Asian Journal of Agricultural Extension, Economics & Sociology

19(3): 1-10, 2017; Article no.AJAEES.35450
ISSN: 2320-7027

Dynamics of Land Use Pattern and Cropping Pattern in Cuddalore District of Tamil Nadu

R. Paramasivam[1*], M. Umanath[2], V. Kavitha[2], A. Kuzhandhaivel Pillai[3] and R. Vasanthi[4]

[1]Department of Social Sciences, Kumaraguru Institute of Agriculture, Erode, India.
[2]Madras Institute of Development Studies, Chennai, India.
[3]Don Bosco College of Agriculture, Vellore, Tamil Nadu, India.
[4]Department of Social Sciences, Agricultural College and Research Institute, TNAU, Killikulam, India.

Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJAEES/2017/35450
Editor(s):
(1) Phokele Isaac Maponya, Agricultural Research Council & University of Johannesburg, South Africa.
Reviewers:
(1) Jordi Comas Angelet, Universitat POlitècnica de Catalunya, Spain.
(2) Mehmood Ali Noor, Institute of Crop Science, China.
Complete Peer review History: http://www.sciencedomain.org/review-history/21021

Original Research Article

Received 13th July 2017
Accepted 17th August 2017
Published 16th September 2017

ABSTRACT

This study aims to assess the structural changes of land use pattern and cropping pattern in the Cuddalore district of Tamil Nadu. We used panel data of land use pattern and area under different crops inclusion of irrigated and unirrigated area from 1960-61 to 2012-13. The collected data was estimated by using Markov chain analysis. The land put forward non-agricultural purposes and current fallow lands accounted for a higher share of retention probabilities while permanent pastures and other grazing lands had lower retentions in 1960-90 and 1991-2012, respectively. Retention probabilities of net sown area also had the same percentage in the same period implies that the district is an agrarian one. The share of retention in rice, oilseeds and fruit crops were high, and the area under sugarcane retains a moderate share and that of maintaining between 1960-90 and 1991-2012. The area under rice, however, was gradually relocated its share to sugarcane. Similar results were also found in field survey conducted in 2001 and 2011 where the share of area under rice was shifted to sugarcane, maize, cotton, fruits and vegetables.

**Corresponding author: E-mail: pazhani650@gmail.com;*

Keywords: Land use pattern; Markov chain analysis; rice; cropping pattern.

1. INTRODUCTION

The land is a prime factor in the factors of production and is an inelastic and immobile nature. Demand for land is increasing continuously for different sectorial development such as food grain production, fruits and vegetable production, meat production, road corridor, infrastructure, real estate, etc. The supply of land cannot be influenced by those factors but the land conversion can be possible among different land use categories. It likely helps to raise the Gross Domestic Product (GDP) of a country. For instance, GDP growth rate of India in 2015-16 marked 7.8%, of which mining and quarrying sector has contributed a higher growth rate of 12.3 while agriculture sector had a lower growth rate of 0.8%. Land use pattern, among different sectors, more important to the farming sector to achieve not only food grain production of 265 Million tonnes (Mt) with gross area under major crops of 125 Million hectare (Mha) in India in 2013-14 [1], but also determines biodiversity, ecosystem and nature conservation. An area under net sown area, nine use land categories, increased tremendously from 118.75 to 141.42 Mha in 1950-51 to 2013-14. Similarly, cropping intensity also raises a potential share of from 111.1 to 242% in the same period. The extent of land use for farming is influenced by technological changes, population size, urbanization, industrialization and country's developmental work such as road and public building construction [2].

In the recent period, allocation of land to the individual is shrinking sharply evidently the per capita land availability declined from 0.34 to 0.12 ha in 1960-61 to 2014-15. The share of agricultural sector in the gross domestic product has accounted a significant decline from 47.6 to 17.9% in the same period. The continuous urbanization, expansion of road corridor and other infrastructure development causes demand for the farmland and adopt intensive cultivation. For instance area under fallow land has registered a steady decline of from 28.12 to 24.84 Mha in 1960-61 to 2013-14, around 12% of the land area was declined over the five decades. Land use pattern and cropping pattern have changed through climatic factors of uneven rainfall, drought and flood [3,4], which not only affect an area under potential crops and also other crops significantly.

Cropping pattern helps to balance the soil nutrients, conserve both implicit and explicit resources and reduces the risk of farm income [5]. However, market-led crops dominance across regions of India over a decade, which narrow down the farmers to follow a mono-cropping system [6]. For instance, banana is persistently growing in various regions of Tamil Nadu in the view of higher return crop. This kind of crops is change the prevailing cropping system like paddy-maize-pulse to the banana or sugarcane as mono-crop, which would over exploit the water resources, increases risk in farm income and create a negative impact on soil fertility [7].

Both land use pattern and cropping are changed considerably in Tamil Nadu state. Though it is an agrarian state where many of the people livelihoods depend upon agriculture and allied activities. Net sown area accounted larger share (45% in 1960-61) of land use pattern and the same share to the total geographical area has been continuously declined from 45% in 1960-61 to around 36% in 2013-14. Also, the gross cropped area declined from 79.57 lakh ha in 1960-61 to 58.97 lakh ha in 2013-14, nearly 26% of the area was reduced over the five decades. The area under rice, among the major crops, is also registered a declining share to the gross cropped area in the state as the crop occupies more than 30% of total cropped area. It is assumed that both climatic and technological factors are crucial in determining land use pattern as well as cropping pattern. Many regions of Tamil Nadu, specifically delta region, have been changed the cropping pattern by inadequate rainfall and heavy downpour. Cuddalore, Villupuram, Nagapattinam, Thiruvarur and Thanjavur are the major delta districts which are frequently undergone many structural changes due to climatic and technological factors. With this background, we intend to study the changes in the land use pattern and cropping pattern in Cuddalore district, one of the largest gross cropped area in the state.

2. METHODOLOGY

The Erstwhile Cuddalore district was selected for this study. Gross irrigated area to the total agricultural area (3.35 lakh ha) of the district was recorded about 72%, whereas net irrigated area has recorded 67% in 2012-13. The district ranks

second in rice production with 3.96 lakh tonne in 2012-13 next tothe Thiruvarur district of Tamil Nadu. This study followed stratified random sampling method, which is adopted by Cost of Cultivation for Principle Crops (CCPC) scheme to study the cost of production among the notified farmers in the selected regions of India. In the three-stage stratified random sampling design, tassels (taluks) acts as the first stage unit, village/cluster of villages as the second-stage unit and holding as the third stage unit in the district. Based on the above sampling procedure, five taluks and seven villages were selected and ten farmers per village to the tune of total sample size of 70 farmers were selected from the study district (Table 1). Farmers who were surveyed in 2001 were again resurveyed in 2012 following CCPC guideline.

Table 1. Distribution of sample respondents in erstwhile Cuddalore district

S. no	Taluk	Village	No. of rice farmers	
			2001	2012
1	Kallakurichi	Elayamnallur	10	10
		Koonathalur	10	10
2	Villupuram	Thiruvamathur	10	10
3	Tindivanam	Saram	10	10
		Vilangamapadi	10	10
4	Thirukovilur	Manampoondi	10	10
5	Ulundurpet	Sengurichi	10	10
	Total		70	70

2.1 Tools of Analysis

2.1.1 Markov chain analysis

Markov chain analysis is an application of dynamic programming to the solution of a stochastic process that can be described by a finite number of states. Markov process was used to study the shifts in the land use classification and thereby gain an understanding of the dynamics of the changes.

2.1.2 Markov probability model

Any sequence of trails (experiments) that can be subjected to probabilistic analysis is called a stochastic process. For a stochastic process, it is assumed that the movements (transitions) of objects from one state (possible outcome) to another are governed by a probabilistic mechanism or system. A finite Markov process whereby the outcome of a given trail "t" (t=1,2,….T) depends only on the outcome of the preceding trail(t-1) and this dependence is the same at all stage in the sequence of trails [8]. Consistent with this definition, let

S_i=Represent the i^{th} state of "r" possible outcomes; i=1,2,…., r

W_{it}= Represent the probability that state S_i occurs on trial *t* or the proportion observed in trail "t" in alternate outcome state I of the multinomial population based on a sample of size n, *i.e.*,Pr(S_{it}).

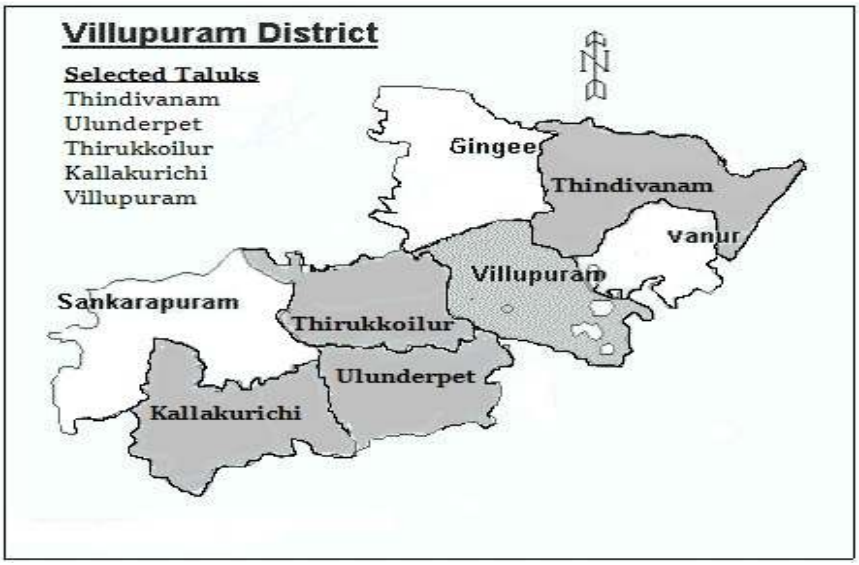

Fig. 1. Selected blocks in erstwhile Cuddalore district

P_i=Represent the transitional probability which denotes the probability that if for any time "t" the process is in state S_i, it moves on the next trail to state S_j, i.e., $Pr(S_jt+l/S_{jt})=P_{ij}P=(P_{ij})$= Represent the transitional probability matrix which denotes the transitional probability for every pair of states (i,j=1,2….r), and has the following properties

$$0 \leq P_{ij} \leq 1, \quad (1)$$

and

$$\sum p_{ij}=1, \text{ for } i=1,2\ldots\ldots r, \quad (2)$$

Given this set of notations and definitions for a first order Markov chain, the probability of a particular sequence S_i on trial "t" and S_j on trial 't+1' may be represented by

$$Pr(S_{it}, S_j.t+1) = Pr(S_{it})\, Pr(S_j.t+1\ 1S_{it}) = W_{it}P_{ij} \quad (3)$$

and the probability of being in state *j* at trial t+1 may be represented by

$$Pr(S_j.t+1) = \sum_i W_{it} = P_j \text{ or } W_j,\ t+1 = \sum W_{it}P_{ij} \quad (4)$$

The data for this study is the proportion of area under land use categories. The proportions change from year to year as a result of different factors. It is reasonable to assume that the combined influence of these individually systematic forces approximates a stochastic process and the propensity of farmers to move from one land use category to another category differs according to the land use category involved. If these assumptions are acceptable, then the process of land use dynamics may describe in the form of a matrix P of first order transition probabilities. The element P_{ij} of the matrix indicates the probability of a farmer in the land use category 'i' in one period will move to land use category 'j' during the following period. The diagonal element P_{ij} measures the probability that the proportional share of i^{th} category of land use will be retained. The transition probability matrix was estimated using the Minimum Absolute Deviation (MAD) estimator. The elements P_{ij} of the matrix are the conditional probabilities of the area under a particular land use category in time "t" given its share in time t-1. The diagonal elements P_{ij} (i=j) indicate the extent of stability of land use categories. Hence, as the diagonal elements approach zero, the area under a particular land use becomes less and less stable, and as they approach one, the land use categories tend to exhibit more and more stable over time. The off-diagonal elements P_{ij} (i≠j) are the probabilities of switching over between different land-use categories. If P_{ij} is the diagonal element corresponding to the i^{th} land use category, the other elements in the i^{th} row give the proportions of the previous period's area of i^{th} the land use category, it is likely to lose to other categories in the current period. The elements of the i^{th} column give the proportions of areas of other land use categories in the previous period the i^{th} land use category is likely to gain in the current period.

2.1.3 Estimation of transition probability matrix

Equation (4) can be used as a base for specifying the statistical model for estimating the transition probabilities. If errors are incorporated in equation (4) to account for the difference between the actual and estimated occurrence of $W_{j(T+1)}$, the sample observations may be assumed to be generated by the following linear statistical model.

$$W_{jt} = \sum_j W_{it}W_{i,}\mathrm{t}-1P_{ij} + U_{jt} \quad (5)$$

or in matrix form, it can be written as

$$Y_j = X_jP_j + U_j \quad (6)$$

where Y_j is a (Tx1) vector of observations reflecting the proportion in land use pattern in time t, X_j is a (Txr) matrix of realizing values of the proportion in land use pattern 'i' in time t-1, P_j is a (rx1) vector of unknown transition parameters to be estimated and U_j is a vector of random disturbances.

3. RESULTS AND DISCUSSION

3.1 Trend of Area under Major Crops in Cuddalore District

Area under cereals, among all crops, have noticed a larger area in all the periods (1990-91 to 2012-13) followed by oil seeds and area under sugarcane has been rises slowly after 2005. Area under cereals have declined from 3 lakh ha in1990-91 to 2.50 lakh ha in 2012-13, around

17% of area was declined. Similar kind of trend was observed in the area under rice and oil seeds in the same period. However, share of rice accounted a major proportion of the total cereal area over the years. It is found that area under fruit crops have upward trend due to the fact that declined area under oil seeds may be shifted to this crop. In additions, area under pulses also increased considerably during the same period (Fig. 2).

3.2 Land Use Pattern in Cuddalore District

The area under forest and barren and uncultivable land had retained around 98% of their land in the first period (1960-90) and decreased to less than 88% in the second period (1991-2012). Land use under these two categories has highest retention probability when compared to the other type of land use categories in both periods. The probability of retention of cultivable waste has decreased from the first period to the second period, and 0.60% of current fallow has shifted to land under miscellaneous tree crops in the first period. This transition probability had increased to 29.3% in the second period. It clearly indicates that a proportionate share of current fallow has been converted into land under miscellaneous tree crops over the period. However, the gained and retained a share of land under miscellaneous tree crops at 37% was transferred to cultivable land in the first period and 69% in the second period indicating that conversion of area under miscellaneous tree crops and current fallow into the cultivable land is increasing over the period. The retention probability of permanent pasture and other grazing land was much lower in both periods. Around 99% of pasture and grazing land has been converted into the cultivable land (Table 3). It is observed that a proportionate share of current fallow through land under miscellaneous tree crops and permanent pasture and other grazing land has been shifted to cultivable land. The reason may be introduced technologies such as ease of pumping well water, mechanization and chemical fertilizers are attracted more of cultivable land.

The present study estimated cropping pattern by using time series data and cross sectional data. The results of the cropping pattern is presented as following sequential order: first one is time series data and second one is cross sectional data.

3.3 Dynamic Changes of Major Crops in Cuddalore District

Cuddalore district is a hub for agriculture owing to labour availabilities and, to some extent, the availability of water is altogether supported for the higher food grain production. The climatic factors of rainfall and temperature have altered the cropping pattern over the year, specifically the cultivation of irrigated crops like rice and sugarcane were changed adversely over the period. The probability of retention of the particular crop can be estimated through the transition probability matrix (diagonal matrix). From the result, it is noted that the retention probability for the area under rice, pearl millet, pulses, groundnut, cotton and other crops had 72, 55, 32, 44, 43 and 50%, respectively, in the first period. The retention probability for same crops in the second period were observed at87, 77, 50, 85, 55 and 68%, respectively. It is found that retaining probability of all crops were more in the second period than the first period. In the first period, most of the rice area was absorbed by groundnut while in the second period, the rice area was gained equally by sugarcane, fruits and other crops. In the second period, rice and groundnut had a higher retention probability. When compared to the first period, rice absorbed some proportion of land from the pulses and cotton. It is infers that area under rice had higher share when compared with other crops in the district.

The retention probabilities of area under spices, oil seeds (except groundnut) and fruits were increased from 0, 0.3 and 8% to 8, 64 and 69%, respectively, from first period to second period, and it is supposed to confirm that economic reforms may favour to more cultivation of market-led crops of fruits. In the transition of crop areas, area under fruit crops gained about 20% share from rice, pearl millet, pulses, oil seeds, spices and other crops, which implies that a transition of an area under these crops towards fruit crops had moderately increased from first period to second period. Area under sugarcane retained probability of around 69% in both periods, whereas cereals except rice and pearl millet retained 84% in the first period and decreases to 64% in the succeeding period. This loss was gained by pulses and cotton at 16 and 18%, respectively, in the same period. Therefore, the results concluded that rice, oil seeds and fruit crops retained relatively higher share compared to other crops in the post liberalization period.

3.4 Cropping Pattern in the Study Area in 2001-02 and 2011-12

The cropping pattern has been followed by the farmers in 2001-02 and 20112 was estimated and the results found that the proportion of the area under the total food crops occupied larger share than non-food crops in the both periods. The share of food crops to the total crop area had increased slightly from 77.5 to 79.8% in 2001-02 to 2011-12, whereas the area under non-food crops lost its land share by 2.5% in the same period. The area under rice found to be declined from 57.03 to 42.83 in 2001-02 to 2011-12. It was noted from the sample respondent that water scarcity and high wage rate for labourers were major reasons for sharp fall of area under rice. The area under maize had a significant rise over a decade. This may be due to a low cost of production, less water requirement and better remunerative price with assured buyback system for poultry and food processing industries. Nearly 19% of the hike in the area under sugarcane was noticed in in 2001-02 to 2011-12 as increased use of machinery for handling intercultural operations. The area under pearl millet, black gram and green gram have shown a declining trend. Normally, these crops grow under rain-fed situation where uneven rainfall is supposed to affect the productivity of pulses and minor millet crops considerably. The typical feature of the cropping pattern is that about two-third of the total cropped area was under food crops (Table 6). Therefore, it is confirmed that area under rice was shifted to sugarcane, maize, cotton and fruit and vegetables significantly.

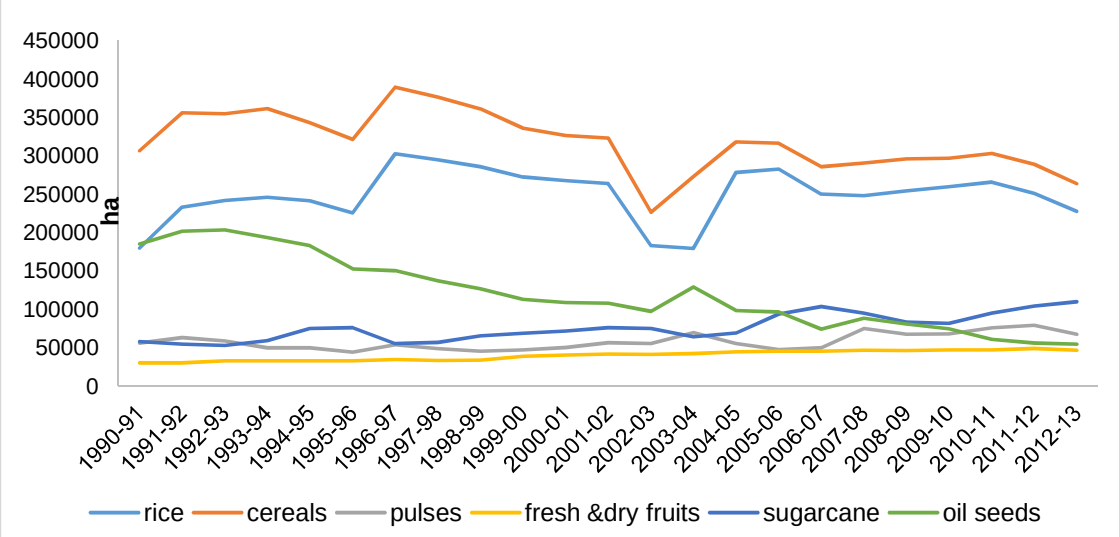

Fig. 2. Trend of area under major crops in Cuddalore district from 1990-2012

Table 2. Summary statistics for land use pattern (ha)

Land classification	Minimum	Maximum	Mean	Standard deviation
Forest	50264	73112	65709	8604
Barren and uncultivable land	48845	161167	109969	36258
Land under non-agricultural uses	95504	194575	138460	32057
Cultivable waste	15874	66784	33599	14467
Permanent pastures and other grazing land	4778	18312	7377	2582
Land under miscellaneous tree crops and groves not included in the net area sown	10034	57806	41882	12666
Current fallows	28372	217873	95130	42803
Fallow land other than current fallows	23289	52677	38070	8459
Net area sown	460697	617211	561254	34682

Table 3. Transitional probability matrix for land use categories in Cuddalore district (1960-61 to 2012-13)

Type of land	Time	FOR	BUL	LNAU	CW	PPOG	LMTC	CF	FLOCW	NSA
FOR	19960-90	**0.982**	0	0	0	0	0	0	0.0175	0
	1991-2012	**0.889**	0.11	0	0	0	0	0	0	0
BUL	19960-90	0	**0.977**	0	0	0.0181	0	0	0.004	0
	1991-2012	0	**0.854**	0.019	0	0.0024	0	0	0	0.123
LNAU	19960-90	0	0	**0.870**	0	0	0	0.13	0	0
	1991-2012	0.008	0	**0.898**	0	0	0	0.0631	0.0299	0
CW	19960-90	0	0	0.047	**0.730**	0.014	0.006	0	0	0.201
	1991-2012	0	0	0	**0.707**	0	0.292	0	0	0
PPOG	19960-90	0	0	0	0	**0.006**	0	0	0	0.993
	1991-2012	0	0.241	0	0.19	**0.0537**	0.514	0	0	0
LMTC	19960-90	0	0	0	0.14	0.026	**0.466**	0	0	0.367
	1991-2012	0	0	0	0	0.0157	**0.294**	0	0	0.69
CF	19960-90	0.002	0	0.109	0	0	0.0001	**0.416**	0.024	0.446
	1991-2012	0.0107	0.0014	0.116	0.0007	0.0048	0	**0.566**	0.0388	0.26
FLOCW	19960-90	0	0.062	0	0	0	0	0	**0.714**	0.223
	1991-2012	0	0	0	0	0.0086	0.022	0	**0.431**	0.537
NSA	19960-90	0.0018	0	0.0105	0.007	0.0076	0.047	0.0374	0.015	**0.872**
	1991-2012	0.009	0.0018	0.007	0.0069	0.0056	0.0175	0.076	0.014	**0.861**

(FOR: Forests; BUL: Barren and uncultivable land; LNAU: Land under non-agricultural uses; CW: Cultivable waste; PPOG: Permanent pastures and other grazing lands; LMTC: Land under miscellaneous tree crops and groves not included in the net area sown; CF: Current fallows; FLOCW: Fallow land other than current fallows; NSA: Net sown area)

Table 4. Summary statistics for crop changes (ha)

Crops	Mean	Standard deviation	Minimum	Maximum
Rice	270737	43009	164463	352796
Peal millet	57225	24452	11067	95359
Other cereals	56514	36623	12721	139832
Total pulse	41038	21421	13846	91629
Spices	6044	2329	964	12559
Sugarcane	47592	28746	7541	110075
Fresh&dry fruits	42542	16012	20390	70410
Groundnut	126173	36687	45036	173652
Other oil seeds	22296	10334	9538	80953
Cotton	7776	4105	1840	17033
Other crops	20677	16282	2682	48799

Table 5. Transitional probability matrix for dynamic changes of crops in Cuddalore district

Crops	Year	Rice	Peal millet	Other cereals	Total pulse	Spices	Sugarcane	Fresh & dry fruits	Ground nut	Other oil seeds	Cotton	Other crops
Rice	1960-90	**0.726**	0.000	0.023	0.0	0.0	0.0	0.0	0.220	0.031	0.0	0.0
	1991-2012	**0.877**	0.000	0.0	0.0	0.004	0.034	0.047	0.0	0.0	0.0	0.038
Peal millet	1960-90	0.0	**0.554**	0.0	0.188	0.0	0.0	0.149	0.0	0.060	0.050	0.000
	1991-2012	0.159	**0.776**	0.0	0.0	0.059	0.0	0.0	0.004	0.0	0.003	0.0
Other cereals	1960-90	0.155	0.0	**0.845**	0.0	0.0	0.0	0.0	0.0	0.0		0.0
	1991-2012	0.0	0.0	**0.647**	0.167	0.0	0.0	0.0	0.0	0.0	0.187	0.0
Total pulse	1960-90	0.0	0.0	0.0	**0.326**	0.0	0.290	0.224	0.000	0.136	0.024	0.0
	1991-2012	0.350	0.0	0.047	**0.503**	0.0	0.0	0.100	0.0	0.0	0.002	0.0
Spices	1960-90	0.0	0.951	0.0	0.0	0.0	0.0	0.049	0.0	0.0		0.0
	1991-2012	0.0	0.0	0.0	0.0	**0.083**	0.0	0.051	0.792	0.074		0.0
Sugarcane	1960-90	0.0	0.114	0.0	0.0	0.0	**0.695**	0.135	0.044	0.0	0.012	0.0
	1991-2012	0.0		0.069	0.199	0.013	**0.696**	0.0	0.0	0.0	0.000	0.015
Fresh &dry fruits	1960-90	0.0	0.495	0.0	0.0	0.185	0.020	**0.089**	0.0	0.188		0.024
	1991-2012	0.0	0.0	0.0	0.0	0.0	0.307	**0.693**	0.0	0.0	0.009	0.0
Ground nut	1960-90	0.433	0.042	0.009	0.0	0.0	0.0	0.059	**0.447**	0.0	0.0	0.010
	1991-2012	0.0	0.078	0.0	0.0	0.0	0.0	0.0	**0.854**	0.067	0.0	0.0
Other oil seeds	1960-90	0.281	0.007	0.005	0.005	0.000	0.038	0.013	0.636	**0.003**	0.0	0.012
	1991-2012	0.032	0.0	0.0	0.0	0.023	0.0	0.012	0.265	**0.639**	0.002	0.028
Cotton	1960-90	0.0	0.0	0.0	0.500	0.068	0.0	0.0	0.0	0.0	**0.432**	0.0
	1991-2012	0.337	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.004	**0.556**	0.102
Other crops	1960-90	0.0	0.032	0.024	0.0	0.005	0.0	0.0	0.430	0.006	0.0	**0.502**
	1991-2012	0.0	0.0	0.0	0.283	0.011	0.0	0.025	0.0	0.0	0.0	**0.680**

Table 6. Decadal change of cropping pattern in Cuddalore district (area in ha)

Particulars	2001-02	2011-12
Food crops	152.20	140.90
	(77.50)	(79.80)
Rice	86.80	60.40
	(57.03)	(42.83)
Maize	3.50	13.80
	(8.96)	(9.82)
Cumbu	13.60	5.90
	(2.28)	(4.17)
Black gram	14.30	8.40
	(9.37)	(5.95)
Green gram	11.40	7.40
	(7.49)	(5.22)
Sugar cane	8.50	26.90
	(5.57)	(19.05)
Fruits and vegetables	6.90	7.60
	(4.55)	(5.39)
Tapioca	5.00	6.40
	(3.31)	(4.56)
Turmeric	2.20	4.30
	(1.44)	(3.02)
Non-food crops	44.20	35.80
	(22.50)	(20.20)
Ground nut	17.60	14.90
	(39.75)	(41.53)
Sesame	15.90	6.60
	(36.06)	(18.40)
Cotton	6.10	10.50
	(13.76)	(29.31)
Other non-food crops	4.60	3.90
	(10.43)	(10.77)
Total food and non-food crops*	196.40	176.70
	(100.00)	(100.00)

(Figures in Parenthesis indicate percentage to total)
**This Classification is based on Season and Crop Report, Tamil Nadu, 2010-11*

4. CONCLUSION

This study focused on changes of land use pattern of which forest land, barren and uncultivable land, land under non-agricultural uses and net sown area accounted higher retention probabilities, but permanent pastures and other grazing lands have lesser retention probabilities in 1960-90 and 1991-2012.Particularly retention capacity for land under non-agricultural uses and current fallow land increased after economic reforms, indicating that non-farming activities may slowly absorb farm lands and in turn, may create a vulnerability to the agriculture and allied sector.

Within available land to the farming sector, there was a dynamic changes of cropping pattern, rice, oil seeds and fruit crops have retained a relatively higher share, compared to other crops. In addition, the area under sugarcane and groundnut retains relatively moderate share in 1960-90 and 1991-2012. This type of cropping pattern supposed to help for adopting alternate crops in an unforeseen season. Results of field survey in 2001 and 2011 revealed that area under rice cultivation were shifted to sugarcane, maize, cotton and fruit and vegetables.This study found that the district has adopted less water intensive crops presently and the same may be maintained to manage existing unforeseen climatic factors. Therefore, there is appropriate policy to be implemented in order to balancing less water intensive crops.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Government of India. Economic Survey 2015-16. Ministry of Finance, New Delhi.
2. Tang Z, Engel BA, Pijanowski BC, Lim KJ. Forecasting land use change and its environmental impact at a watershed scale. J Environ Manag. 2005; 76:35-45.
3. Krishnan P, Swain DK, Chandra, Bhaskar B, Nayak SK, Dash RN. Impact of elevated CO and temperature on rice yield and methods of adaptation as evaluated by crop simulation studies. Agri Ecosys Environ. 2007;122:233–242.
4. Xiong W, Conway D, Lin E, Holman I. Potential impacts of climate change and climate variability on China's rice yield and production. Climate Res. 2009;40:23–35. DOI: 10.3354/cr00802
5. Scoones I, Toulmin C. Soil nutrient balances: What use for policy? Agri. Ecosys. Environ. 1998;71(1):255-67.
6. Paramasivam R, Raj SVaradha, Shanmugam TR, Deshmukh SS, Umanath M. Decadal changes in rice cultivation in Tamil Nadu: Resurvey Approach. Internat. J. Agri. Eco. Stat. 2016;7(1):95-99.

7. Paramasivam R, Paramasivam P, Balasubramanian R. Sustainability analysis of nutrient inflow for soil health management-evidence from Tamil Nadu. Annal. Plant Soil Res. 2015;17:303-306.

8. Lee TC, Judge GG, Takayama T. On estimating the transition probabilities of a Markov process. J Farm Econ. 1965; 47(3):742-762.

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/21021