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RESEARCH ARTICLE

AN ECONOMIC ANALYSIS OF LAND USE DYNAMICS IN PUNJAB

Anup Adhikari, and M K Sekhon*
Department of Economics and Sociology
Punjab Agricultural University, Ludhiana-141004

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****Corresponding Author***

sekhonmk@yahoo.co.in
M K Sekhon

Abstract

Land is a basic input for agriculture and it occupies an important position among all the resources. The present study was conducted to analyze the land use dynamics in Punjab state by using 30 years data from 1980-81 to 2009-10. Secondary data were collected and analyzed using tabular analysis, growth rate, markov chain analysis, and instability index. The compound growth rate analysis of the land use pattern for the entire period showed that, the area under forest has significantly increased at rate of 1.43 per cent per annum, while, area under barren and uncultivable land, and cultural waste have significantly decreased by 4.92 per cent, and 9.07per cent per annum respectively. Dynamics of land use pattern was studied using markov chain analysis, and results showed that all land use categories have shown stability in period I and the highest was in case of forest land. But, during second period the net area showed the highest probability of retention, and fallow land was having the probability of retention zero. The study found Socio economic development plays very important role in bringing change in land use pattern. Population growth, urbanization, and governmental policies are drivers of change in land use pattern in Punjab. The predicted share of different land use categories revealed that the area under forest and fallow land is likely to retain its share in the future while land not available for cultivation is likely to decrease its share in future. The share of other uncultivated land excluding fallow land is likely to increase its share in future while that of net area sown is likely to lose its share in future. The highest instability was observed in respect of miscellaneous tree crops and groves followed by permanent pasture and cultivable waste. The lowest index was noticed in case of net area sown. The study suggested to increase forest area by afforestation in barren and uncultivated land, utilization of barren and culturable land for non agricultural uses and minimization of current fallow land for better utilization of land resources. A suitable land use policy should be adopted for proper management of land to ensure sustainable agricultural growth.

INTRODUCTION:

Agricultural production is mainly dependent on natural resources e.g. land, water, biodiversity (plant, animal and microbial genetic resources), along with air and sunlight. Land is a basic input for agriculture and it occupies an important position among all the resources required for the modern economy (Ramasamy *et al*,2005). Land use pattern includes types of land and how much land is being utilized under different uses for example, the area actually cultivated, forest, fallow land, pasture land and area under settlement and so on. Country like India, where agriculture is major source of food, employment and livelihood for the majority of the people, land is very important natural source and it should be put for right use according to its capacity and according to its type. Fertile land should be used for cultivation purposes and infertile land should be used for non agricultural purposes. The land use

pattern in the area depends upon the physical, environmental, and pressure of population on land. Dynamics of land use is a complex phenomenon which is affected by several socio economic, agro-climatic, and ecological variables. Both climatic and institutional factors are crucial in determining land use pattern. The extent of land use is also influenced by technological changes over a period of time. The technological changes in agricultural ignited intensive cultivation resulting in conversion of marginal lands in to productive agricultural lands through capital intensive cultivation (Gaire, 2010).

At national scenario, a little more than half of total land mass of 328.73 million hectare used for agriculture, which includes 140.02 million hectare net sown area under cultivation and 26.17 million ha for non agricultural uses (GoI, 2013). Over the years there is gradual increase in area under non agricultural uses. Same situation prevails in Punjab also. The total geographical area of the Punjab state is 5036 thousands hectares but according to village paper it is 5033 thousand hectares. Over a period of time there is gradual shift in land use pattern in Punjab state. As a normal process of urbanization, industrialization and economic development occurs, certainly it exerts tremendous pressure on the limited natural resources (Bardhan and Tewari, 2010). So a scientific study of land use pattern is important for the formulation of appropriate land use options and agricultural development policies for balancing natural resources, its sustainability and for food and livelihood security. Hence keeping this view the present study was undertaken to study the temporal change in land use dynamics in Punjab.

The specific objectives of the study are:

- To study the growth in different land use categories
- To study the dynamics of different land use categories.
- To predict the future share of different land use categories, and
- To measure the variability in different land use categories.

. **Data and Methodology:**

Punjab state was selected for the analysis of land use dynamics from 1980-81 to 2009-10. The study was based on the secondary data. Time series data on area under different land use from 1980-81 to 2009-10 were collected from various issue of Statistical Abstract of Punjab, Statistical Abstract of India, various journals and websites; which was further divided in to two periods for analysis; Period-I (1980-81 to 1994-95) and period-II (1995-96 to 2009-10).

Tools of the analysis:

i. Compound growth rate

The growth in area under different land use categories were worked for two sub periods and for the overall period i.e.1980-81 to 1994-95,1995-96 to 2009-10 and 1980-81 to 2009-10 using exponential function.

$$Y = a\, b^t$$

Where,

Y = land use categories, a = Intercept, b = Regression coefficient, and t = Time variable

The compound growth rate was obtained using the logarithmic form of the equation as below:

$$\text{Ln } Y = \text{Ln } a + t \text{ Ln } b$$

The compound growth rate was computed by using the relationship

$$CGR = (\text{Antilog of } (b) - 1 \times 100)$$

ii. Markov chain analysis:

The markov chain analysis is the application of dynamic program to the solution of a stochastic decision process that can be described by a finite number of states. The Markov process was used to study the shift in the shares of land use categories there by gain in understanding about the dynamics of the changes in land use (Dent,1967).

The data for the study were the proportion of area under land use. 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 systemic forces approximate a stochastic process and the propensity of farmers to move from one land use category to another differs according to the land use category involved. If these assumptions are accepted, then the process of land use dynamics may describe in the form of a matrix P of first order transition probabilities. The element Pij of the matrix indicates the probability of a farmer in land use category i in one period will move to land use category j during the following period. The diagonal element Pij measures the probability that the proportion share i th category of land use will be retained.

Estimation of Pij:

The transitional probability matrix was estimated using the Minimum Absolute Deviation (MAD) estimator. The conventional linear programming technique was used, as this satisfies the properties of transitional probabilities of non-negativity restrictions and row sum constraints in estimation. The element Pij 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 element Pij (i =j) indicate the extent of stability of land use categories. The linear programming formulation is stated as

$$\text{Min } O.P^* + Ie$$

Subject to, $XP^* + V = Y$

$$G.P^* = 1$$

$$P^* \geq 0$$

Where,

0 is a vector of zeros
P* is a vector of the probabilities Pij
I is an appropriately demonstrated identity matrix
e is the vector of errors U
Y is the vector of share of land to each category
X is a block diagonal matrix of lagged values of Y
V is the vector of absolute errors
G is a grouping matrix to add the row element of P arranged in P*, to unity

After estimating transition probability matrix (Pij), expected proportion of area under land use categories during period t can be obtained by multiplying the share of each land use categories in previous period (t-1) to transitional probability matrix. Similarly future shares of each land use category can also be estimated.

iii. Analysis of instability:

The formula suggested by Cuddy and Della Valle was used to compute the degree of variation. This method corrects the coefficient of variation, if data are scattered around the negative or positive trend line. The Cuddy-Della Valle Index is given follows.

$$I = CV *(1-R^2)^{0.5}$$

Where, CV is coefficient of variation defined as the ratio of sample standard deviation to its mean and R^2 is the corrected coefficient of determination of the trend function that best fits the time series. If the F-test is significant at 5% level of significance, then the Index is calculating by selecting the trend function(linear or log linear) having highest R^2.When a) test statistics is not significant or b) $R^2 < 0$,the unmodified CV is chosen. In this paper both linear and log linear trend line were fitted.

Result and Discussion:

Land use pattern in Punjab

In the view of increasing pressure of population on land and growing demand of food and other materials, the pattern of land utilization has acquired a special significance, because, with the increase in population, area under cultural uses also increases and consequently it will lead to decline in cultivated area. Thus, increase in agricultural production will mainly come from enhancement in farm productivity with optimal use of land resource. The land use pattern in Punjab has been presented in Table 1.Three points of time were taken for analysis of share of land use pattern i.e.1980-81, 1994-95 and 2009-10. The area under forest had increased from 4.29 per cent in 1980-81 to 5.86 per cent in 2009-10. The reason for increase in forest area were favorable topography in some district like Gurdashpur, Hoshiarpur, SAS Nagar, Patiala, Jalandhar which are lying in hills and foot hills for forestry and government policies to avoid soil erosion caused by seasonal streams. The barren and uncultivated land has declined from 1.91 in 1980-81 to 0.5 per cent in 2009-10 because farmer had leveled the land and taken under cultivation. There has been an increase in putting land in to non agricultural uses to accommodate developmental activities like industries, housing, transport, irrigation etc. The land put to non agricultural uses had jumped from 8.66 per cent in 1980-81 to 9.99 per cent in 2009-10. It is evident from the Table1, that the share of culturable waste had decline to 0.04 per cent in 2009-10 from 0.81 per cent in 1980-81. During the time period most of land put under cultivation

with the innovation of farm technique and reclamation of water logged area that made more area under net sown. Similarly, industrial development, urban centers and settlements also reduced the culturable waste but increase in land put to non agricultural uses was noticed. Over the years there is no change in area under permanent pasture and other grazing lands. Likewise, area under miscellaneous tree crops and groves found increase from 0.08 per cent in 1980-81 to 0.1 in 2009-10. But the area under current fallows was declined from 0.89 per cent to 0.74 per cent during the same period of time. During the period of time, government has taken progressive action to make highest utilization of land under farming. Government has introduced many incentives for the farmer such as agricultural loan at very low interest rate, provides High Yielding Varieties of seeds at subsidized rate etc. Reclamation of land and use of agricultural equipments etc brought current fallows land under crops. Net area sown first increased to 83.65 per cent in 1994-95 from 83.27 per cent in 1980-81 but reduced to 82.61 per cent in 2009-10. During the last three decades there is gradual shifting of land use pattern in Punjab state, at the same time government has taken various judicious measure for better use of land.

Growth rates in area in different land use categories:

With the increasing population, the demand for non agricultural land for settlement and food grain requirement also increases. The only prospect of increase food grains and meeting the need of food lie in expansion of cultivated area, reduction of fallow, increase in net sown area and enhancing productivity. Therefore, Various factors such as population growth, urbanization, infrastructure development, demand of land for settlement purpose, demand for food grains are responsible for change in land use pattern. From 1980-81 to 2009-10 land use pattern of Punjab state has changed significantly. The growth rate in the area under different categories of land use over the period of 30 years (from 1980-81 to 2009-10) were analysed using the compound growth rate and is presented in Table 2.

Table 1: Share of different land use categories to total reported area in Punjab ('000'hectare)

S.N.	Particulars	1980-81	1994-95	2009-10
1	Total Reported Area	5033 (100.00)	5033 (100.00)	5033 (100.00)
2	Area Under Forest	216 (4.29)	291 (5.78)	295 (5.86)
3	Barren and Uncultivable land	96 (1.91)	26 (0.51)	25 (0.50)
4	Land put to non agriculture uses	436 (8.66)	458 (9.10)	503 (9.99)
5	Culturable waste	41 (0.81)	6 (0.12)	2 (0.04)
6	Permanent pasture and other grazing lands	4 (0.08)	3 (0.06)	4 (0.08)
7	Miscellaneous tree crops and groves not included in net area sown	4 (0.08)	2 (0.04)	5 (0.1)
8	Current fallow	45 (0.89)	55 (1.09)	37 (0.74)

9	Fallow land other than current fallows	@	2 (0.04)	4 (0.08)
10	Net area sown	4191 (83.27)	4210 (83.65)	4158 (82.61)

Note: Figures in parenthesis indicate percentage to total reported area, @: Area below 500 hectares
Source: Statistical abstract of Punjab

During the period I, the area under forest has increased at the rate of 1.88 per cent per annum. The increase in area was due to the topography suitable for forestry in the districts like Hoshiarpur, Gurda shpur, SAS Nagar, Patiala, Jalandhar etc and governmental policies also encouraged the farmers for the plantation of tree to avoid the soil erosion caused by seasonal streams in these areas. But, during period II the area under forest has increased only by 0.08 per cent per annum. The area under barren and uncultivable land is decreased by 3.73 per cent per annum during the first period and by 9.06 per cent per annum during second period. Due to rough and hilly topography in some districts of the state, most of the land is put under tree plantation and farmers leveled the land and put under net sown area which were the main reason for decreasing growth rate of barren and uncultivated land during the both periods. As the population increases, the demand of land for settlement and other infrastructure development also increases. The land put to non agricultural uses has showed increasing trend at the rate of 2.92 per cent per annum during the second period. The area under culturable waste has declined by 7.94 per cent per annum during first period and 17.32 per cent per annum during the second period. The rate of decline was higher during the second period than first period. The negative growth rate during both the period was because of the fact that most of land put under cultivation with the innovation of farm technique in early period. Also, reclamation of water logging area are responsible for bring more area under cultivation there by decline the share of culturable waste. Similarly, permanent pasture and other grazing lands, and land under miscellaneous tree crops and groves have declined at the rate of 3.66 per cent and 5.46 per cent per annum during the second period. Current fallow showed the increase at rate of 5.52 per cent per annum during the first period. This is due to the fact, that most of land were left as fallow for industrial development and water logging problem was the major problem in reclamation of land during the first period which lead to positive growth of current fallow. But during the second period a decreasing growth rate is observed at 3.21 per cent per annum mainly due to the progressive action taken by the government to make the highest utilization of land under farming. Net area sown was declined by 0.005 per cent per annum during the first period and 0.078 per cent during second period.

The analysis of the land use pattern for the entire period showed that the area under forest has increased at rate of 1.43 per cent per annum. The area under barren and uncultivable land has declined by 4.92 per cent while land put to non agriculture uses increased by 0.16 per cent annually. Land under permanent pasture and other grazing land, and culturable wastes decreased by 0.17 and 9.07 per cent per annum respectively but that of miscellaneous tree crops and groves is increased by 0.34. Current fallow showed the decline at the rate of 1.29 and net area showed increase at rate of 0.002.Only growth rate of forest, barren and uncultivable land and cultural waste were significant at 1 per cent level of significance. Berdhan and Tewari (2010) also found non significant growth rate in case of permanent pasture and grazing land, miscellaneous trees and groves, cultural waste, other fallow and net sown area while that of forest area was increased at the rate of 0.55 per cent per annum and barren and uncultivable land and current fallow were decreased by 7.55 per cent and 13.14 per cent per annum simultaneously. The results also revealed that area under forest is increasing it may due to favorable impacts of afforestationa and policy related forest. Increasing population, urbanization and industrialization may cause shift of barren and uncultivable to non agricultural uses. The declined in cultural waste was due to land reclamation for agricultural use.

Dynamics of land use pattern

The Markov chain analysis was carried out for two periods to analyse the shift in land use pattern in Punjab .The stability of the area share of the different land use categories and the direction and the volume of change over time is captured by transitional probability matrix and the result are presented in Table 3 and Table 4.

It can be inferred from the Table 3 that during the period –I all land use categories have shown stability. But the highest stability was acquired by forest land as reflected in high probability of retention at 1.000 i.e. the probability that forest land retains its share from one period to another period is 100 per cent. Similar interpretation could be made for land not available for cultivation, other uncultivated land excluding fallow land, fallow land and net area sown with probability of retention of 0.635, 0.521, 0.659 and 0.954. The major gainer among the different land use categories during period I was net area sown which was having a transfer probability of 0.325 from land not

available for cultivation, 0.229 from other uncultivated land excluding fallow land and 0.340 from fallow land and showed highest probability of retention i.e.0.951during the second period as illustrated in Table 4.

Table 2: Compound growth rates of various land uses categories in Punjab

S.N.	Land use categories	Area in period I 1980-81 to1994-95)	Area in period II 1995-96 to 2009-10	Overall period 1980-81 to 2009-10
1	Area Under Forest	1.88*** (3.69)	0.08 (0.37)	1.43*** (8.63)
2	Barren and Uncultivated land	-3.73** (2.52)	-9.06*** (5.93)	-4.92*** (8.15)
3	Land put to non agriculture uses	-0.99* (2.07)	2.92*** (7.56)	0.16 (0.65)
4	Cultural waste	-7.94*** (3.37)	-17.32*** (8.05)	-9.07*** (8.99)
5	Permanent pasture and other grazing ands	2.71 (1.27)	-3.66** (2.16)	-0.17 (0.24)
6	Miscellaneous tree crops and groves not	-0.69 (0.19)	-5.46*** (3.11)	0.34 (0.31)
7	Current fallow	5.52*** (3.83)	-3.21 (1.40)	-1.29 (1.60)
8	Net area sown	-0.005 (0.17)	-0.078 (1.56)	0.0021 (0.13)

Note: '***','**' and '*' significant at 1, 5 and 10 per cent level of significance
Figure in parentheses represents the respective t-values.
Source: Author's calculation based on data provided by Statistical Abstracts of Punjab

The forest land ,land not available for cultivation and other uncultivated land excluding fallow land showed the probability of retention of 0.299, 0.662 and 0.630 .On the contrary fallow land was having the probability of retention of zero indicating that share of fallow land is unstable which means it could not retained its share during the period. Fallow land is likely to lose its 0.849 share to net area sown and 0.140 share to forest land. The action taken by the government to make highest utilization of land under farming was the main reason of losing share of fallow land to net sown area. Similarly, afforestation program also helped to gain 0.299 share to forest land from fallow land. Land not available for cultivation is likely to gain 0.557 share from forest land. Due to increase demand of land for settlement, industrial purpose and infrastructure development the area under forest is losing its share to land not available for cultivation.

Projected share of different land use categories

The share of different land use categories were predicted for the next five years (2010-11 to 2014-15) using transitional probabilities and results are presented in Table 5. The results revealed that the area under forest, and fallow land is likely to retain its share in the future, while land not available for cultivation is likely to decrease its share in future. The share of other uncultivated land excluding fallow land, and net area sown is likely to increase its share in future.

Table 3: Transitional probability matrix for land use categories in Punjab for Period-I(1980-81 to 1994-95)

Land use categories	Forest	Land not available for cultivation	Other uncultivated land excluding fallow land	Fallow land	Net area sown

Forest	**1.000**	0.000	0.000	0.000	0.000
Land not available for cultivation	0.000	**0.635**	0.040	0.000	0.325
Other uncultivated land excluding fallow	0.000	0.000	**0.521**	0.248	0.229
Fallow land	0.000	0.000	0.000	**0.659**	0.340
Net area sown	0.000	0.044	0.000	0.000	**0.954**

Table 4: Transitional Probability matrix for land use categories in Punjab for period –II (1995-96 to 2009-10)

Land use categories	Forest	Land not available for cultivation	Other uncultivated land excluding fallow land	Fallow land	Net sown area
Forest	**0.299**	0.557	0.020	0.122	0.000
Land not available for cultivation	0.000	**0.662**	0.000	0.009	0.328
Other uncultivated land excluding fallow land	0.000	0.000	**0.630**	0.000	0.369
Fallow land	0.140	0.000	0.010	**0.000**	0.849
Net area sown	0.048	0.000	0.000	0.000	**0.951**

Table 5: Projected share of land use categories in Punjab

Categories Years	Forest	Land not available for cultivation	Other uncultivated excluding fallow land	Fallow land	Net area sown
2010-11	5.83	10.20	0.26	0.80	82.84
2011-12	5.83	10.00	0.29	0.80	82.99
2012-13	5.84	9.87	0.30	0.80	83.05
2013-14	5.85	9.79	0.31	0.80	83.09
2014-15	5.85	9.73	0.32	0.80	83.09

Table 6 and Table 7 indicate actual and estimated proportion of the land use categories in Punjab state. A comparison of these proportion reveals, that the actual and estimated proportion are almost same implying that the model was reasonably efficient and the structural changes captured in the land use pattern are fairly accurate. However, there are some differences in few years which are mainly due to limitation of the model that the present estimate depends only on the previous year observation.

Table 6: Actual and estimated proportion of land use categories in Punjab for period I(1980-81 to 1994-95)

(Per cent)

Years	Forest	Land not available for cultivation	Other cultivated land excluding fallow land	Fallow land	Net area sown

	A	E	A	E	A	E	A	E	A	E
1980-81	4.29	-	10.57	-	0.97	-	0.89	-	83.27	-
1981-82	4.23	4.29	10.51	10.36	0.89	0.93	0.71	0.89	83.64	83.43
1982-83	4.31	4.23	10.53	10.34	0.89	0.88	0.77	0.76	83.48	83.69
1983-84	4.41	4.31	10.41	10.34	0.83	0.88	0.65	0.80	83.68	83.57
1984-85	4.39	4.41	10.31	10.28	0.97	0.85	1.09	0.70	83.23	83.66
1985-86	4.39	4.39	10.27	10.19	0.93	0.91	1.01	1.02	83.38	83.38
1986-87	4.37	4.39	10.31	10.18	0.87	0.89	0.95	0.96	83.48	83.48
1987-88	4.45	4.37	10.43	10.21	0.97	0.86	1.54	0.91	82.59	83.55
1988-89	4.41	4.45	10.09	10.24	0.93	0.92	1.01	1.32	83.54	82.96
1989-90	4.56	4.41	9.87	10.07	0.99	0.89	1.25	0.96	83.31	83.57
1990-91	4.41	4.56	8.46	9.92	1.13	0.91	2.18	1.13	83.80	83.37
1991-92	4.17	4.41	9.02	9.05	0.93	0.92	2.12	1.78	83.74	83.73
1992-93	5.70	4.17	9.69	9.40	0.65	0.84	1.70	1.70	82.23	83.79
1993-94	5.76	5.70	8.62	9.76	0.39	0.72	1.49	1.35	83.72	82.36
1994-95	5.78	5.76	9.61	9.15	0.21	0.55	1.13	1.14	83.64	83.30
1995-96	-	5.78	-	9.77	-	0.49	-	0.86	-	83.39

Note: A: Actual, and E: Estimated

Instability of land use pattern

Instability index is a measure of extent of variability or the absence of stability in time series data and hence, the instability indices for various land use categories were worked out for 30 years (1980-81 to 2009-10) and presented in Table 8.

Table 7:Actual and Estimated proportion of land use categories in Punjab for period – II(1994-95 to 2009-10)

Years	Forest		Land not available for cultivation		Other cultivated land excluding fallow land		Fallow land		Net area sown	
	A	E	A	E	A	E	A	E	A	E
1995-96	5.76	5.78	9.67	9.77	0.83	0.49	1.49	0.86	82.23	83.39
1996-97	5.72	5.87	7.94	9.61	0.67	0.65	1.76	0.79	83.90	83.02
1997-98	6.06	5.98	7.82	8.44	0.91	0.55	0.97	0.76	84.22	84.20
1998-99	6.06	5.99	7.57	8.55	0.81	0.70	0.81	0.80	84.72	83.89
1999-00	5.56	5.99	9.37	8.38	0.63	0.64	0.75	0.80	83.66	84.11
2000-01	5.56	5.78	8.70	9.30	0.43	0.51	0.85	0.76	84.44	83.58
2001-02	6.07	5.83	8.62	8.85	0.25	0.39	0.51	0.75	84.52	84.11
2002-03	5.44	5.94	9.09	9.09	0.33	0.28	1.64	0.81	83.46	83.81
2003-04	6.11	5.86	8.96	9.05	0.33	0.33	0.31	0.74	84.26	83.95
2004-05	5.94	5.91	9.59	9.34	0.33	0.33	0.67	0.82	83.44	83.53
2005-06	5.96	5.87	9.53	9.66	0.35	0.33	0.85	0.81	83.29	83.27
2006-07	5.92	5.89	10.01	9.63	0.21	0.35	0.71	0.81	83.13	83.26
2007-08	5.70	5.86	10.07	9.92	0.19	0.26	0.83	0.81	83.19	83.09
2008-09	5.88	5.81	10.27	9.84	0.19	0.24	0.77	0.78	82.87	83.26
2009-10	5.86	5.84	10.49	10.07	0.21	0.25	0.81	0.81	82.61	82.97

2010-11	-	5.83	-	10.20	-	0.26	-	0.81	-	82.84

Note: A: Actual, and E: Estimated

Table 8 indicates that during the first period area under miscellaneous tree crops and groves registered the highest instability with instability index 54.94 per cent and lowest instability achieved in net area sown with instability index 0.51 per cent. Similarly, during the second period the highest instability was recorded by area under current fallow and lowest instability by area under net area sown with the instability index 42.00 per cent and 0.88 per cent respectively. For the entire period the highest instability was observed in respect of miscellaneous tree crops and groves with instability index 50.00 per cent. The lowest index was noticed in case of net area sown which was only 0.72 per cent. During the entire period (1980-81 to 2009-10) the study experienced year to year variation under the different land use pattern. Socio economic development played very important role in bringing the change in land use pattern. Thus highest instability was due to more year to year variation in area of miscellaneous tree crops and less instability was due to less year to year variation in area of net area sown.

Table 8: Instability Index of different land use categories in Punjab

(Per cent)

Land use categories	Period-I(1980-81 to 1994-95)	Period –II(1995-96 to 2009-10)	Overall period 1980-81 to 2009-10)
Forest	8.87	3.41	7.47
Barren and Uncultivable land	16.78	31.01	24.95
Land put to non agriculture use	8.42	5.67	11.21
Permanent pasture and other grazing land	43.47	27.09	36.26
Culturable land	23.52	38.50	30.9
Miscellaneous tree crops and groves	54.94	36.2	50.00
Current fallow	22.52	42.00	38.1
Net area sown	0.51	0.88	0.72

CONCLUSION AND POLICY IMPLICATIONS

Land is very important natural resource, and should be put for right use according to its capacity, and according to its type. The compound growth rate analysis of land use pattern exhibited, that area under forest has significantly increased over a period of time, which may due to governmental policies for the plantation of trees, and shifting of barren land to forest land. Barren and uncultivable land, and cultural waste showed significant declining pattern. Dynamics of land use pattern was studied by markov chain analysis showed that all land use categories have shown stability in period I and the highest is in case of forest land. But during second period the net area showed the highest probability of retention and fallow land was having the probability of retention zero which meant by it could not retained its share during the period. The share of different land use categories were predicted for next five years using transitional probability matrix. The result revealed that the area under forest and fallow land is likely to retain its share in the future while land not available for cultivation is likely to decrease its share in future. The share of other uncultivated land excluding fallow land is likely to increase its share in future while that of net area sown is likely to lose its share in future. The highest instability was observed in respect of miscellaneous tree crops and groves followed by permanent pasture and cultivable waste. The lowest index was noticed in case of net area sown during overall period of time.

The area under forest covers only 5.86 per cent of the total geographical area in Punjab state which is far below than the minimum suggested level of at least one third of the geographical area. About 0.49 per cent area in

the state is under the barren and uncultivated which may be use for afforestation programme. So efforts to be made to implement afforestation program and protect available forest land from deforestation. Similarly there is a great scope for expansion of further area under cultivation by diverting culturable wastes and fallow other than current fallow. With the increasing pressure of population, the only prospect of increasing food grain production and meeting the needs of food lie in expansion of cultivated area, reduction of fallow land and increase in net sown area and enhancing per unit yield of crops. This may help in achieving food security of the country. The area under non agricultural use has been increasing over the years. This certainty puts pressure on the size of the culturable land. So efforts to be made to utilize barren and culturable land for non agricultural uses. There are some area under current fallow due to non availability of irrigation facility or variation in rainfall pattern and its disturbance which can be minimize and stabilized for better utilization of land resources. To sum up, for proper management of land resource and to ensure sustainable agricultural growth in country, there is need for a land use policy.

Note

Forest Land: Area under forest includes all lands classified as forests under any legal enactment dealing with forest or administered as forest, state-owned or private and whether wooded or maintained as potential forest land.

Land Under non-agricultural uses: This stands for all lands occupied by building, roads and railways or under water other than agriculture.

Land not available for cultivation: It includes barren and uncultivated land, land like mountains ,deserts or land covered by building, road railways etc.

Barren and un culturable lands: This covers all barren and uncultivable land like mountains, deserts and similar type of land or land which cannot be brought under cultivation unless at a high cost is classified as cultivable, whether such land is in isolated blocks or within cultivated holdings.

Permanent pastures and other grazing lands: These cover all grazing lands, whether they are permanent pasture and meadows or not ; village common grazing lands included under this head.

Culturable waste: This includes lands available for cultivation, whether not taken up for cultivation or taken up for cultivation once but not cultivated during the current year and the last five years or more in succession for one reason or other. Such lands may be either fallow or covered with shrubs and jungles which are not put to any use. They may be assessed or unassessed and may lie in isolated blocks or within cultivated holdings. Land once cultivated but not cultivated for five years in succession is also included in this category at the end of the five years.

Land under miscellaneous tree crops and groves not included in the net area sown: This category included all cultivable land which is not included under "Net area sown", but which is put to some agricultural use.

Current fallows: This class comprises cultivated areas, which are kept fallow during the current year. If any seedling area is not cropped again in the same year, it may be treated as current fallow.

Fallows land other than current fallow: These include all lands, which were not taken up for cultivation for a period not less than one year.

Net area sown: It is the net area sown under crops.

Reference

Bardhan, D. and Tewari, S. K. (2010). An investigation in to land use dynamics in India and land under-utilization. Indian Journal of Agricultural Economics **65**(4):658-676

Dent, W.T.(1967). Application of markov analysis to international Wool flows. Review of Economics and Statistics. **49**(2):613-616

Gaire, S.(2011). Land use dynamics in Karnataka-An economic analysis, MSc.(Agri Econ) Thesis, submitted to University of Agricultural Science,Dharwad, Karnataka (India).

GoI(2013). State of Indian Agriculture 2012-13. Ministry of Agriculture, New Delhi. India

Government of Punjab (various issues). Statistical Abstract of Punjab, Economics and Statistical Organisation, Chandigarh,Punjab.

Gupta, S. and Sharma, R. K. (2010). Dynamics of land utilization, land degradation and factors determining land degradation in Himanchal Predesh. Indian Journal of Agricultural Economics **65**(2):245-259

Ramasamy,C., Balasubramanian, R. and Sivakumar, D. (2005). Dynamics of land use pattern with special reference to fallow lands-An empirical investigation in Tamil Nadu. Indian Journal of Agricultural Economics **60** (4): 629-644.

Singh,J.,Grover,D.K., and Dhaliwal, T.K.(2012). State agricultural profile-Punjab, AERC study No.30,Department of Economics and Sociology ,PAU, Ludhiana.