AN ECONOMIC ANALYSIS OF CROP DIVERSIFICATION AND DYNAMICS OF CHANGES IN THE CROPPING PATTERN IN VILLUPURAM DISTRICT OF TAMIL NADU

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ABSTRACT *A society faced with diminishing natural resources and every increasing demand for food consumption and food security due to increase in population growth, agricultural intensification is the only course of action for future growth of agriculture. Agricultural intensification can be achieved by changes in cropping pattern or crop diversification. It is certainly an important component of the overall strategy for small farm development. Given the importance of changing scenarios in cropping pattern, this study was undertaken to analyse the dynamic changes in the cropping pattern and to examine the extent of crop diversification over the years in the study area. This study has been confined to Villupuram district of Tamil Nadu. The major crop categories namely cereals, millets, pulses, oil seeds, vegetables and fruits, sugar and tapioca were selected. The study was completely based on secondary data and the area under major crops in Villupuram district for the last 20 years i.e. from 1994-95 to 2013-14 has been collected from the Government of Tamil Nadu publications. It is concluded from the study that the compound growth rate of area under major crops like cereals and millets were negative whereas it was positive for pulses, oilseeds, vegetables and fruits, sugar, tapioca. Hence, it could be concluded that the probability of retention for cereals and sugar were the highest among the various crop categories. Based on the crop diversification index value, it is clear that there is less crop intensification in the district over the year.*

Keywords: *Cropping Pattern, Growth Rate, Crop Diversification, Villupuram*

INTRODUCTION

Agriculture is the mainstay of the Indian economy. Agriculture fosters economic growth and development, acts as sources of raw material to industries, ensures food and nutritional security, earns foreign exchange, increases the per capita income of the farmers, increases the employment opportunities, improves the national income, and alleviates poverty. More than
70 per cent of India's population live in rural areas, where in the main occupation is agriculture. Indian agriculture is characterized by small farm holdings and the average farm size is only
1.57 hectares. Around 93 per cent of farmers have land holdings smaller than four hactares and they cultivate nearly 55 per cent of the arable land (Kalaiselvi, 2012).

A society faced with diminishing natural resources and every increasing demand for food consumption and food security due to increase in population growth, agricultural intensification is the only course of action for future growth of agriculture. Agricultural intensification can be achieved by changes in cropping pattern or crop diversification. It is certainly an important component of the overall strategy for small farm development (Kalaiselvi, 2012).

Agricultural diversification really started in the early eighties in India and it has picked up momentum over the recent past and farmers were always quick to diversify into higher value crops as market opportunities developed. To improve the income, to provide gainful employment and to stabilize the income flow, diversification of crops emerges as a major strategy. In several instances, cropping systems have been diversified or new cropping systems have been introduced to retain or to enhance the value of natural resources principally land and water. There is also the claim that diversification tends to stabilize farm income at a higher level. This happens when the pattern of diversification is such as to accommodate more and more rewarding crops. This is particularly important for the small farmers who strive to make their farms viable.

Cropping pattern in a state, keep on changing from time to time with the change in related factors. It is determined mainly by physical, socio-cultural and historic factors besides technological factors have also played an important role. Tamil Nadu, one of the important agrarian states in India has attained rapid rate of growth in the agricultural sector. It is one among 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. But the state has witnessed deceleration from 1990's onwards since the growth in agriculture faced major constraints such as growing water scarcity, urbanization, land degradation, declining farm sizes, rise in cost of labour and transition from traditional crops to commercial crops. Given the importance of changing scenarios in cropping pattern, this study was undertaken to analyse the dynamic changes in the cropping pattern and to examine the extent of crop diversification over the years in the study area.

MATERIALS AND METHODS

This study has been confined to Villupuram district of Tamil Nadu. The major crop categories namely cereals, millets, pulses, oil seeds, vegetables and fruits, sugar and tapioca were selected. The study was completely based on secondary data and the area under major crops in Villupuram district for the last 20 years i.e. from 1994-95 to 2013-14 has been collected from the Government of Tamil Nadu publications.

TOOLS OF ANALYSIS

Growth Rate Analysis

Compound growth rates of area under major crops were estimated to capture the changes in the cropping pattern in the district. The major crops considered for the analysis were cereals, millets, pulses, oil seeds, vegetables and fruits, sugar and tapioca. Exponential function of following form was used to estimate the growth rate for the area under major crops (Gujarati 2012).

$$Y_t = Y_o (1+r)^t \quad \text{———} \quad (1)$$

Where,

Y_t - Area under the crop at time t (ha)

r - Compound rate of growth of Y

Y_o - Initial year area under the crop (ha)

By taking natural logarithm of (1),

$$\ln Y_t = \ln Yo + t \ln (1+r) \quad \text{———} \quad (2)$$

Now letting

$$\beta_1 = \ln Y_o$$

$$\beta_2 = \ln (1+r)$$

Equation (2) can be written as

$$\ln Y_t = \beta_1 + \beta_2 t \quad \text{———} \quad (3)$$

Adding the disturbance term to (3), it can be written as

$$\ln Y_t = \beta_1 + \beta_2 t + U_i$$

Y_t = Area under crop at time't' (ha)

t = time in years

β_1 = constant term

β_2 = regression co-efficient

This log linear function was fitted by using ordinary least square (OLS) method. The compound growth rate (r) was obtained using the formula.

$$r = (\text{Antilog } \beta_2 - 1) \times 100$$

Markov Chain Analysis

In this study direction of changes in the cropping pattern has been examined by using the Markov chain approach. Markov chain models are concerned with the problems of movement, both in terms of movement from one location to another and in terms of movement from one "state" to another. These models are used for describing and analyzing the nature of changes generated by the movement of such variables, in some cases these models may also be used to forecast future changes.

The direction of changes in the cropping pattern was worked out assuming that it follows a first order Markov chain, as explained below.

A first order Markov chain is characterized by the transition probability matrix, given by expression (1):

$$P = \begin{pmatrix} p_{11} & p_{12} \cdots & p_{1n} \\ p_{21} & p_{22} \ldots & p_{2n} \\ \cdots & \cdots & \cdots \\ p_{n1} & p_{n2} \ldots & p_{nn} \end{pmatrix} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where, P_{ij} is the probability that an item under the classification T during the current year changes into the classification 'j' next year and 'n' is the number of crops. That is,

$$P_{ij} = \Pr\{X_{(t+1)} = jX_{(t)} = i\} \quad \text{..... (2)}$$

Where, $X_{(t)}$ = State of the system at the year't'. It is clear that
$P_{ij} \geq 0$, i, j= 1, 2...n and

$$\sum_{j=1}^{j=n} P_{ij} = 1, \quad i = 1,2, \ldots . n \quad \text{..... (3)}$$

The estimation of the transitional probability matrix ***(P)*** was central to this analysis. The element $\boldsymbol{P_{ij}}$ of the matrix indicated the probability that the item would switch from the ith classification to j^{th} classification over a period of time. The diagonal elements P_{ij} indicated the probability that the share of particular item would be retained in the successive time periods.

Herfindahl Index

Herfindahl index was used to study the extent of diversification in the state. Herfindahl index is defined as:

$$HI = \sum_{i=1}^{n} P_i^2$$

Pi = Proportion of area under i^{th} crop

$Pi = Ai / \sum A_i$

In which Ai = Area under i^{th} crop and $\sum_{i=1}^{n} A_i$ = Total cropped area

The value of HI index varies between zero to one. It is one in case of perfect specialization and zero in case of perfect diversification.

RESULTS AND DISCUSSION

Growth rate of area under major crops in Villupuram district

Area under major crops in Villupuram district were collected for the period from 1994-95 to 2013-14 and compound growth rate of these crops were worked out using exponential growth model. The results are presented in Table 1.

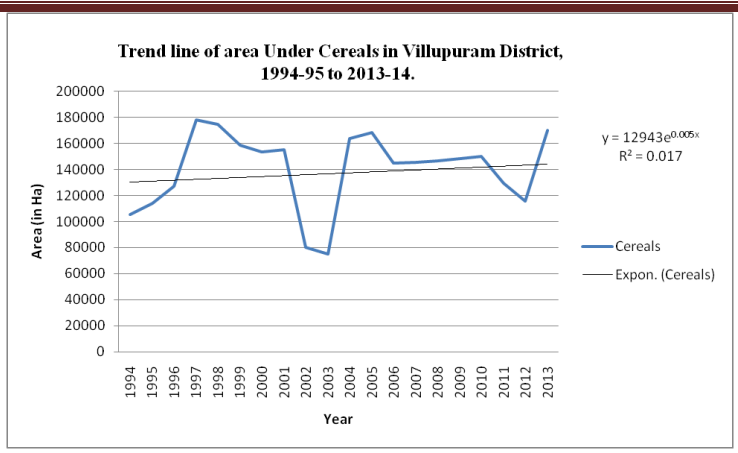
Table 1. The compound growth rate of area under major crops in Villupuram district, 1994-95 to 2013-14.

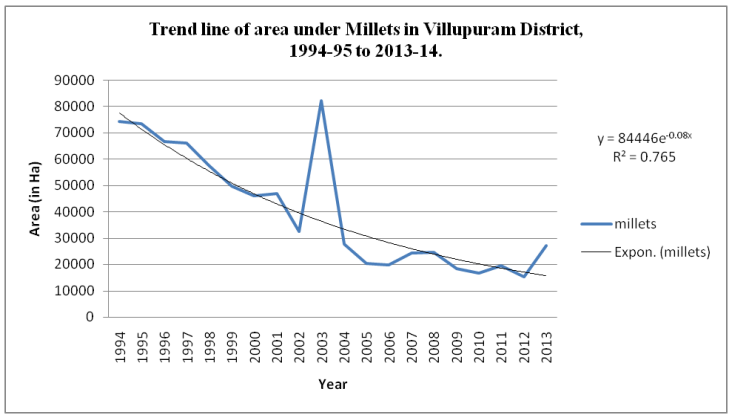
(in Ha)

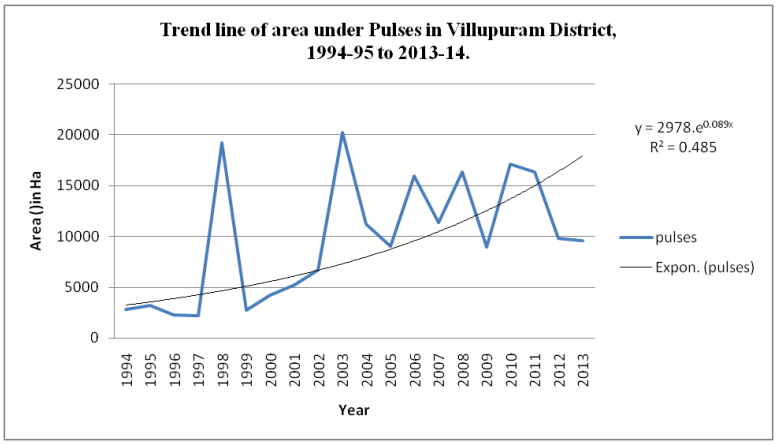
S.No	Major Crops	1994-95 to 2003-04	2004-05 to 2013-14	Over All 1994-05 to 2013-14
1.	Cereals	-2.95	0.10	-0.49
2.	Millets	0.01	7.25***	-7.68***
3.	Pulses	10.29***	-3.92**	9.30***
4.	Oil Seeds	1.81	-16.47***	56.67
5.	Vegetables and Fruits	7.57***	-2.95	4.18**
6.	Sugar	4.28**	10.40***	4.60**
7.	Tapioca	-2.95	2.12	1.51

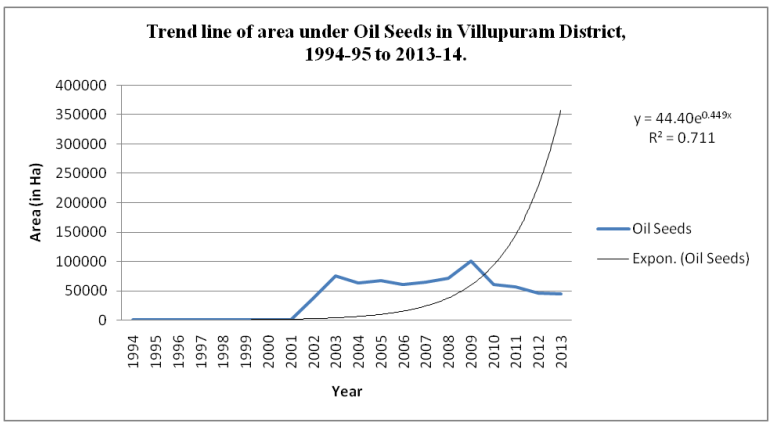
** and *** indicate significance of values P =5 per cent and 1 per cent, respectively.

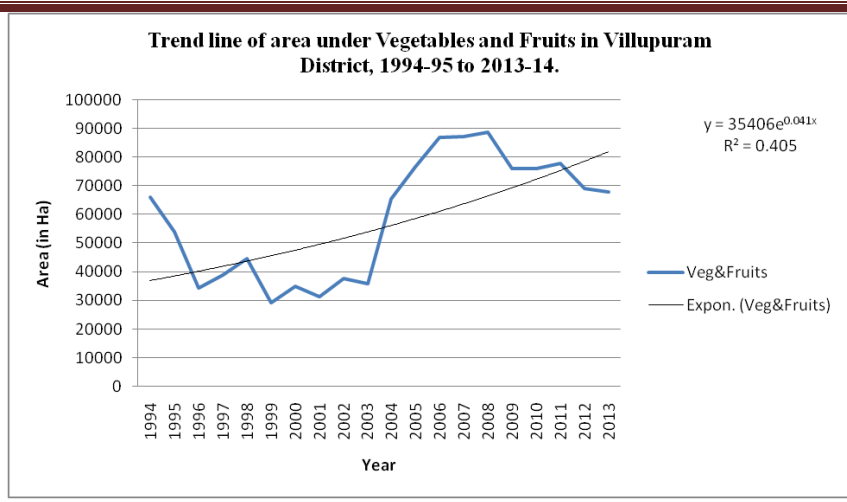
It could be seen from table that the compound growth rate of area under Oilseeds (56.67), Pulses (9.30), Sugar (4.60), Vegetables and Fruits (4.18) and Tapioca (1.51) were found to be positive, while the area under Cereals (-0.49) and Millets (-7.68) had negative growth rate. The compound growth rate was the highest for oilseeds at 56.67 per cent followed by pulses at 9.30 per cent. The results would clearly indicate the shift in the cropping pattern towards the high remunerative crops like oilseeds, pulses, sugarcane etc. the trend line are shown in the figures.

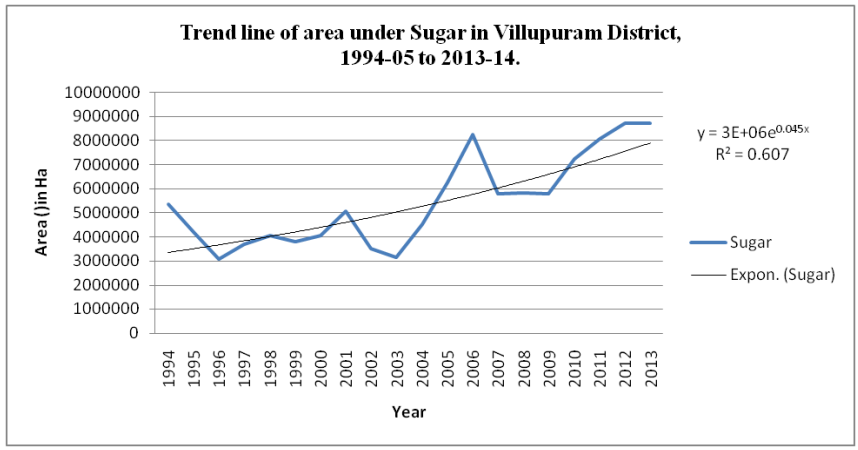

Trend line of area Under Cereals in Villupuram District, 1994-95 to 2013-14.
Area (in Ha)
Year
y = 12943e^0.005x
R² = 0.017
Cereals
Expon. (Cereals)

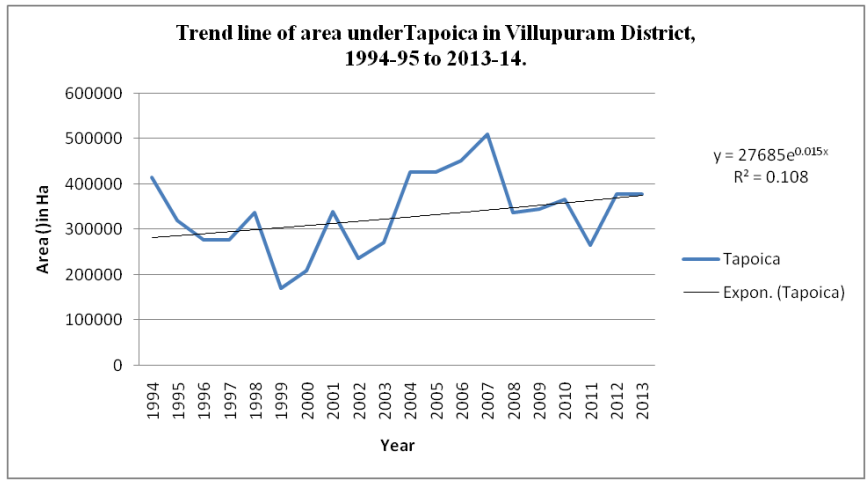

Trend line of area under Millets in Villupuram District, 1994-95 to 2013-14.
Area (in Ha)
Year
y = 84446e^-0.08x
R² = 0.765
millets
Expon. (millets)


Trend line of area under Pulses in Villupuram District, 1994-95 to 2013-14.
Area (in Ha
Year
y = 2978.e^0.089x
R² = 0.485
pulses
Expon. (pulses)


Trend line of area under Oil Seeds in Villupuram District, 1994-95 to 2013-14.
Area (in Ha)
Year
y = 44.40e^0.449x
R² = 0.711
Oil Seeds
Expon. (Oil Seeds)







Dynamic Changes of Major Crops in Villupuram District

Markov chain analysis was used to study the direction of changes in cropping pattern by estimating the transitional probability matrices. The probability of retaining the particular crop (gain or loss) was interpreted by studying the diagonal and off diagonal elements of transitional matrix. The transitional probability matrix for dynamic changes in the cropping pattern in Villupuram district of Tamil Nadu were analysed using the data on cropped area from 2004-05 to 2013-14. The nine major categories considered for the analysis were cereals, millets, pulses, oil seeds, vegetables & fruits, sugar crops, tapioca and other crops. The results of Markov chain model are discussed in Table.2

Table 2 Transitional Probability Matrix of Dynamic Changes in Major Crops in Villupuram District, 2004-05 to 2013-14.

Crops	Cereals	Millets	Pulses	Oil Seeds	Veg. &Fruits	Sugar	Tapioca	Others
Cereals	**0.7799**	0.0017	0.0737	0.0246	0.0056	0.0043	0.0173	0.0929
Millets	0.0245	**0.1253**	0.1848	0.0825	0.1016	0.1805	0.1539	0.1468
Pulses	0.1024	0.1291	**0.1406**	0.1292	0.1448	0.0740	0.1633	0.1166
Oil Seeds	0.0411	0.0929	0.2334	**0.2127**	0.0768	0.0526	0.1202	0.1704
Veg. &Fruits	0.0050	0.2430	0.1082	0.0260	**0.1766**	0.1050	0.1938	0.1425
Sugar	0.0000	0.0583	0.0000	0.0000	0.1187	**0.6486**	0.1665	0.0080
Tapioca	0.0000	0.2994	0.0446	0.0040	0.2436	0.0599	**0.2311**	0.1175
Other Crops	0.0821	0.0669	0.2124	0.1764	0.1214	0.0544	0.1580	**0.1284**

The diagonal elements represent the probability of retention of existing area under different crops in the future. For instance the probability of retention of existing area under cereals was estimated at 78 per cent. Similarly, for millets the probability of retention was 13 per cent , the probability of area under pulses, oilseeds, vegetable & fruits, sugar, tapioca and other crops was 14, 21, 18, 65, 23, 13 per cent respectively. Hence, it could be concluded that the probability of retention for cereals and sugar were the highest among the various crop categories.

The analysis also reveals that the probability of shift in area from cereals to millets was only 0.17 per cent, to pulses was 7.37 per cent, to oilseeds was 2.46 per cent, to vegetables & fruits was 0.56 per cent, to sugar was 0.43 per cent, to tapioca was 1.73 per cent and to other crops was 9.29 per cent.

Crop Diversification

A study of crop diversification has great significance for any future land use planning and agricultural development. The index of crop diversification depends on the conditions of soil, characteristics of rainfall, the extent of irrigation facilities and availability of arable land. The results of crop diversification is presented in Table 3.

Table 3 Crop Diversification Index

S.No	Period	Herfindahl Index
1.	1994 -1999	0.7916
2.	1999 -2004	0.7921
3.	2004-2009	0.7885
4.	2009 -2014	0.8462

For measuring the level of specialization or diversification, Herfindahl Index has been used. It is important to note that diversification index here captures the change in the level of spread and concentration of crops overtime. The diversification index indicates whether study area has experienced any difference in the overall concentration or spread in the cropping pattern. Higher the concentration is expected to increase the variance in the income and may prove detrimental to the growth of the region.

From the results, it is noted that the index value was 0.7916 for the period 1994-99 and it has been slowly increased to 0.8462 in 2009-2014. It is clear from the results that less crop diversification is taking place over the years in the district.

CONCLUSION

It is concluded from the study that the compound growth rate of area under major crops like cereals and millets were negative, whereas it was positive for pulses, oilseeds, vegetables and fruits, sugar, tapioca. Based on the crop diversification index value, it is clear that there is less crop intensification in the district over the years.

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