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Research Paper

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An Analysis on the Degree of Crop Diversification and Shift in Cropping Pattern in Villupuram District of Tamil Nadu Dry

I Chandrakanth Reddy, C Prabakar* and Y Shelton Peter

Department of Agricultural Economics,

Faculty of Agriculture, Annamalai University, Annamalai Nagar - 608 002, Tamil Nadu, India

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A B S T R A C T

The study was carried out with an overall objective of analyzing the degree of crop diversification and shift in cropping pattern in Villupuram district of Tamil Nadu. The specific objectives were to assess the existing degree of farm level crop diversification, to assess and analyze the shift in cropping pattern in the last two decades and to rank the reasons for the non-adoption of crop diversification in Villupuram district of Tamil Nadu. With regard to selection of block, Marakkanam was purposively selected, since it is more prone to risks due to natural calamities (Cyclone, floods and tsunami etc.) and salinity. The analyses implied that; efforts need to be enhanced by the institutional authorities to popularize the concept of Crop diversification among farmers. Needed technical know-how on cultivation of alternative suitable crops may be provided to farmers vide trainings and workshops.

Key words: Risk, Crop diversification, Shift in cropping pattern, Markov Chain analysis

Villupuram is one of the predominant agricultural district of Tamil Nadu in which 75 per cent of population is involved in agriculture and allied activities for their livelihood. Agriculture continues to be the predominant sector of the district's economy. In the total Geographical area of 7,22,203 ha, 45 per cent i.e. 3,37,305 ha is net sown area. In net sown area, 1,37,647 ha is sown more than once. Villupuram district has 5.68 lakh farm families. In this 75 per cent are marginal farmers, 16 per cent belongs to small farmers and 9 per cent are big farmers. The main water sources of the district are open wells and bore wells.

Paddy is the principal crop extensively cultivated in all three seasons namely Sornavari, Samba and Navarai. Paddy accounts to 40 per cent of the total cropped area in the district. Pulses are another important food grain crop. Blackgram is a predominant pulse crop which covers more than 80 per cent of the total pulses area in Villupuram district. Sugarcane is an important commercial crop in Viluppuram District and it supplies entire cane requirement for 7 sugar mills located within the district and partial cane supply for 5 other sugar mills located in the neighbouring districts. Hence the district acts as the sugar bowl of Tamil Nadu.

Villupuram district shares a remarkable place in State food grain production. From 2013-14 to 2017-18, Villupuram district stands first in food grain production. Each year Viluppuram contributes more than 10% of the State's food production (villupuram.nic.in). Even though, the district's engagement with agriculture is immensely good, it also experiences several risks especially in the coastal blocks vide, salinity, cyclones, floods and other disasters. To overcome these hardships in agriculture, crop diversification has been identified as an apt solution to mitigate risk from vagaries of the natural calamities and other production risks. It could also help farmers to increase their farm income which leads to livelihood enhancement. Crop diversification is intended to give a wider choice in the production of a variety of crops in a given area so as to expand production related activities on various crops and also to lessen risk. Crop diversification in general is also viewed as a shift from traditionally grown less remunerative crops to more remunerative crops (Kalaiselvi 2012).

In Villupuram district, most of the farmers seem to cultivate crops with conventional wisdom and are associated with monocropping model of cultivation only. The judicious

***Corresponding author:** Dr. C. Prabakar, Associate Professor, Department of Agricultural Economics, Faculty of Agriculture, Annamalai University, Annamalai Nagar - 608 002, Tamil Nadu

e-mail: prabakaragri@yahoo.co.in

annual-perennial mix could be a better alternative to combat risk, as well as for livelihood enhancement. Under this background the following study was conceived with the following objectives:

- To assess the existing degree of farm level crop diversification in Villupuram district of Tamil Nadu
- To assess and analyze the shift in cropping pattern in the last two decades in Villupuram district
- To rank the reasons for the non-adoption of crop diversification in Villupuram district.

MATERIALS AND METHODS

Study area and selection of farmers

Villupuram district formed the universe of study. With regard to selection of block, Marakkanam was selected purposively since it is more prone to risks due to natural calamities (Cyclones, floods and tsunami etc.) and salinity. From selected block, 60 farmers were selected at random. The primary data on crop wise area allocation at farm level and reasons for non-adoption of crop diversification were collected from the selected farmers. With regard to the secondary data the district level data on crop coverage for the past twenty two years was collected from Department of Economics and Statistics, Villupuram, Tamil Nadu.

Tools of analysis

Herfindahl Index (HI): The Herfindahl index is a measure of concentration. The degree of crop diversification in a region could be assessed using the Herfindahl index. It is an economic concept widely applied in competition law in USA (Brown Donald *et al*. 1988).

Index was computed by taking the sum of square of area proportion of each crop in the gross cropped area of the farm. This index was worked out by the following formula:

$$HI = \sum_{i=1}^{N} Pi^2$$

Where,

N = Total number of crops

P_i = Average proportion of the i^{th} crop in gross cropped area

With increase in diversification, the index decreases. The index takes a value of one when there is a complete specialization and approach to zero as N is large, i.e. diversification is perfect. The Herfindahl index was estimated separately for each farm and the average value of the farm level indices was considered for district level interpretation.

Simpson index (SI): The Simpson Index (SI) is also a suitable index of measuring diversification in a particular geographical region. Mathematically, SI is defined as

$$SI = 1-\Sigma^{N}_{i=1} P_i^2$$

Where,

$P_i = A_i / \Sigma A_i$ is the proportion of the i^{th} activity in acreage.

If Simpson Index is nearer to zero, it indicates that the zone or region is near to the specialization in growing of a particular crop and if it is close to one, then the zone is fully diversified in terms of crops. The Simpson index was estimated separately for each farm and the average value of the farm level indices was considered for district level interpretation.

Markov Chain Analysis

The direction of shift in cropping pattern of area under major crops was analyzed using the first order Markov chain approach using LINGO software. Central to Markov chain analysis is the estimation of the transitional probability matrix 'P' whose elements, P_{ij} indicate the probability (share) of crop categories switching from i^{th} crop category to j^{th} crop category over time. The diagonal element P_{ij}, where i=j, represents the retention share of respective crop category in terms of area under crops.

This can be denoted algebraically as:

$$E_{jt} = \sum_{i=1}^{n}(E_{it-1})\ P_{ij} + e_{jt}$$

Where,

E_{jt} = Area under major crops to the j^{th} crop in the year t

E_{it-1} = Area under i^{th} crop during the year t-1

P_{ij} = The probability of shift in area under i^{th} crop to j^{th} crop

e_{jt} = The error term which is statistically independent of $E_{i\ t-1}$

n = The number of major crops

The transitional probabilities P_{ij}, which can be arranged in a (m x n) matrix, have the following properties:

$$\sum_{i=1}^{n} P_{ij} = 1 \text{ and } 0 \leq P_{ij} \leq 1$$

Thus, the expected share of each crop during period 't' is obtained by multiplying the share of these crops in the previous period (t^{-1}) with the transitional probability matrix.

The transitional probability matrix is estimated using linear programming (LP) framework by a method referred to as minimization of Mean Absolute Deviation (MAD), the formulation is stated as:

$$\text{Min, } OP^* + I\ e$$

Subject to:

$X P^* + V = Y$

$GP^* = 1$

$P^* \geq 0$

Where,

P^* is a vector of the transitional probabilities P_{ij} to be estimated

O is the vector of zeros

I is an appropriately dimensional vector of areas

e is the vector of absolute errors

Y is the proportion of area to each crop category.

X is a block diagonal matrix of lagged values of Y

V is the vector of errors

G is a grouping matrix to add the row elements of P arranged in P* to unity.

This Markov Probability model was also used to study the changes in the cropping pattern in the study area.

Garrett's Ranking Technique

To study the reasons for non-adoption of crop diversification, Garrett's ranking technique was employed (Garette 1969). The order of merit assigned by the respondents were converted in to ranks using the formula:

$$\text{Percent position} = \frac{100\ (R_{ij} - 0.5)}{N_j}$$

Where,

R_{ij} = rank given for i^{th} factor by j^{th} individual
N_j = number of factors ranked by j^{th} individual

By referring to Garrett's table, the percentage positions estimated were converted in to scores and then for each factor the scores of various respondents were added and mean value was arrived at. These means were arranged in descending order. The problem having the highest mean value was considered as the most important and was given the highest rank and vice versa.

RESULTS AND DISCUSSION

Crop diversification

The degree of farm level crop diversification in Marakkanam block was assessed and quantified using Herfindahl Index and Simpson Index for the three recent years viz. 2017, 2018 and 2019. The indices were estimated for each farm separately and the average value of these farm level indices is presented in (Table 1). The Herfindahl index would decrease with increase in diversification. It could be observed that the calculated values of Herfindahl index was relatively high and almost equal in all the three years in Marakkanam block i.e. 0.7821, 0.8092 and 0.7216. The indices vividly conveys the fact that crop diversification is much limited in Villupuram district. With regard to Simpson index, the lower values indicate a decreased level of diversification and the higher values indicate an increased level of crop diversification. As per (Table 1), the Simpson indices for the recent three years were 0.2179, 0.1908 and 0.2784. The values indicate that crop diversification is not upto the needed level in Villupuram district. From the above results, it is evident that, the farmers of Villupuram district do not consider the concept of crop diversification as a tool for risk mitigation even though, they encounter with several production and marketing risks every year.

Table 1 Farm level crop diversification indices for Marakkanam block of Villupuram district

Name of the Block	Herfindahl Index			Simpson Index		
	2017	2018	2019	2017	2018	2019
Marakkanam	0.7821	0.8092	0.7216	0.2179	0.1908	0.2784

Shift in cropping pattern

Markov Chain Analysis was used to study the shift in cropping pattern in Villupuram district over the last two decades. The probability of retaining the particular crop and the shift was interpreted by studying the diagonal and off diagonal elements of transitional matrix. The transitional probability matrix and steady state probabilities pertaining to shift in cropping pattern in the study area were computed using the data on area under major crops and presented in (Table 2).

Table 2 Transitional probability matrix for area under major crops in Villupuram district between 1996-97 and 2017-18

Major crops	Paddy	Cumbu	Maize	Turmeric	Sugarcane	Groundnut	Banana	Coconut	Cotton	Other annuals	Other perennials
Paddy	0.6352	0.0555	0.0007	0.0025	0.0855	0.1510	0.0059	0.0091	0.0258	0.0245	0.0040
Cumbu	0.6278	0.1243	0.0000	0.0000	0.0000	0.2318	0.0015	0.0000	0.0050	0.0094	0.0000
Maize	0.0026	0.0000	0.3819	0.0161	0.5268	0.0125	0.0016	0.0077	0.0150	0.0000	0.0354
Turmeric	0.0000	0.0000	0.6143	0.0000	0.3453	0.0000	0.0026	0.0125	0.0000	0.0000	0.0250
Sugarcane	0.0000	0.0436	0.0665	0.0419	0.8083	0.0000	0.0000	0.0001	0.0391	0.0000	0.0003
Groundnut	0.6762	0.0058	0.0000	0.0000	0.0526	0.1830	0.0057	0.0133	0.0248	0.0353	0.0026
Banana	0.6666	0.0060	0.0000	0.0000	0.0543	0.1883	0.0059	0.0137	0.0257	0.0365	0.0027
Coconut	0.9681	0.0000	0.0000	0.0000	0.0000	0.0318	0.0000	0.0000	0.0000	0.0000	0.0000
Cotton	0.0000	0.3245	0.0000	0.0000	0.0000	0.6463	0.0000	0.0000	0.0000	0.0290	0.0000
Other annuals	0.1490	0.3846	0.0000	0.0000	0.0038	0.4370	0.0004	0.0009	0.0018	0.0215	0.0001
Other perennials	0.0000	0.0000	0.0026	0.0094	0.3433	0.0000	0.0000	0.0000	0.0088	0.0000	0.6356
Steady State probability	0.3132	0.0557	0.0602	0.0181	0.3886	0.1040	0.0027	0.0050	0.0272	0.0130	0.0116
Current year share of major crops (%)	42.19	7.41	6.24	1.10	26.63	10.64	0.42	0.76	2.54	1.32	0.69

Shift in the area under major crops in Villupuram district

Markov chain analysis is the way of analyzing current movement of variables in an effort to predict future movement. In the transitional probability matrix, the rows identify the current state of cropping pattern in major crops and the columns identify the alternatives to which the cropping pattern could move. The diagonal elements represent probability of retaining the same level of area with a specific crop. The transitional and steady state probabilities for the shift in cropping pattern was computed based on the area under major crops between 1996-97 and 2017-18. Out of this twenty two years of temporal data available on cropping pattern, only the intermittent values with an interval of two years i.e. every third year was only considered for the analysis. The results reveal the following inferences:

- The probability of retention of existing area under sugarcane was estimated at 80.83 per cent, other perennials at 63.56 per cent and paddy at 63.52 per cent.
- The analysis revealed that the shift in area from paddy to groundnut was 15.10 per cent, 'other perennials' to sugarcane was 34.33 per cent and maize to sugarcane was 52.68 per cent.
- Turmeric, coconut and cotton crops were found to be unstable and could retain zero per cent.
- Banana and other annual crops were identified to be less stable and could retain only 0.59 and 2.15 per cent. The possible shift in area from banana was estimated at 66.66 per cent to paddy, 18.83 per cent to groundnut and 5.43 per cent to sugarcane. Eventually, the possible shift in the area from other annual crops was estimated at 43.70 per cent to groundnut, 38.46 per cent to cumbu and 14.90 per cent to paddy. But a parallel observation which needs to be contemplated is that the cumulative current area under turmeric, coconut, cotton, banana and other annual crops account to only 2.74 per cent. And hence this may not have a significant impact on the larger cropping scenario of the district.

The study state probabilities revealed that if the trend continues like this, in future 38.86 per cent of area would be under sugarcane, 31.32 per cent would be under paddy and 10.40 per cent of area would allocate to groundnut. The future forecasted share of area under different crops vide steady state probabilities tend to deviate a little away from the current share of area under the respective crops. It is evident that, nearly 10 per cent of area from paddy would be shifted to sugarcane. The share of crops namely turmeric and 'other perennials' are expected to increase marginally. In the perspective of crop diversification and risk mitigation, the shift in crops observed in the district is not in a much appreciable pattern.

Table 3 Major reasons for non-adoption of crop diversification by farmers

Particulars	Rank
More associated with the conventional wisdom of cropping pattern	I
Fear for undulating commodity prices in the market	II
Unwillingness to accept due to fear of failure	III
Lack of technical knowledge	IV
Absence of training to promote crop diversification	V
Inadequate involvement in related trainings	VI

Major reasons for non-adoption of crop diversification by farmers

The major reasons for non-adoption of crop diversification are presented in (Table 3). It could be understood from the table that the reason, "More associated with the conventional wisdom of cropping pattern" ranked first followed by "Fear for undulating commodity prices in the market" as rank second. "Unwillingness to accept due to fear of failure" had been reported as the third major reason for non-adoption of crop diversification. Subsequently, "Lack of technical knowledge", "Absence of training to promote crop diversification" and "Inadequate involvement in related trainings" were ranked fourth, fifth and sixth respectively.

Policy suggestions

- Efforts need to be enhanced by the institutional authorities to popularize the concept of Crop diversification among farmers.
- Needed technical know-how on cultivation of suitable alternative crops may be provided to farmers vide trainings and workshops.

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