Journal of Experimental Agriculture International

Volume 45, Issue 1, Page 9-20, 2023; Article no.JEAI.95716
ISSN: 2457-0591
(Past name: American Journal of Experimental Agriculture, Past ISSN: 2231-0606)

Land Use Changes and Extent of Crop Diversification in North Western Zone of Tamil Nadu

V. Priyanga [a*], M. Thilagavathi [a], K. N. Selvaraj [a], P. Dhevagi [b] and M. R. Duraisamy [c]

[a] Department of Agricultural Economics, CARDS, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India.
[b] Department of Environmental Science, TNAU, Coimbatore, India.
[c] Department of Physical Sciences and Information Technology, AEC & RI, TNAU, Coimbatore, India.

Authors' contributions

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

Article Information

DOI: 10.9734/JEAI/2023/v45i12092

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/95716

Original Research Article

Received: 27/10/2022
Accepted: 29/12/2022
Published: 05/01/2023

ABSTRACT

Tamil Nadu, one of the important agrarian states in India, has experienced remarkable growth in the agricultural sector. Among the seven agro-climatic zones of Tamil Nadu, north western zone is known for intensive agrarian economy of which, the economy of Salem district is predominantly agrarian having 2.20 lakh hectares of net cultivated area (42.31 percent of total geographical area). The district has distinctive cropping patterns and the major crops grown in the district include Paddy, Tapioca, Maize, Sorghum and Vegetables. Given the importance of changing scenarios in cropping patterns, this study was undertaken to analyze the land use and cropping pattern changes and to examine the extent of crop diversification in Salem District over the year using the time series data for 20 years, i.e., from 2000-01 to 2019-20. Direction of changes in land use and

**Corresponding author: E-mail: vpriyanga12@gmail.com;*

cropping pattern was investigated using Markov chain analysis and for each year, crop diversification index was calculated. It was concluded from the study that the compound annual growth rate of area under crops like cereals and millets, pulses, spices and condiments, fruits, fibres. drugs, narcotics & plantation crops and other non-food crops were positive whereas it was negative for sugar crops, oilseeds, vegetables, fodder and green manure. Based on the crop diversification index value, it is evident that Salem district is moving towards crop diversification rather than specialization however the process as analysed on a time series basis is stagnant.

Keywords: CAGR; crop diversification; cropping pattern; land use pattern; Salem district.

1. INTRODUCTION

Crop diversification is a concept which is opposite to crop specialization. In India, crop diversification is typically viewed as a shift from the traditionally grown less-remunerative crops to more remunerative crops. Crop diversification ensures greater security for food, nutrition, income, and employment to a wider section of society; as a result, it significantly affects the GDP (Gross Domestic Product) of the country [1]. According to Acharya et al. [2] crop diversification contributes to increased cropping intensity, higher employment, commercialization of farming, a decrease in male member migration, and participation of women in income-generating activities. “Crop diversification as an effective strategy for sustainable agriculture development has the sound capacity for achieving the goal of nutritional security, stabilize farm income, food security, employment generation, reduce poverty, and conserve natural resources” [3-6,1]. “In a developing country like India where the man-land ratio is high, the concept of crop diversification is very much significant as it is an important way to enhance agricultural output” [7].

Tamil Nadu, a Southern States of Indian union with overall geographical area, covers 130,058 sq.km which is about 3.96 percent of country’s total geographical area. The share of agriculture and allied activities declined from the level of 24.57 percent of the state GDP (Gross Domestic Product) in the 1980s to 21.85 percent in 1990s before declining to the current level of 13 percent [8]. The economy of the state is predominantly agrarian in nature with almost 70 percent of the state’s population is engaged in agricultural activity. It is an agrarian state, the share of net sown area to total geographical area has been continuously declining from 45 percent in 1960-61 to around 36 percent in 2020-21 with the continuous changes in its land use pattern and cropping pattern. Also, the gross cropped area had declined from 79.47 lakh ha in 1960-61 to 59.42 lakh ha in 2020-21, nearly 26 percent of the area has been reduced over six decades [9]. Since rice takes up more than 30% of the state's total cropped area, it is one of the primary crops whose area has likewise seen a decline in gross cultivated area. It is presumable that technological as well as climatic elements play a significant role in influencing crops and land use patterns. Cropping pattern changes occurred in many regions of Tamil Nadu in recent decades where in it was at higher rate in North Western Zone of Tamil Nadu. Specifically in Salem district, it was noticed that the major crops viz., paddy, groundnut and sugarcane was rapidly varied at 15 percent to 6 percent in paddy, 13 percent to 6 percent in groundnut and 4 percent 2 percent in sugarcane over the two decades. But the share of area under horticultural crop-tapioca, the perennial crop-mango and cereal crop-maize are increasing steadily, indicating that there was a definite shift in the area allocation from paddy, ground nut and sugarcane to tapioca and mango in the district. This continuous shift increases in the area under tapioca and mango which will lead to specialization in these crops and the cost of other food and commercial crops [10].

Given the importance of this changing scenarios in cropping patterns of Salem district, to analyse the dynamic changes in land use and cropping pattern of major crop groups and to examine the extent of crop diversification over the years. This study was undertaken by hypothesized that crop diversification is varied over the years in the district.

2. DATA SOURCE AND METHODOLOGY

Salem district has been randomly selected from the North Western Zone of Tamil Nadu for the analysis of land use and cropping pattern changes from 2000-02 to 2019-20. The study was based on the secondary data. The time series data on land use classification and area under different crop groups for the period of 20

years from 2000-01 to 2019-20 was collected using secondary sources like Season and Crop Report and District Statistical Handbook, Salem district and analysed to assess the land use changes and cropping pattern changes in the Salem district of Tamil Nadu. The major crop groups selected for the study are cereals and millets, pulses, sugar crops, spices and condiments, fruits, vegetables, oilseeds, fibre crops, Drugs, Narcotics and plantation crops, fodder crops, green manure and other non-food crops.

To ascertain the changes in different categories of land and cropping pattern changes, the three-year average was calculated for two time periods viz., Period I (TE 2009-10) and Period II (TE 2019-20). The study also attempted to analyse the growth rate and extend of crop diversification for 20 years (2000-01 to 2019-20) using the statistical tools such as Compound Annual Growth Rate (CAGR) and Crop Diversification indices, respectively. Markov chain analysis was used to measure the direction of changes in land use category and area under major crop groups in Salem district.

2.1 Compound Annual Growth Rate

The exponential type functional form was used to compute the compound annual growth rate of land use classification and cropping pattern of major crop groups in the Salem district.

$$Y = ab^t e_t$$

where,

Y= dependent variables such as land use classification and area under major crop groups,
a = Intercept,
b = Regression co-efficient,
t = Time variable and
e = Error term

The above equation was transformed into a log form and is estimated by applying the the Ordinary Least Square (OLS) method. The t-test was applied to test the significance of 'b'.
ln Y = ln a + t ln b + ln e_t

Then, the compound annual growth rate (per cent per annum) was calculated by using the following relationship.

CAGR = {antilog of b-1} x 100

The standard error of the growth rate was estimated and tested for its significance with "t" statistic which is defined as,

$$t = \frac{b}{se(b)}$$

Where, b= regression coefficient and se(b)= standard error of the regression coefficient.

2.2 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 and cropping pattern there by gain in understanding about the dynamics of the its changes" [11,12].

Transitional probabilities were evaluated based on a linear programming (LP) approach using LINGO software to analyse the dynamics of land use and cropping pattern from 2010 to 2020. The elements *Pij* of the transitional probability matrix '*P*' developed by Markov chain analysis represent the likelihood (share) of land area and crops moving from i^{th} to j^{th} category over time. Its diagonal parts show the retention share in terms of land and cropping area.

This can be algebraically represented as:

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

Where

E_{jt}= area under land use/ crop group to the j^{th} category in year '*t*'
E_{it} –1= area under land use/ crop group of i^{th} categories during the year '*t* – 1'
P_{ij}= probability of shift in area under land use/ crop group from i^{th} to j^{th} category
e_{jt} = error term statistically independent of E_{it}–1
n = number of land use category/crop groups

The transition probabilities of $P_{ij,}$ which can be arranged in a (c×n) matrix, are as follows:

$$\sum_{i=1}^{n} P_{ij} = 1 \ for\ all\ "i" \qquad 0 \leq P_{ij} \leq 1$$

Thus, the expected area share under each category during the period t were calculated by multiplying the preceding period's area (t-1) by the transitional probability matrix "P". A method known as minimization of Mean Absolute

Deviation (MAD) was used to estimate the transitional probability matrix in the linear programming (LP) framework. The LP formula is as follows:

Min O*P + Ie

Subject to, $XP^{*} + v = y$ $GP^{*}=1$

$P^{*} \geq 0$

"Where, P^{*} is a vector of the probabilities $P_{ij,}$ 0 is a vector of zero, I is an appropriately demonstrated identity matrix, e is the vector of absolute error, y is the vector of share in land use/ crop group to each category, X is a block diagonal matrix of lagged values of y and v is the vector of errors and G is a grouping matrix to add the row elements of P arranged in P^{*} to unity" [13].

2.3 Crop Diversification Indices

There are few methods, which explain either concentration/ specialization or diversification of commodities or activities. Table 1 provides a summary of different measures of diversification and their properties.

"Each method has some limitation and/or superiority over the other. Entropy index (EI) and modified entropy index (MEI) are widely used by agricultural economists for analysing diversification of agriculture" [14,15]. "Whereas Ogive Index was first used to measure the industrial diversity. However, the Simpson's index takes into account both richness (the number of crop species present in a particular area) and evenness (the relative abundance of different crop species) of crops present in a particular area. As crop richness and evenness increase, diversity increases. Thus, the Simpson's index provides a clear dispersion of crops in a particular area. The most widely used method for measuring diversity in recent times is Simpson's index, which is the modified version of Herfindahl Index (SI= 1-HI). It is easy to compute and interpret" [16]. Considering the study objective of assessing the extent of diversity in crops, Herfindhal and the Simpson's index has been used.

Table 1. Characteristic features of different measures of diversification

Index	Formula	Measure of	Perfect diversification	Perfect concentration
Ogive index	$OI = N\sum_{i=1}^{N}\left\{P_i - \left(\frac{1}{N}\right)\right\}^2$	Diversification	1	0
Entropy index	$EI = \sum_{i=1}^{N} Pi * \log\left(\frac{1}{Pi}\right)$	Diversification	Ln (N)	0
Modified Entropy index	$MEI = \sum_{i=1}^{N} Pi * log_N\ (\frac{1}{Pi})$	Diversification	1	0
Composite Entropy Index	$CEI = -\sum_{i=1}^{N}(P_i log_N P_i) \times \{1 - (1/N)\}$	Concentration	1	0
Herfindahl index	$\mathrm{HI} = \sum_{\mathrm{i=1}}^{\mathrm{N}} \mathrm{Pi}^2$	Concentration	0	1
Simpson Index	$\mathrm{SI} = 1 - \sum_{\mathrm{i=1}}^{\mathrm{N}} \mathrm{Pi}^2$	Diversification	1	0

3. RESULTS AND DISCUSSION

3.1 Land Use Pattern of Salem District

The rapid pace of economic development along with population growth, urbanization and industrialization exert tremendous pressure on the limited natural resource base of a district or a region. Land, being one of the most basic natural resources has always been the subject matter of debate regarding its effective use. A study on land use patterns would be more useful in planning for expanding the forest area, reclamation of fallow lands and other classifications to make them suitable for the provision of environmental services, farming and so on. The overall geographical area of Salem district was 5.20 lakh hectares as shown in Table 2.

The changes in the proportion of different categories of land in the Salem district are presented in Table 2. The area under each category of land was assessed for two period viz., Period I (2009- 10) and Period II (2019-20) in order to o ascertain the dynamic changes. During the Period II (2019-20), it was assessed as Net area sown as 38.29 percent of the total geographical area, while the gross cropped area accounted for 53.23 percent. The forest area covered on an average 24.15 percent of the total geographical area. Land put to non-agricultural use accounted for 12.42 percent of the total geographical area, whereas the barren and uncultivable wasteland accounted for 7.34 percent of the total geographical area. Fallow land other than current fallow and the current fallows account for 15.26 percent whereas culturable waste land accounts for only 1.19 percent of geographical area, implied the scope for improving the utilization of these lands for agriculture. Over the past twenty years, there has been an increasing trend in the land under current and other fallows with the declining area under net area sown in Period II compared to Period I which is a major concern for policy makers.

The result in Table 2 also revealed that during 2000-01 to 2019-20, there had been increases in the land put to non-agricultural uses, cultivable waste land, total fallow land and area sown more than once whereas decreases in the net area sown, total cropped area. However, barren and uncultivable land, permanent pastures and grazing land and land under miscellaneous trees, groves, *etc.*, also exhibited negative growth. Changes in barren and unculturable land (-0.41 percent), permanent pastures and other grazing land (-1.33 per cent) and land under miscellaneous trees, groves, *etc.* (-1.14 percent) was observed as negative growth with a one percent significance level. On the other hand, land put to non-agricultural uses and culturable wasteland has a positive growth rate of 1.28 percent and 0.71 percent per annum with a one percent and 10 percent significance level, respectively which implied that in selected study district, the change in land use pattern might be due to industrialization (total number of registered units around 2258 during Period I to 8906 during Period II) and urbanization (4.07 percent of the total geographical area was urban during Period I to 12.88 percent during Period II) . However, the fallow land other than the current fallow and current fallow land exhibited a positive growth rate of 0.36 and 3.33 percent per annum which was at five percent significant level might be due to low receipt of rainfall (1069.37 mm in Period I to 801.32 mm in Period II) and non-availability of agricultural labour.

The decrease in net area sown and the total cropped area is due to more area occupied under current fallow land. A similar result to Mohanty [17], there was a decline in the net area sown, which was mostly attributed to increasing agricultural land area for non-agricultural purposes. Over the last 20 years, cropping intensity had slightly improved with a positive growth rate of 0.57 percent per annum.

3.2 Dynamic Changes of Land Use Category in Salem District

Markov chain analysis helped us to analyse the dynamic changes in land use category in common. This analysis was carried out and the results are presented in Table 3. The Markov chain analysis was carried out for the period from 2010-11 to 2019-20 to analyse the shift in land use pattern in Salem district. The stability/ retention of the area shares of the different land use categories and the direction and the volume of changes over time is captured by transitional probability matrix and the results are presented in Table 3.

It can be inferred from the Table 3 that land use categories have shown stability. But the highest stability was acquired by forest land, Barren and Unculturable Land and Permanent Pasture and Other Grazing Land as reflected in high probability of retention at 1.00 i.e., the probability

Table 2. Land use pattern of Salem district

Particulars	Period I (2009-10) (Area in ha)	Period II (2019-20) (Area in ha)	CAGR (%)
Geographical Area	5,20,530.00	5,20,530.00	0
Forest	1,25,682.00 (24.15)	1,25,682.00 (24.15)	0
Land put to non-agricultural uses	59,775.00 (11.48)	64,670.67 (12.42)	1.28***
Barren and Unculturable Land	38,894.00 (7.47)	38,198.00 (7.34)	-0.41***
Permanent Pastures and other Grazing Land	4,200.00 (0.81)	4,200.00 (0.81)	-1.33***
Land under Misc. trees, groves, etc.,(not included in net sown area)	3,104.00 (0.60)	2,855.33 (0.55)	-1.14***
Culturable Wasteland	5,040.00 (0.97)	6,187.67 (1.19)	0.71*
Fallow Land other than current fallow	20,741.33 (3.98)	21,143.67 (4.06)	0.36
Current Fallow	55,497.67 (10.66)	58,275.67 (11.20)	3.33**
Net Area sown	2,07,596.00 (39.88)	1,99,317.33 (38.29)	-0.67**
Gross Cropped Area	2,42,336.33 (46.56)	2,77,062.00 (53.23)	-0.15
Area sown more than once	34,740.33 (6.67)	81,282.33 (15.62)	2.69
Cropping Intensity	116.65	140.78	0.57

Source: Author's calculation based on data from District Statistical HandBook (different columns), Assistant Director of Economics and Statistics, Salem.
Note: Figures in parentheses indicate the percentage of total geographical area

Table 3. Transitional Probability matrix of dynamic changes of land use category (2009-10 to 2019-20)

Particulars	Forests	Area Under Non-Agricultural Uses	Barren and Unculturable Land	Permanent Pasture and Other Grazing Land	Land Under Misc. Tree Crops and Groves not Included in Net Area Sown	Culturable Waste Land	Fallow Lands Other Than Current Fallows	Current Fallow	Net Area Sown
Forests	**1.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Area Under Non-Agricultural Uses	0.00	**0.85**	0.00	0.00	0.00	0.02	0.00	0.13	0.00
Barren and Unculturable Land	0.00	0.00	**1.00**	0.00	0.00	0.00	0.00	0.00	0.00
Permanent Pasture and Other Grazing Land	0.00	0.00	0.00	**1.00**	0.00	0.00	0.00	0.00	0.00
Land Under Misc. Tree Crops and Groves not Included in Net Area Sown	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	1.00	0.00
Culturable Waste Land	0.00	0.00	0.00	0.00	0.00	**0.75**	0.00	0.25	0.00
Fallow Lands Other Than Current Fallows	0.00	0.00	0.00	0.00	0.01	0.00	**0.84**	0.15	0.00
Current Fallow	0.00	0.07	0.00	0.00	0.01	0.00	0.06	**0.39**	0.47
Net Area Sown	0.00	0.03	0.00	0.00	0.01	0.00	0.00	0.09	**0.87**

Source: Author's calculation based on data from District Statistical HandBook (different columns), Assistant Director of Economics and Statistics, Salem

of these land area retains its share from one period to another period is 100 percent. Similar interpretation could be made for net area sown, area under non-agricultural uses, fallow lands other than current fallows, culturable waste land and current fallow with probability of retention of 0.87, 0.85, 0.84, 0.75 and 0.39 respectively. Current fallow land could be retained its major share and it is likely to contribute its 0.47 share to net area sown and 0.07 share to area under non-agricultural uses. Implemented development programmes by the Government motivates the farmers to utilize their land productivity. On the contrary, land under misc. tree crops and groves not included in net area sown was having the probability of zero retention indicating that its share of land is unstable which means it could not retain its share during the period.

3.3 Cropping Pattern in Salem District

An analysis of cropping patterns would reveal information on farmers' decision-making behaviour on the crop – mix prevalent in the region. The growth in the area under different crop groups over the last 20 years from 2000-01 to 2019-20 was analysed and presented in Table 4.

The results showed a positive growth rate in the area of fruits with 3.87 percent per annum, followed by 2.91 percent per annum for other non-food crops, 2.37 percent per annum for cereals and millets and 0.93 percent per annum for Drugs, Narcotics and Plantation crops annually with one percent, 10 percent, 5 percent and 10 percent significance level, respectively. The area under pulses, spices and condiments and fibres increased at the rate of 2.24 percent, 1.01 percent and 1.09 percent per annum, respectively. But, in the case of fodder crops, oilseeds and vegetables, the growth rate during 2000-01 to 2019-20 were negative at the rate -10.88 percent and -3.02 percent per annum with a one percent significance level for fodders and oilseeds and -1.84 percent per annum for vegetables with 5 percent significance level, respectively.

The changes in the cropping pattern for the period from Period I to Period II were analysed for the Salem district. The results in Table 4 indicated that the share of the area of cereals and millets, pulses, fruits, and other non-food crops has increased during the period. The share in the area of sugar crops, vegetables, oilseeds, fodder and green manure crops had declined over the years. The share in the area of cereals and millets increased from 31.03 percent during Period I to 41.64 percent during Period II. Thus, cereals crops occupied the major share of the total cropped area, indicating that the farmers in the region have aware of the value of food security. For the pulse crop, the area share increased from 6.79 percent during Period I to 18.88 percent during Period II, which indicates the farmers' awareness of nutritional requirements. The area share of sugar crops was less in the total cropped area and decreased over the years. The area share of oilseed crops has also lessened from 17.29 percent during Period I to 12.50 percent during Period II. In the case of fruits crops, their share of the total cropped area increased from 3.09 percent during Period I to 3.36 percent during Period II, whereas the vegetable crops declined from 13.08 percent during Period I to 8.18 percent during Period II.

3.4 Dynamic Changes of Major Crop Groups in Salem District

Using transitional probability matrices, Markov chain analysis was used to investigate the direction of cropping pattern changes. The transitional matrix's diagonal and off-diagonal components were used to determine the likelihood of keeping a specific crop (gain or loss), whereas the row elements indicated the possibility of crop loss due to competing crops. The column elements represent the probability of another crop gaining ground in the area. As the diagonal elements approach zero, the crops become less and less stable, and as they approach one, they grow more and more stable over time. The data on cultivated area of various crop groups from 2010-11 to 2019-20 was used to analyse the transitional probability matrix for cropping pattern changes in Salem district of Tamil Nadu. Table 5 summarize the results of the Markov chain model. The Table 5 showed that fodder crops have been the most stable crop among other crop groups, as evidenced by the greater chance of retention of 0.63., i.e., the chance of fodder crops maintaining their area share over the study period was 63 percent. Cereals and millets has a probability retention of 0.59, which means it has kept 59 percent of area share, followed by oilseeds, which has kept 34 percent of area share. It can be further seen from the table that the probability of shift in area from cereals and millets to pulses was 33 percent and oilseeds was 6.4 percent whereas to other crop groups was only in meagre. The sugar crops, fruits and oilseeds have lost 52, 83 and 56

Table 4. Cropping pattern in Salem (area in ha)

Crop groups	Period I (2009-10) (Area in ha)	Period II (2019-20) (Area in ha)	CAGR (%)
Cereals and Millets	75,206.33 (31.03)	1,15,369.67 (41.64)	2.37**
Pulses	16,465.00 (6.79)	52,311.00 (18.88)	2.24
Sugar crops	11,511.33 (4.75)	5,242.33 (1.89)	-0.51
Spices and Condiments	10,329.00 (4.26)	7,584.67 (2.74)	1.01
Fruits	7,493.33 (3.09)	9,305.67 (3.36)	3.87***
Vegetables	31,690.67 (13.08)	22,666.00 (8.18)	-1.84**
Oilseeds	41,893.33 (17.29)	34,637.00 (12.50)	-3.02***
Fiber crops	14,252.33 (5.88)	13,510.33 (4.88)	1.09
Drugs, Narcotics and Plantation crops	7,270.33 (3.00)	8,234.00 (2.97)	0.93*
Fodder crops	23,406.00 (9.66)	3,302.00 (1.19)	-10.88***
Green manure	289.67 (0.12)	114.33 (0.04)	-14.50
Other non-food crops	2523.67 (1.04)	4776.00 (1.72)	2.91*
Gross cropped area	2,42,336.33 (100)	2,77,062.00 (100)	-0.15

Source: Author's calculation based on data from District Statistical HandBook (different columns), Assistant Director of Economics and Statistics, Salem.
Note: Figures in parentheses indicate the percentage of the gross cropped area

Table 5. Transitional probability matrix of dynamic changes in major crop groups (2010-11 to 2019-20)

Crops	Cereals & millets	Pulses	Sugar crops	Condiments and Spices	Fruits	Vegetables	Oilseeds	Fibres	Fodder crops	Others
Cereals & millets	**0.59**	0.34	0.00	0.00	0.01	0.00	0.06	0.00	0.00	0.00
Pulses	0.000	**0.00**	0.08	0.13	0.05	0.27	0.26	0.09	0.01	0.11
Sugar crops	0.53	0.40	**0.00**	0.00	0.00	0.07	0.00	0.00	0.00	0.00
Condiments and Spices	0.00	0.00	0.12	**0.00**	0.03	0.05	0.58	0.00	0.00	0.22
Fruits	0.83	0.00	0.00	0.00	**0.17**	0.00	0.00	0.00	0.00	0.00
Vegetables	0.02	0.00	0.00	0.08	0.14	**0.24**	0.00	0.36	0.00	0.16
Oilseeds	0.56	0.00	0.00	0.00	0.00	0.09	**0.35**	0.00	0.00	0.00
Fibres	0.00	0.94	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	0.06
Fodder crops	0.00	0.00	0.16	0.07	0.00	0.04	0.00	0.05	**0.63**	0.05
Others	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**

Source: Author's calculation based on data from District Statistical HandBook (different columns), Assistant Director of Economics and Statistics, Salem

Table 6. Indices of crop diversification in Salem district from 2000-01 to 2019-20

Year	Herfindahl index	Simpson index	Year	Herfindahl index	Simpson index
2001	0.172	0.828	2011	0.166	0.834
2002	0.167	0.833	2012	0.151	0.849
2003	0.165	0.835	2013	0.138	0.862
2004	0.179	0.821	2014	0.177	0.823
2005	0.176	0.824	2015	0.211	0.789
2006	0.184	0.816	2016	0.219	0.781
2007	0.162	0.838	2017	0.165	0.835
2008	0.154	0.846	2018	0.231	0.769
2009	0.182	0.818	2019	0.227	0.773
2010	0.166	0.834	2020	0.254	0.746

Source: Author's calculation based on data from District Statistical HandBook (different columns), Assistant Director of Economics and Statistics, Salem

percent of their area to paddy, respectively. The study also found that shifting in area from sugar crops and fiber crops to pulses was 40 and 93 percent respectively, whereas it has gained 8 percent and 9 percent from pulses respectively. The study also revealed that shifting in area from spices and condiments to oilseed was 57 percent, vegetables to fiber crops.

3.5 Crop Diversification Index

For measuring the extent of crop diversification and changes over the period from 2000-01 to 2019-20, the Herfindahl index (HI) and Simpson index (SI) were examined and presented in Table 6. Both these indices were computed based on the proportion of gross cropped area under different crop groups (cereals and millets, pulses, sugar crops, spices and condiments, fruits, vegetables, oilseeds, fibre crops, Drugs, Narcotics and plantation crops, fodder crops, green manure and other non-food crops) cultivated in Salem district.

The calculated average value of the Herfindahl index for different crop groups was 0.182 (i.e., less than 0.5), which means that diversification took place. The value of the Herfindahl index in the Salem District was found to be low i.e., the value moved up from 0.138 during 2012-13 to 0.254 during 2019-20. The result of the Simpson index has a high crop diversification value, which lies between 0.746 and 0.862 during 2019-20 and 2012-13, respectively. The factors which are responsible for crop diversification are that most of the farmers were moved from low-value crops to high-value crops for sustaining economic prosperity and to generate alternate sources of income [18-21].

The results clearly show that farmers in the Salem district were progressive towards diversification rather than specialization. Thus, the diversification from subsistence crops to more commercial crops was taking place in the district. Therefore, the result of the analysis has proved the hypothesis that crop diversification took place in the Salem district over a period of time.

4. CONCLUSIONS

According to the study, there has been a positive increase in land used for non-agricultural purposes, culturable waste land, total fallow land, and area sown more than once. However, the increase in non-agricultural land use was caused by a significant increase in the district's population. Further, it was observed that there has been negative growth in barren and unculturable land, permanent pastures and other grazing land and land under misc. trees, groves in Salem district during 2000-01 to 2019-20. The cropping intensity has been slightly increasing over the period in the Salem district.

Agricultural diversification is an important mechanism for economic growth. The Salem district showed a high level of diversification as measured by these Indices but the process as analysed on a time series basis is somewhat stagnant. It is concluded from the study that the share of crops like cereals and millets, pulses, spices and condiments, fruits, fibre and non-food crops has increased over the years with a positive compound annual growth rate in the area of each crop group in the district. However, the share of sugar crops, vegetables, oilseeds, fodder crops and green manure decreased over the years with a negative compound annual growth rate of the area of crops in the area of each crop group. This shows that the district is moving towards crop diversification rather than specialization.

5. POLICY IMPLICATIONS

Presently, diversification in agriculture is leading to agribusiness, and the focus on vertical integration between farmer and retailer is increasingly becoming common therefore public and private investments, especially in the areas of research and development, extension services delivery and technology development need to be enhanced. More high-value crops should be incorporated into the cropping system which would expect to increase both the farm income and cropping intensity.

ACKNOWLEDGEMENTS

I sincerely thank ICSSR (Indian Council of Social Science Research) for providing financial assistance to the study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Amirthalingam N, Devi KS. An economic analysis of crop diversification and dynamics of changes in the cropping pattern in Villupuram district of Tamil Nadu. International Journal of Research and Analytical Reviews. 2018; 5(4):243 to 248.
2. Acharya SP, Basavaraja H, Kunnal LB, Mahajanashetti SB, Bhat ARS. Crop diversification in Karnataka: An economic analysis. Agricultural Economics Research Review. 2011;24(1):351-357.
3. Von Braun J. Agricultural commercialization: Impacts on income and nutrition and implications for policy. Food Policy. 1995;20(3):187-202.
4. Pingali PL, Rosegrant MW. Agricultural commercialization and diversification: Processes and kalaipolicies. Food Policy. 1995;20(3):644-651.
5. Ryan JG, Spencer DC. Future challenges and opportunities for agricultural R&D in the semi-arid tropics. International Crops Research Institute for the Semi-Arid Tropics, Patancheru, Telangana; 2001.
6. Birthal PS, Joshi PK, Gulati A. Vertical coordination in high-value commodities: Implications for smallholders. MTID Discussion Paper No. 85. International Food Policy Research Institute, Washington, D.C; 2005.
7. Nagpure SC, Deshmukh RG, Sharma PK, Ingole DN. Pattern of crop concentration and crop diversification- An economic analysis. Maharashtra J. of Agril. Econ. 2017;20(2):128-132.
8. Government of Tamil Nadu, Season and Crop Report of Tamil Nadu (2001-2020), Directorate of Economics and Statistics, Chennai; 2021.
9. Government of Tamil Nadu. District Statistical Handbook, Assistant Director of Economics and Statistics. Salem District; 2021.
10. Kumar PN, Rajasekar DD, Felix TK. Study on crop diversification of major crops in Salem district. Trends in Biosciences. 2018;11(30):1-3.
11. Adhikari A, Sekhon MK. An economic analysis of land use dynamics in Punjab. Int. J. of Adv. Res. 2014;2(5): 551-560.
12. Narmadha N, Karunakaran KR. Agricultural Diversification in Tamil Nadu-An Economic analysis. Economic Affairs. 2014;67(3):183-188.
13. Muthulakshmi K, Thilagavathi M, Shivakumar KM, Duraisamy MR, Kavino M, Gowri MU. Determination of growth and export performance of mango in India. J. of Exp. Agric. Int. 2022;44(10):163-169.
14. Singh AJ, Jain KK, Sain I. Diversification of Punjab agriculture: An econometric analysis. Ind. J. Agric. Econ. 1985;40(3): 298-303.
15. Shiyani RL, Pandya HR. Diversification of agriculture in Gujrat: A spatial-temporal analysis. Indian J. Agric. Econ. 1998;53(4):627-639.
16. Joshi PK, Ashok G, Bertha PS, Tiwari L. Agricultural diversification in South Asia: Patterns Determinants and Policy Implication. Econ. Polit. Wkly. 2004; 39:24.
17. Mohanty S. Population growth and changes in land use in India. Mumbai: IIPS Mumbai, ENVIS Centre; 2007.
18. Sandipan G, Palash P. Crop concentration and crop diversification analysis of Maldah district, West Bengal, India. Int. J. of Multidisciplinary Res. 2015;5(5): 56-65.
19. Chand R, Raju SS, Pandey LM. Progress and potential of horticulture in India. Ind. J. Agric. Econ. 2008;63:3.

20. Ganguly S, Patra P. Crop concentration and crop diversification analysis of Maldah district, West Bengal, India. International Journal of Multidisciplinary Research. 2015;5(5):56-65.

21. Kalaiselvi V. An economic analysis of crop diversification in Tamil Nadu. International Journal of Current Research and Review. 2012;4(8): 147-153.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/95716