regression analysis carried out to assess the causes for land use changes in Kerala is given in Table 1. In the analysis, the area under forests was not considered as it remained constant in the state from 1985-2019. In the case of land put to non-agricultural uses, population density (7.54) and the number of factories (0.20) positively influenced its increase in area. Among the two factors, population density is significant at 1% level. The variables, annual rainfall, road length, railway route length, literacy and number of emigrants from Kerala negatively influenced the land put to non-agricultural uses. Although literacy (5.40) is negative, it is significant.

The factors such as number of factories (1.46), literacy rate (20.09) and no. of emigrants from Kerala (1.19) positively and significantly influenced the barren and uncultivable land. Permanent pastures showed a significantly positive response to literacy (155.92), no. of emigrants from Kerala (10.37) and a significant negative response to population density. As far as land under miscellaneous tree crops is concerned, the no. of factories (8.80) and literacy rate (34.62) had a positive and significant impact on it. The variables railway route length (1.13) and no. of emigrants (0.42) exhibited a positive and significant influence on cultivable wastes. If we take the case of current fallow, many of the selected variables showed a considerable impact on it *viz*, road length (0.20), railway route length (0.08), no. of factories (0.81), literacy rate (6.05) and no. of emigrants from the state (0.69). The positive influence of these factors leads to the rise in area under current fallow in Kerala. It was noticed that only the no. of factories (0.58) and literacy rate (1.45) had a positive and significant impact on the net area sown. Although rainfall was positive, it was non-significant. The influence of other factors resulted in the decline in the net area sown at the state level. From the analysis, it can be highlighted that all the factors could explain a sizable variation in Kerala's respective land use categories.

The farmer's decision regarding area allocation to various crops is based on various price and non-price factors. The price factors are the minimum support price, the previous year's harvest price of the crop, prices of inputs like fertiliser, seeds, electricity, and plant protection chemicals. Similarly, the major non-price factors which influence the farmer's decisions are previous year's acreage, previous year's yield, the yield of crop under study, rainfall, irrigated area, extension services, *etc.* In the present study, the regression analysis of the area response

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Table 2. Determinants of area under Paddy in Kerala (1985-2019)

Explanatory variables	coefficients
Area under the crop lagged by i years (A_{t-i})	1.03***(0.14)
Expected price of the crop (Pt_e)	0.03(0.08)
Average annual rainfall (RF_t)	0.02(0.07)
Yield of the crop lagged by i years (Y_{t-i})	-0.34(0.29)
Expected yield risk in the current year (YRt_e)	-0.003(0.02)
Expected price risk in the current year (PRt_e)	-0.01(0.02)
Irrigated area lagged by i years (I_{t-i})	-0.35***(0.18)
Intercept	2.68***(1.24)
F value	186.47***
Adj.R^2	0.97
Durbin-Watson statistic	2.28

*Note: Figures in parentheses indicate standard error; *** denotes significant at 1% level*

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model for paddy (1985-2019) was carried out with a few variables whose data were available. The regression coefficients of the explanatory variables are given in Table 2. Among the independent variables, the lagged area and lagged irrigated area under paddy was observed to be the only significant factors influencing the area response of the farmer.

The expected price of paddy (0.03) and average annual rainfall (0.02) positively influenced the farmer's in allocating the area under paddy. These are in conformity with the findings of Karunakaran (2014). In contrast to this, the previous year's yield (0.34), expected yield risk (0.003) and expected price risk (0.01) were negative and non-significant. The negative price risk factor indicated farmer's risk aversion behaviour towards paddy. Although the irrigated area under paddy in the previous year was negative, it was observed to be significant in the study. The explanatory variables could explain 97 per cent variation in the area under paddy in the current year.

CONCLUSION

Over the decades, the land use changes in Kerala can be attributed to factors such as the increase in population, literacy rate, urbanisation, migration, and environmental factors such as rainfall. The conversion of land for non-agricultural purposes has been escalating in Kerala. These factors have contributed to the substantial increase of this land category. Appropriate policy measures must be undertaken to minimise the impact of these factors in aggravating the land use shifts. Even the area under food crops has plummeted in Kerala due to the dominance of cash crops. Although various price and non-price factors influence the farmers in allocating area for various crops, the area allocation for food crops need atmost priority as their decline can affect the food security and ecological sustainability of the state.

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