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Impact of Urbanisation on Cropping Pattern in Tamil Nadu – An Economic Analysis

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Abstract— *Urbanisation per se becomes significant, since it affects land use, cropping pattern, occupational pattern, migration, literacy, access to markets and infrastructure, etc. Dynamics of cropping pattern is usually expressed at macro level and it has a significant bearing on the urbanization, mainly due to the availability and proximity of markets in the urban areas. The specific objectives set forth for the study are, to study the temporal changes and the shift in the cropping pattern and to measure the extent of diversification in the study area. The tools used for the study were descriptive statistics, growth rate analysis, markov chain analysis and diversification indices. The changes in the cropping pattern was estimated for the period from 2000-01 to 2019-2020 and further discussed under two decadal periods. The results revealed that there has been a gradual shift in the cropping pattern in Tamil Nadu state. The shift in cropping pattern, might be due to the awareness of the farmers on the profitability of the crops and developments in the market infrastructure and urbanisation.*

Keywords— ***Cropping pattern, dynamic changes, urbanization, diversification***

I. INTRODUCTION

Urbanisation and economic development are broadly synonymous and therefore the issue of agriculture needs to be dealt in the context of recent developments of sustained growth in incomes and urbanisation as well. Urbanisation *per se* becomes significant, since it affects land use, cropping pattern, occupational pattern, migration, literacy, access to markets and infrastructure, etc. Dynamics of cropping pattern is usually expressed at macro level and it has a significant bearing on the urbanization, mainly due to the availability and proximity of markets in the urban areas. The changes in the cropping pattern of India for the period from 1950-51 to 1997-98 revealed that the proportion of area under cereals to total cropped area had decreased from 61.10 per cent to 53.80 per cent, which was attributed to conversion of land for non-agricultural uses led by pressures of urbanization, industrialization, and demand for land for housing (Goswami and Challa, 2004).

The economic implications of urbanisation from a general perspective and the effect of labour migration on the demand for agricultural products and changes in cropping pattern which witnessess the noticeable changes with the urban profile. Besides urban demand, a well-developed infrastructure (roads, electricity, cold storage, processing, input markets, information sources, etc.) in urban areas encourage farmers to diversify towards high-value perishable food commodities. And the impact of urbanisation on crop diversification with temporal variations. With the above background, the present study was done to study the temporal changes, shift in the cropping pattern in the study area and to measure the extent of diversification in the study area.

II. MATERIALS AND METHODS

2.1 Methodology:

The time series data pertaining to area under different crops, net area sown, area sown more than once and gross cropped area was collected from the published sources, viz., the Season and Crop Report of Tamil Nadu. The changes in the cropping pattern was estimated for the

period from 2000-01 to 2019-2020 and further discussed under two decadal periods, namely, Decade I (2000-01 to 2009-10) and Decade II (2010-11 to 2019-2020). The major crop categories considered for the analysis were cereals, pulses, oilseeds, fiber crops, cash crops and fruits and vegetables.

2.2 Tools of Analysis

2.2.1 Descriptive Analysis - Descriptive statistical analysis was undertaken using percentage, mean etc.

2.2.2 Growth Rate Analysis

Compound growth rates of area under major crops were estimated to capture the trend in these variables. Exponential function of the following form was used to estimate the growth rates

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

Where,

Y_t = Area under the crop category at time t (ha)

r = Compound rate of growth of Y

Y_o = Initial year area under the crop category (ha)

By taking natural logarithm,

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

Now letting,

$\beta_1 = \ln Y_o$

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

Equation (2) can be written as

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

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

$$\ln Y_t = \beta_1 + \beta_2 t + U_i \quad \text{------- (4)}$$

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

Y_t = Area under crop category 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.

$$r = (\text{Antilog of } \beta_2 - 1) \times 100 \quad \text{------- (5)}$$

The major crop categories considered for the growth rate analysis were cereals, pulses, oil seeds, fiber crops, cash crops and fruits and vegetables.

2.2.3 Markov Chain Analysis

The dynamism in the direction of area under crop categories were 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 crop categories.

This can be denoted algebraically as

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

Where,

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

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

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

e_{jt} = The error term which is statistically independent of E_{it-1}

n = Number of crop categories

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

Thus, the expected share of each crop category during the period ‘t’ is obtained by multiplying the share of these crop categories 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

Min, OP* + I e

Subject to,

X P* + V = Y

GP* = 1

P* ≥ 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.

2.2.4 Diversification Indices

There are quite a few methods, which explain either concentration (i.e. specialization) or diversification of crops in a given time and space. Each method has some limitations and/or superiority over the others. The following indices were used in the study to measure the extent of diversification.

2.2.4.1 Herfindahl Index (HI)

Herfindahl Index is the sum of square of the acreage proportion of each crop in the total cropped area. The index is computed as

$$= \sum_{i=1}^{N} P_i^2$$

where, P_i represents acreage proportion of the i^{th} crop in total cropped area.

2.2.4.2 Simpson Index (SI)

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

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

Where, $P_i = A_i / \Sigma A_i$ is the proportion of the i^{th} crop 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.

2.2.4.3 Entropy Index (EI)

The Entropy Index is a direct measure of diversification having a logarithmic character. The index is computed as:

$$EI = \sum_{i=1}^{N} P_i * \log (1/P_i)$$

where, P_i represents acreage proportion of the i^{th} crop in total cropped area.

2.2.4.4 Modified Entropy Index

Modified Entropy Index is used to overcome the limitation of Entropy Index by using variable base of logarithm instead of fixed based logarithm. It can be computed as:

$$MEI = \sum_{i=1}^{N} P_i * \log_N P_i$$

where, P_i represents acreage proportion of the i^{th} crop in total cropped area.

2.2.4.5 Composite Entropy Index

This index possesses all desirable properties of Modified Entropy Index and is used to compare diversification across situations having different and large number of crops, since it gives due weightage to the number of crops. The formula of CEI is given by:

$$CEI = - [\sum_{i=1}^{N} P_i * \log_N P_i] * \{1-(1/N)\}$$

where, P_i represents acreage proportion of the i^{th} crop in total cropped area.

2.2.4.6 Ogive Index

Ogive Index (OI) is used to measure diversity. It measures deviations from benchmark given by equal proportion of each crop. For example, if there are N crops, the norm used for measuring deviations is 1/N. The formula of computing Ogive Index is as follows.

$$OI = \sum_{i=1}^{N} P_i \quad \{Pi - (1/N)\}^2 / (1/N)$$

where, P_i represents acreage proportion of the i^{th} crop in total cropped area.

III. RESULT AND DISCUSSION

3.1 Changes in the Area under Major Crop Categories

The average area under selected major crop categories, the relative share of each crop category in the total area and the decadal growths have been calculated to study the changes in the cropping pattern in the study area. These changes in the cropping pattern were estimated for the period from 2000-01 to 2019-2020 and further discussed under two decadal periods, namely, Decade I (2000-01 to

2009-10) and Decade II (2010-11 to 2019-2020), and are presented here under.

It could be seen from Table 1 that the share of average area under cereals in the total cropped area of Tamil Nadu state was accounted for 57.58 per cent in Decade I, and it has increased marginally to 58.66 per cent in Decade II. The decadal growth of the average area under cereal crops was only 0.79 per cent, which revealed that the average area under cereal crops was consistent over the years and still occupied the major share in the total cropped area.

The proportion of pulses area, the second major crop, accounted for 11.25 per cent in Decade I and it has sharply increased to 15.42 per cent in Decade II and the decadal growth was 35.48 per cent, which recorded the highest decadal change. Also, the average proportion of area under fiber crops has increased marginally from 2.63 per cent to 3.46 per cent and the decadal growth was 30.17 per cent. The proportion of average area under fruits and vegetables has also increased from 6.54 per cent to 7.36 per cent, thus resulting in a decadal growth of 11.45 per cent.

A further look at Table 1 would reveal that the share of average area under oilseeds declined from 15.05 to 9.23 per cent and has recorded a negative change of -39.37 per cent. Also, the share of cash crops area has declined from 6.95 per cent to 5.87 per cent between the decades, with a negative decadal change of -16.33 per cent and there was a marginal decline in the total cropped area by 1.07 per cent in the state.

The above results revealed that the area under four major crop categories, *viz.*, cereals, pulses, fiber crops and fruits and vegetables have recorded a positive change between the two decadal periods and the other crop categories, such as, oilseeds and cash crops had negative decadal growths, still had a considerable share in the total cropped area.

Table 1. Average Area under Major Crop Categories in the Study Area, 2000-01 to 2019-2020

(in '000 hectares)

S. No	Major Crop Categories	Tamil Nadu State		
		Decade I (2000-01 to 2009-10)	**Decade II (2010-11 to 2019-2020)**	**Decadal Growth**
1.	Cereals	25.37 (57.58)	25.57 (58.66)	0.79
2.	Pulses	4.96 (11.25)	6.72 (15.42)	35.48
3.	Oilseeds	6.63 (15.05)	4.02 (9.23)	-39.37
4.	Fiber crops	1.16 (2.63)	1.51 (3.46)	30.17
5.	Cash crops	3.06 (6.95)	2.56 (5.87)	-16.33
6.	Fruits and Vegetables	2.88 (6.54)	3.21 (7.36)	11.45
	Total	**44.06 (100.00)**	**43.59 (100.00)**	**-1.07**

Note: Figures in the parentheses indicate percentage to the respective totals

3.1.2 Growth Rates of Area under Major Crop Categories in the Study Area

The changes in the cropping pattern of Tamil Nadu state could also be ascertained through studying the growth in area under major crops. The growth rates of different crop categories have been analyzed using an exponential growth function. The results of the growth rates in area under major crop categories are presented in Table 2 and Figure 1.

It could be observed from Table 2 that the growth rate of area under cereals had shown a negative trend in Decade I (-0.05 per cent) and it had been positive in Decade II (1.28 per cent) and thus recorded a significant overall growth of 0.20 per cent. So also, the pulses area has shown

a negative growth rate of -0.87 per cent in Decade I and then recorded a positive trend in Decade II (3.67 per cent), with an overall significant growth of 2.60 per cent.

The growth in area under fiber crops and fruits and vegetables have registered a positively significant overall growth rates of 2.01 per cent and 1.15 per cent over the two decadal periods. However, the area under oilseeds and cash crops have recorded significant negative growth rates of -4.33 per cent and -2.63 per cent, respectively. It is understood that oilseeds and cash crops showed a negative trend in the area under these crops in Tamil Nadu. On the contrary, cereals, pulses, fiber crops and fruits and vegetables had a positive growth trend over the periods. This result is in accordance with Velavan and Balaji (2012).

Table 2. Growth Rates of Area under Major Crop Categories in the Study Area, 2000-01 to 2019-2020

S. No	Major Crop Categories	Tamil Nadu State		
		Decade I (2000-01 to 2009-10)	Decade II (2010-11 to 2019-2020)	Overall Period (2000-01 to 2019-2020)
1.	Cereals	-0.05	1.28	0.20***
2.	Pulses	-0.87	3.67	2.60***
3.	Oilseeds	-4.07***	-1.59	-4.33
4.	Fiber crops	-3.37	2.62	2.01***
5.	Cash crops	1.81	-10.16	-2.63
6.	Fruits and Vegetables	2.29***	0.34	1.15

(** and *** indicate significance at 5 per cent and 1 per cent levels, respectively)

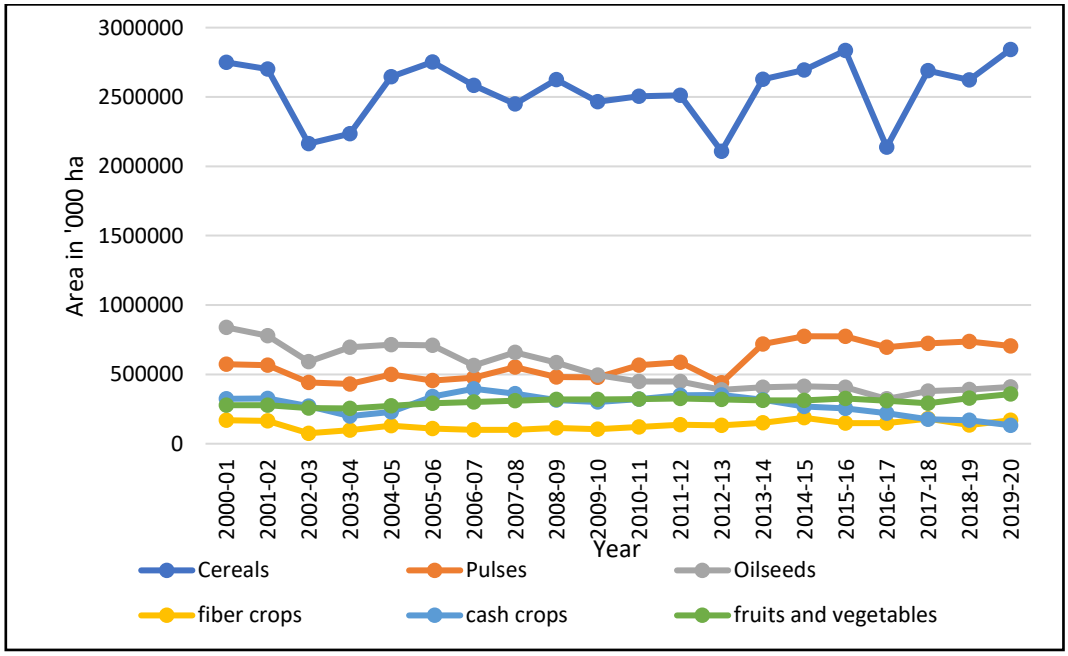

Fig. 1. Trends in the Area under Major Crop Categories in Tamil Nadu State

3.1.3 Crop Diversification Indices for Area under Major Crop Categories

Crop diversification based on the proportion of area under major crop categories has been measured and quantified using Herfindahl Index (HI), Simpson Index (SI), Entropy Index (EI), Modified Entropy Index, Composite Entropy Index and Ogive Index for a period of 20 years and for the two decadal periods separately, i.e., Decade I (2000-01 to 2009-10) and Decade II (2010-11 to 2019-2020). The average values of these indices for different crop categories in the study area are presented in Table 3.

The Herfindahl index would decrease with increase in diversification. It could be seen from Table 3 that the calculated average values of Herfindahl Index for the selected crop categories have been decreased in Tamil Nadu over the two decadal periods, i.e., from 0.38 in Decade I to 0.35 in Decade II, implying more crop diversification over the period of study.

The Simpson index and Entropy index would increase with the increase in diversification and vice versa**.** The results revealed that the calculated average values of Simpson Index moved up from 0.62 in Decade I to 0.65 in Decade II in Tamil Nadu, implying a gradual shift in the cropping pattern.

The Modified Entropy index increases with increase in diversification and vice-versa. The modified entropy index of crop diversification on the proportion of area under the selected crop categories in Tamil Nadu during Decade I to Decade II, clearly revealed that this index of crop diversification varied from 1.32 to 1.44, indicating increased diversification in Tamil Nadu over the decadal periods.

The Composite Entropy index increases with decreases in concentration. This index of crop diversification on the proportion of major crop categories in Tamil Nadu varied from Decade I to Decade II, i.e., 1.30 to 1.28, implying increased diversification in the state

The ogive index measures the idealness or equity with the crop categories and this index clearly revealed that the crops grown were not ideal and shows slight variation in the cropping pattern from Decade I to Decade II in both the state.

From the above results, it is evident that there has been a gradual shift in the cropping pattern in Tamil Nadu state.

Table 3. Crop Diversification Indices for Area under Major Crop Categories in the Study Area

S. No	Diversification Indices	Tamil Nadu State		
		Decade I (2000-01 to 2009-10)	**Decade II (2010-11 to 2019-2020)**	**Overall Period (2000-01 to 2019-2020)**
1.	Herfindahl Index	0.38	0.35	**0.38**
2.	Simpson Index	0.62	0.65	**0.62**
3.	Entropy Index	0.57	0.56	**0.56**
4.	Modified Entropy Index	1.32	1.44	**1.29**
5.	Composite Entropy Index	1.30	1.28	**1.28**
6.	Ogive Index	2.61	2.46	**4.84**

3.1.4 Dynamic Changes in the Area under Major Crop Categories

The direction of changes in the area under major crop categories in Tamil Nadu state have been analysed by employing Markov chain analysis using the secondary data on the area under major crop categories for a period of 20 years. The results are presented in Table 4.

It could be revealed from Table 4 that the diagonal elements represent the probability of retention of existing area under different crops. The probability of retention of existing area under cereals was estimated to be the highest at 81.69 per cent, followed by 48.45 per cent for pulses, 39.11 per cent for oilseeds, 10.14 per cent for cash crops and 8.88 per cent for fruits and vegetables. The probability of shift in area from cereals was 9.91 per cent to fruits and vegetables and 8.40 per cent to oilseeds. However, it gained around 99 per cent of area from fiber crops, 51.55 per cent from pulses and 17.73 per cent from oilseeds.

The fiber crops were found to be less stable in the state and could retain only at 0.03 per cent. The shift in the area from fiber crops was only to cereals (99.97per cent). However, it gained 43.54 per cent of area from cash crops.

The estimated steady state probability reveals that if the cropping pattern continues, in the future, around 62.39 per cent of area will be under cereals, 15.71 per cent will be under pulses, 8.60 per cent will be under oilseeds, 7.37 per cent will be under fruits and vegetables, 4.13 per cent under cash crops and only 1.80 per cent will be under fiber crops. These results are in conformity with Paramasivam *et al.*, (2017).

The future forecasted share of area under different crop categories obtained vide steady state probabilities revealed that the area under cash crops and fibre crops would likely to increase its share in the future, while all the other crop categories would likely to retain its share, indicating the shift in the cropping pattern in the state.

The analysis revealed that cereals was found to be highly stable in the state and could retain as high as 81 per cent, followed by pulses, oilseeds, cash crops and fruits and vegetables. The fiber crops was found to be highly unstable and could retain as low as 0.03 per cent.

Table 4. Transitional Probability Matrix for Area under Major Crop Categories in Tamil Nadu, 2000-01 to 2019-2020

Major Crops Categories	Cereals	Pulses	Oilseeds	Fiber crops	Cash crops	Fruits and Vegetables
Cereals	**0.8169**	0.0000	0.0840	0.0000	0.0000	0.0991
Pulses	0.5155	**0.4845**	0.0000	0.0000	0.0000	0.0000
Oilseeds	0.1773	0.0000	**0.3911**	0.0000	0.4316	0.0000
Fiber crops	0.9997	0.0000	0.0000	**0.0003**	0.0000	0.0000
Cash crops	0.0000	0.3352	0.0000	0.4354	**0.1014**	0.1280
Fruits and Vegetables	0.0000	0.9112	0.0000	0.0000	0.0000	**0.0888**
Steady State Probability	**0.6239**	**0.1571**	**0.0860**	**0.0180**	**0.0413**	**0.0737**
Current Year Share (in Percentage)	**61.59**	**15.25**	**8.86**	**3.67**	**2.88**	**7.75**

IV. CONCLUSIONS

The results on the changes in the cropping pattern in the study area, it is understood that oilseeds and cash crops area showed a negative trend in Tamil Nadu. On the contrary, cereals, pulses, fiber crops and fruits and vegetables had a positive growth trend over the periods.

The area under cereals was found to be highly stable in the state. The fiber crops were found to be highly unstable in the state. From the above results, it is evident that there has been a gradual shift in the cropping pattern in Tamil Nadu state. The shift in cropping pattern, might be due to the awareness of the farmers on the profitability of the crops and developments in the market infrastructure and urbanisation. Thus, the government should need to take up productivity enhancing measures in these crops, like varietal improvement, improved cultural practices, disease control measures, etc.

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