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RESEARCH PAPER

Intensive farming and dynamics of land use in Tamil Nadu

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ABSTRACT

With the advent of Green Revolution in 1960's, India has attained food self-sufficiency. It has been of late recognized that the efforts to increase agriculture production through intensive farming results in the form of natural resource degradation like decline in ground water level, deterioration of soil quality, loss of biodiversity and changes in land use pattern over the years. This study attempts to analyse the implications of intensive farming on dynamics of land use, because as land use changes, the proportion of land allotted for agricultural and non-agricultural uses will be changed. With this objective, the study has been undertaken in Tamil Nadu state in India, for the period 1980 to 2010 using ordinary least square estimation technique. The results showed that intensive farming factors such as area irrigated under tube wells, paddy and sugarcane productivity were found to have significant influence over land use pattern.

KEY WORDS : Composite index, Ordinary least square, Sustainability, Intensive farming

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In India, Intensive farming as a result of green revolution leads to sustainability problems like decreases in productivity level, depletion of soil organic manure or reduction in the number of traditional varieties. Concern has been expressed that intensive agriculture slowly harms the environment. In particular increase in the input responsive high yielding varieties leads to changes in land use pattern. It also leads to extension of area under irrigation. Being the largest user of groundwater for irrigation in the world, irrigated area in India, has doubled over four decades, from 19% to 38% of the net sown area.

Tamil Nadu which is one of the important agrarian states in India has attained rapid rate of growth in the agricultural sector. It is one of the leading states in the production of principal crops like paddy and sugarcane. With the limited gross area sown, higher productivity of many crops has been achieved by practicing intensive farming. After green revolution, erosion and degradation of soil and loss of fertility due to mining of soil nutrients are taking place in the state. Lack of erosion control measures and drainage facilities, inadequate investments in soil and moisture conservation, imbalanced fertilizer use and inadequate use of micro-nutrients are some of the important factors contributing for low productivity and poor soil health (Raveendran *et al.,* 2005). Over the years intensive farming due to population explosion and technological development results in changes in land use pattern. It is necessary to study these effects in order to maintain the sustainability of resources for the future. Thus, this paper attempts to analyse the effects of intensive farming on land use pattern over the decades.

METHODOLOGY

For identifying the districts in Tamil Nadu which are practicing intensive farming, composite index was constructed. The index comprised of the indicators such as net irrigated area by tube wells, area irrigated per tube well, area under high yielding varieties of rice and sugarcane, fertilizer consumption per hectare of net area sown and number of

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tractors used per net area sown. Based on the composite index, Cuddalore and Villupuram districts were selected, since these two districts hold first two ranks in intensive farming in the state. The study is based on secondary data collected from Season and Crop Report of Tamil Nadu, Department of Economics and Statistics, Chennai pertained to the period 1980 to 2010. Using ordinary least square estimation technique, various parameters of land use pattern were regressed along with the variables of intensive farming and the equations are given below :

LPNAU = a + b1 NIAT + b2 PPDTY+ b3 SPDTY+b4 TT

CW=a+b1 NIAT+b2 PPDTY+b3 SPDTY+b4 TT+ b5 NAS

BUCL = a + b1 NIAT + b2 PPDTY + b3 SPDTY + b4 TT + b5 NAS + b6 LPNAU

LMTC = a + b1 NIAT + b2 PPDTY + b3 SPDTY + b4 TT + b5 LPNAU + b6 NAS

PPAGL = a + b1 NIAT + b2 PPDTY + b3 SPDTY + b4 TT + b5 NAS + b6 RF

CFL = a + b1 NIAT + b2 PPDTY + b3 SPDTY + b4 TT+ + b5 LPNAU + b6 RF

OFL=a+b1 TT ++ b2 LPNAU + b3 RF + b4 NIAT + b5NAS

NAS=a+b1 NIAT+b2 PPDTY+b3 SPDTY+b4 TT+b5 RF

where,

BUCL = Barren and Un-Cultivable Land, LPNAU = Land Put to Non-Agricultural Uses

CW = Cultivable Wastes, PPAGL = Permanent Pastures and other Grazing Lands

MTC = Miscellaneous Tree Crops, CFL = Current Fallow Land, OFL = Other Fallow Land,

NAS = Net Area Sown, LPNAU = Land Put to Non Agricultural Use,

PPDTY = Paddy Productivity, SPDTY = Sugarcane Productivity,

TT = Time Trend from 1980 to 2010, RF = Rainfall

ANALYSIS AND DISCUSSION

Before studying the implications of intensive farming, the trends in land use pattern of the study area was analyzed (Table 1). It could be seen that over the years there has been a decline in the area under several categories of land use. The negative growth trend in barren land, cultivable waste land, permanent pasture land, land under miscellaneous tree crops and other fallow land due to rise in population pressure leads to positive growth in land put to non-agricultural use. Current fallows have increased and showing higher growth rate of 2 per cent per annum and the growth rate was negative in the case of net area sown, gross cropped area and area sown more than once.

Ordinary least square estimates of land use and intensive farming :

Analysis of factors affecting the changes in land use categories has been carried out to examine the influence of intensive farming on land use pattern. For the study, intensive farming variables like area irrigated under tube wells, paddy productivity and sugarcane productivity were collected. Since tube wells become the major source of irrigation after industrial farming was introduced, it was selected as one of the variables. Paddy and sugarcane productivity were selected since these two crops occupied more than 60 per cent of cropping area in the selected districts and demands intensive farming for better productivity. Along with these, other variables like time trend and rainfall were also selected to find out the effects of all these variables on land use changes.

Factors influencing land put to non-agricultural use :

This includes all land occupied by buildings, roads and railways or under water, e.g. rivers and canals, and other land put to use other than agriculture. The influence of various

Table 1 : Trend analysis of land use pattern in Cuddalore and Villupuram districts **(ha)**

Particulars	1980-81 to 1990-91	1991-92 to 2000-01	2001-02 to 2010-11	1980-81 to 2010-11	Growth rate (%) (1980-81 to 2010-11)
Forest	84998 (7.64)	73112 (6.77)	73112 (6.71)	77330 (7.06)	0.33
Barren and un cultivable waste land	99603 (8.95)	79345 (7.34)	71296 (6.54)	83937 (7.67)	-1.76
Land put to non agricultural use	145904 (13.12)	154096 (14.26)	188428 (17.29)	162264 (14.82)	1.17
Cultivable waste	36332 (3.27)	18403 (1.70)	16850 (1.55)	24264 (2.22)	-3.38
Permanent pasture	7071 (0.64)	5154 (0.48)	4830 (0.44)	5730 (0.52)	-1.85
Land under miscellaneous tree crops	45184 (4.06)	37545 (3.48)	24962 (2.29)	36196 (3.31)	-2.95
Current fallow	106366 (9.56)	92296 (8.54)	139849 (12.83)	112628 (10.29)	2.01
Other fallow	37488 (3.37)	27643 (2.56)	34895 (3.20)	33476 (3.06)	-0.31
Net area sown	549493 (49.40)	592786 (54.87)	535762 (49.15)	559029 (51.06)	-0.12
Area sown more than once	151935	141060	105826	133553	-1.95
Gross cropped area	707110	662505	641588	671585	-0.37
Geographical area	1112439 (100)	1080380 (100)	1089984 (100)	1094854 (100)	

Source : Own estimation using data from various issues of season and crop report of Tamil Nadu

factors over land put to non-agricultural use category is given in the Table 2.

From Table 2 it is observed that, of the three intensive farming factors selected, tube well irrigated area and paddy productivity were found to have significant influence over land put to non-agricultural use. Thus one hectare increase in tube well irrigated area was found to decrease the dependent variable by 0.4 hectare. The possibility of irrigation by tube wells in the agricultural lands, other sources of irrigation are devoid off, will reduce the conversion of land for non-agricultural purposes. The variable paddy productivity is also found to have negative relation. One kg rise in paddy productivity will reduce the land put to non-agricultural use by 4.5 hectares. The variable time trend seems to have a positive relationship with the land put to non agricultural uses indicates that the changes in economic growth is mainly responsible for the increase in area under this category of land use.

Factors influencing land under cultivable waste :

This includes land available for cultivation, whether taken up or not taken up for cultivation once, but not cultivated during the last five years or more in succession including the current year for some reason or the other . Such land may be either fallow or covered with shrubs and jungles which are not put to any use. Some of the factors which have an influence over the land under cultivable waste are given in Table 3. The analysis showed that increase in tube well irrigated area by one hectare will decrease the cultivable waste land by 0.1 hectare. It was significant at 10 per cent confident level. The variable time trend which is an indicator of economic growth is having a negative relation with that of the dependent variable. As expected, the variable net area sown was found to have negative relation with that of the endogenous variable.

Table 2 : Land put to non-agricultural uses vs intensive farming

Particulars	Co-efficients	t Stat	P-value
Intercept	***177660	14.654	0.000
Tube well irrigated area (ha)	**-0.434	-3.008	0.006
Paddy productivity (kg/ha)	*-4.573	-1.870	0.073
Sugarcane productivity (T/ha)	-38.812	-0.493	0.626
Time trend	***3132	7.893	0.000
R square	0.851		

Source : Own estimation from secondary data, *, ** and *** indicates significance of values at P=0.05, 0.01 and 0.1, respectively

Table 3 : Land under cultivable waste vs intensive farming

Particulars	Co-efficients	t Stat	P-value
Intercept	***89859	6.698	0.000
Tube well irrigated area (ha)	*-0.156	-1.936	0.064
Paddy productivity (kg/ha)	-0.783	-0.527	0.603
Sugarcane productivity (T/ha)	67.622	1.504	0.145
Time trend	*-568.81	-2.538	0.018
Net area sown (ha)	**-0.079	-3.102	0.005
R square	0.824		

Source : Own estimation from secondary data, *, ** and *** indicates significance of values at P=0.05, 0.01 and 0.1, respectively

Table 4 : Barren and uncultivable waste land vs intensive farming

Particulars	Co-efficients	t Stat	P-value
Intercept	**75621	3.280	0.003
Tube well irrigated area (ha)	*-0.156	-1.810	0.083
Paddy productivity (kg/ha)	-1.453	-1.015	0.320
Sugarcane productivity (T/ha)	21.657	0.520	0.608
Time trend	***-1680.57	-4.452	0.000
Land put to non agricultural use (ha)	**0.329	3.231	0.004
Net area sown (ha)	0.002	0.067	0.947
R Square	0.927		

Source : Own estimation from secondary data, *, ** and *** indicates significance of values at P=0.05, 0.01 and 0.1, respectively

An increase in net area sown by one hectare will decrease the cultivable waste land by 0.07 hectare.

Factors influencing barren and uncultivable waste land:

This includes all land covered by mountains, deserts, etc. Land which cannot be brought under cultivation except at an exorbitant cost is classified as uncultivable whether such land is in isolated blocks or within cultivated holdings. Some of the factors which influence area under barren and uncultivable waste land is given in Table 4.

It is observed from Table 4 that tube well irrigated area was found to have profound negative and significant influence over the barren land. The variable time trend was found to be significant at 1 per cent confident level and the negative value indicates that over the years the economic development and the demand thereby for non agricultural purposes (which is positive and significant at 5 %) resulted in reduction of land under this category. Thus an important policy implication from the analysis is that the barren land and the land put for non-agricultural purposes have direct and significant relationship. It is clear that the land required for non-agricultural purposes has been met from barren and uncultivable land and the agricultural land has not been taken off since the net area sown doesn't show any signs of significance over land put to non-agricultural purposes. The higher R^2 value indicates the best fit of the model.

Factors influencing permanent pasture and grazing land :

This includes all grazing land whether it is permanent pasture/meadows or not. Village common grazing land is also included under this category. The factors which affect the permanent pasture and grazing land are given in Table 5.

From Table 5 it is observed that among the intensive farming variables tube well irrigated area was found to be negatively associated with permanent pasture and grazing land. Since those lands which acquired tube well irrigation was used for cultivation rather than merely kept as pasture or grazing land. The variable sugarcane productivity was positive and significant indicating that increase in sugarcane productivity resulted in conversion of more pasture and grazing lands for sugarcane cultivation. Increase in time trend and net area sown were found to have a significant negative relation with that of the dependent variable, since as years passed by more pasture land has been converted either for agriculture or for non-agricultural purposes. The R^2 value of 0.88 indicates that 88 per cent of the variation in the dependent variables is explained by the independent variables.

Factors influencing land under miscellaneous tree crops :

This includes all cultivable land which is not included in 'Net area sown' but is put to some agricultural use. Land under trees, thatching grasses, bamboo bushes and other

Table 5 : Permanent pasture and grazing land Vs intensive farming

Particulars	Co-efficients	t Stat	P-value
Intercept	***13077	9.891614	0.000
Tube well irrigated area (ha)	**-0.028	-3.162	0.004
Paddy productivity (kg/ha)	-0.069	-0.449	0.657
Sugarcane productivity (T/ha)	*8.979	1.830	0.080
Time trend	*-51.627	-1.844	0.078
Net area sown (ha)	*-0.008	-2.625	0.015
Rain fall (mm)	0.223	0.531	0.600
R square	0.883		

Source : Own estimation from secondary data, *, ** and *** indicates significance of values at P=0.05, 0.01 and 0.1, respectively

Table 6 : Land under miscellaneous tree crops vs Intensive farming

Particulars	Co-efficients	t Stat	P-value
Intercept	40514	1.016	0.320
Tube well irrigated area (ha)	0.031	0.210	0.835
Paddy productivity (kg/ha)	1.610	0.650	0.522
Sugarcane productivity (T/ha)	-51.129	-0.709	0.485
Time trend	*-1220.96	-1.870	0.074
Land put to non agricultural use (ha)	0.016	0.091	0.928
Net area sown (ha)	0.018	0.434	0.668
R square	0.675		

Source : Own estimation from secondary data Note: * indicates significance of values P=0.1

groves etc. which are not included under 'Orchards' are classified under this category. Factors which have an influence over the land under miscellaneous tree crops are indicated in the Table 6.

It could be observed from Table 6 that time trend was the only variable found to be significant among all the variables. Since for the economic growth, more land under miscellaneous tree crops were converted for better infrastructure facilities of the district, change in one year of time period resulted in depletion of 1220 hectares of land under miscellaneous tree crops.

Factors influencing land under current fallow :

This represents cropped area which is kept fallow during the current year. Various factors which determine the land under current fallow are given in Table 7.

It is observed from Table 7 that, paddy and sugarcane productivity has a negative at 10 per cent significant effect over land under current fallow. It has an important policy implication since increase in productivity of the two major crops of the district as a result of intensive farming will reduce the current fallow land by nearly 620 hectares. Similarly rainfall has a negative effect over land under current fallow. One mm increase in rainfall reduces the current fallow to an extent of 83 hectares. From the R^2 value it is evident that 52 per cent of the variation in the dependent variable is explained by the given independent variables.

Factors influencing land under other fallow :

This includes all land which was taken up for cultivation but is temporarily out of cultivation for a period of not less than one year and not more than five years. Factors which

Table 7 : Land under current fallow vs intensive farming

Particulars	Co-efficients	t Stat	P-value
Intercept	169601	1.304	0.205
Tube well irrigated area (ha)	0.117	0.195	0.847
Paddy productivity (kg/ha)	*-19.132	-2.080	0.048
Sugarcane productivity (T/ha)	*-603.77	-2.091	0.047
Time trend	1278.69	0.496	0.624
Land put to non agricultural use (ha)	0.778	1.056	0.302
Rain fall (mm)	**-83.046	-3.484	0.002
R square	0.524		

Source : Own estimation from secondary data * and ** indicate significance of P=0.1 and 0.05, respectively

Table 8 : Land under other fallow vs intensive farming

Particulars	Co-efficients	t Stat	P-value
Intercept	**109550	3.328	0.003
Time trend	340.53	0.741	0.465
Land put to non agricultural use (ha)	-0.070	-0.462	0.648
Rainfall (mm)	2.920	0.559	0.581
Tube well irrigated area (ha)	-0.167	-1.487	0.150
Net area sown (ha)	**-0.099	-2.924	0.007
R square	0.407		

Source : Own estimation from secondary data ** indicate significance of 0.05, respectively

Table 9 : Net area sown vs intensive farming

Particulars	Co-efficients	t Stat	P-value
Intercept	***298331	4.711	0.000
Tube well irrigated area (ha)	0.857	1.534	0.138
Paddy productivity (kg/ha)	**24.981	2.822	0.009
Sugarcane productivity (T/ha)	*646.746	2.185	0.038
Time trend	*-4106.81	-2.489	0.020
Rain fall (mm)	**77.282	3.371	0.002
R square	0.477		

Source: Own estimation from secondary data, *, ** and *** indicates significance of values at P=0.05, 0.01 and 0.1, respectively

have an influence over the land under other fallow are indicated in Table 8.

It is observed from Table 8 that of all the variables selected for analysis only net area sown has a significant influence over the dependent variable. The variables time trend, land put to non-agricultural use and area irrigated under tube wells though not significant but has the expected sign over the endogenous variable.

Factors influencing net area sown :

This represents the total area sown with crops and the area sown more than once in the same year is counted only once. The various factors which affect the net area sown are given in Table 9.

It is evident from Table 9 that increase in paddy and sugarcane productivity over the years resulted in improvement in net area sown. These variables were significant at 5 per cent and 10 per cent confident level, respectively. The variable time trend was found to have negative relation with that of the net area sown, because area under crops other than paddy and sugarcane has been reduced over the years. As expected, rainfall has a positive and significant effect over net area sown.

Summary and conclusion :

Using time series data from season and crop report of Tamil Nadu, the effects of intensive farming of paddy and sugarcane over land use pattern was analysed for the most intensive farming districts in Tamil Nadu *viz.*, Cuddalore and Villupuram. From the results of the ordinary least square estimation, it was observed that, intensive farming indicators such as paddy and sugarcane productivity and area under tube well irrigation have a significant negative influence over several land use categories. The study confirms that increase in productivity of input intensive crops brings more marginal lands for cultivation and these lands in turn needs more inputs for better productivity. This chain of activities leads to soil deterioration thereby increase in the current fallow lands over the years. Thus, proper and precise management of resources is the immediate need for sustainability of resources in the future.

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