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Impact of Urbanisation on Cropping Pattern in Tiruchirapalli district – An Economic Analysis

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ABSTRACT: 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. Urbanization's overall economic effects, the impact of labour migration on the demand for agricultural goods, and shifts in cropping patterns are all factors that contribute to the urban profile's marked alterations. Under this 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.

Keywords: Cropping pattern, dynamic changes, urbanization, diversification.

INTRODUCTION

The topic of agriculture must be addressed in light of recent trends of steady income growth and urbanisation, as the two terms are essentially interchangeable. Urbanisation in general becomes important because it impacts migration, literacy, land use, farming patterns, occupational patterns, access to markets and infrastructure, and more. The availability and closeness of markets in urban areas are the primary reasons why cropping pattern dynamics, which are typically articulated at the macro level, have a considerable impact on urbanisation.

Cropping pattern definedas the time and space sequence of crops Kanwar (1971). The percentage of India's total cropped area that was under cereals fell from 61.10 percent to 53.80 percent between 1950–51 and 1997–98. This decline was ascribed to the conversion of land for non-agricultural uses, which was prompted by the demands of urbanisation, industrialisation, and housing demand (Goswami and Challa 2004). Over time, the percentage of important crop groups such as cereals, oilseeds, and millets has declined. Nonetheless, over time, the proportion of fruits, sugarcane, plantation crops, and pulses rose. Urbanisation may be the reason for crop diversification by cultivating highly profitable crops rather than specialising (Amirthalingam and Devi 2018)

Urbanization's overall economic effects, the impact of labour migration on the demand for agricultural goods, and shifts in cropping patterns are all factors that contribute to the urban profile's marked alterations. Along with urban demand, a well-developed urban infrastructure (such as roads, energy, cold storage, processing, input markets, and information sources) encourages farmers to diversify into high-value perishable food products as well as how crop diversity is affected by urbanisation throughout time. Under this 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.

MATERIALS AND METHODS

A. 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 Tiruchirapalli district. 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.

B. Tools of Analysis

(i) Descriptive Analysis. Descriptive statistical analysis was undertaken using percentage, mean etc.

(ii) 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

$$Y_t = Y_o (1+r)^t \quad (1)$$

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,

$$\ln Y_t = \ln Y_o + t \ln (1+r) \quad (2)$$

Now letting,
$\beta_1 = \ln Y_o$
$\beta_2 = \ln (1+r)$
Equation (2) can be written as

$$\ln Y_t = \beta_1 + \beta_2 t \quad (3)$$

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

$$\ln Y_t = \beta_1 + \beta_2 t + U_i \quad (4)$$

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.

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

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

(iii) 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

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

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

$$\sum_{i=1}^{n} P_{ij} \;) \leq P_{ij} \leq 1$$

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.

(iv) 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.

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

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

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

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.

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.

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.

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:

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

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

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.

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

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

RESULT AND DISCUSSION

A. 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 Tiruchirapalli district, which accounted for the highest share of 64.85 per cent in Decade I, has been marginally reduced to 60.81 per cent in Decade II. Though the decadal growth of the average area under cereals was negative (-15.89 per cent), it still occupied the major share in the total cropped area. The area under fruits and vegetables, the second major crop category in the district was almost equal in Decade I and Decade II with around 13 per cent, but the decadal growth was -13.04 per cent. The average area under oilseeds and fiber crops have declined over the decades and recorded negative decadal growths of -29.41 per cent and -40 per cent, respectively. Also, the total cropped area in the district has declined by 10.30 per cent.

However, the proportion of area under pulses was accounted for 4.24 per cent in Decade I and it has considerably increased to 6.08 per cent in Decade II and recorded a decadal growth of 28.57 per cent. So also, the proportion of cash crops area accounted for only 3.63 per cent in Decade I and drastically increased to 9.46 per cent in Decade II and the decadal growth was the highest for cash crops with 133.33 per cent growth.

The above results revealed This indicates the shift in cropping pattern in favour of high remunerative crops, might be due to the developments in the infrastructure and better facilities for marketing their produce. All the other crops have declined over the two decadal periods in Tiruchirapalli district.

Table 1: Average Area under Major Crop Categories in the Study Area, 2000-01 to 2019-2020 (in '000 hectares).

Sr. No.	Major Crop Categories	Tiruchirapalli District		
		Decade I (2000-01 to 2009-10)	Decade II (2010-11 to 2019-2020)	Decadal Growth
1.	Cereals	1.07 (64.85)	0.90 (60.81)	-15.89
2.	Pulses	0.07 (4.24)	0.09 (6.08)	28.57
3.	Oilseeds	0.17 (10.30)	0.12 (8.10)	-29.41
4.	Fiber crops	0.05 (3.03)	0.03 (2.03)	-40.00
5.	Cash crops	0.06 (3.63)	0.14 (9.46)	133.33
6.	Fruits and Vegetables	0.23 (13.95)	0.20 (13.52)	-13.04
	Total	**1.65 (100.00)**	**1.48 (100.00)**	**-10.30**

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

B. Growth Rates of Area under Major Crop Categories in the Study Area

The changes in the cropping pattern of Tiruchirapalli district 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 Fig. 1.

It could be observed from Table 2 the growth rate of area under cereals have registered a negative growth rate of -0.45 per cent in Decade I and a positive growth rate of 0.56 per cent in Decade II and had a significant negative growth rate (-1.35 per cent) in the overall period. The same declining trends have been noticed in oilseeds, fiber crops and fruits and vegetables in the overall period, registering growth rates of -2.58 per cent, -5.35 per cent and -2.02 per cent, respectively. However, the area under pulses and cash crops have registered positive growths of 2.85 per cent and 8.09 per cent, respectively, in the overall period.

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

Sr. No.	Major Crop Categories	Tiruchirapalli District		
		Decade I (2000-01 to 2009-10)	Decade II (2010-11 to 2019-2020)	Overall Period (2000-01 to 2019-2020)
1.	Cereals	-0.45	0.56	-1.35***
2.	Pulses	6.43	4.45	2.85
3.	Oilseeds	0.36	1.42**	-2.58**
4.	Fiber crops	3.19	-13.52	-5.35
5.	Cash crops	6.32**	-4.01	8.09
6.	Fruits and Vegetables	1.85***	-6.21	-2.02

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

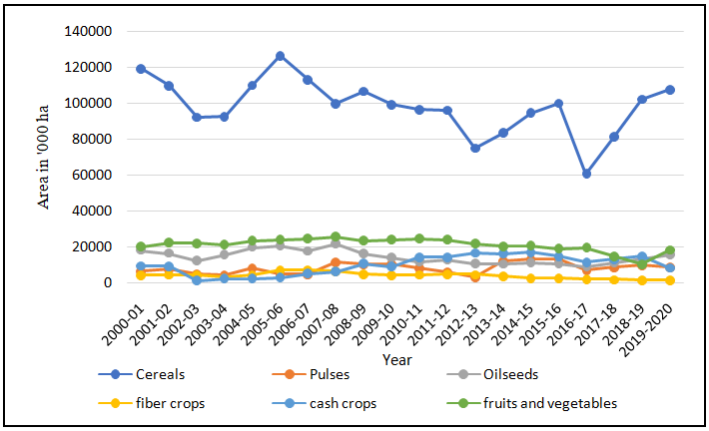

Fig. 1. Trends in the Area under Major Crop Categories in Tiruchirapalli District.

C. 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 Herfindahl Index has declined from 0.39 in Decade I to 0.37 in Decade II, which shows crop diversification during the periods.

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 Simpson index value increased from 0.61 to 0.63 over the period of study and the Entropy index has increased from 0.52 to 0.56, thereby implying crop diversification in the study area.

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. in Tiruchirapalli district also, the value of modified entropy index has increased from 1.28 to 1.29, showing the prevalence of crop diversification in the district.

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. where the composite entropy index has decreased from 1.18 to 1.07 over the two decades.

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 the district.

From the above results, it is evident that there has been a gradual shift in the cropping pattern in Tiruchirapalli district.

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

Sr. No.	Diversification Indices	Tiruchirapalli District		
		Decade I (2000-01 to 2009-10)	Decade II (2010-11 to 2019-2020)	Overall Period (2000-01 to 2019-2020)
1.	Herfindahl Index	0.39	0.37	0.38
2.	Simpson Index	0.61	0.63	0.62
3.	Entropy Index	0.52	0.56	0.54
4.	Modified Entropy Index	1.28	1.29	1.24
5.	Composite Entropy Index	1.18	1.07	1.24
6.	Ogive Index	2.86	2.48	2.67

D. 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 probability of retention of existing area under cereals were estimated at 76.21 per cent, which was the highest in Tiruchirapalli district, followed by cash crops (6.81 per cent) and oilseeds (0.60 per cent). And the probability retention of all the other crops such as pulses, fiber crops and fruits and vegetables were estimated at zero probability of retention. The probability of shift in area under cereals was 19.13 per cent to oilseeds, and 4.66 per cent to fiber crops. However, it gained, around 79 per cent of area from cash crops and 64 per cent from fruits and vegetables.

The pulses, fiber crops and fruits and vegetables were found to be highly unstable with zero retention. The probability of shift in area from pulses was estimated at 100 per cent to cash crops and it gained from cash crops and fruits and vegetables (14.41 per cent and 36.45 per cent, respectively). Whereas, the probability of shift in area from fiber crops was 88.37 per cent to cash crops and remaining 11.63 per cent of area to fruits and vegetables.

The estimated steady state probability reveals that if the cropping pattern continues, in the future around 59.83 per cent of area will be under cereals, 11.77 per cent will be under fruits and vegetables, 11.51 per cent will be under oilseeds, 8.57 per cent will be under cash crops, 5.53 per cent will be under pulses and only 2.79 per cent will be under fiber crops.

The analysis revealed that the cereals was found to be highly stable in Tiruchirapalli district and could retain as high as 76 per cent.

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

Major Crops Categories	Cereals	Pulses	Oilseeds	Fiber crops	Cash crops	Fruits and Vegetables
Cereals	**0.7621**	0.0000	0.1913	0.0466	0.0000	0.0000
Pulses	0.0000	**0.0000**	0.0000	0.0000	1.0000	0.0000
Oilseeds	0.0000	0.0000	**0.0060**	0.0000	0.0000	0.9940
Fiber crops	0.0000	0.0000	0.0000	**0.0000**	0.8837	0.1163
Cash crops	0.7878	0.1441	0.0000	0.0000	**0.0681**	0.0000
Fruits and Vegetables	0.6355	0.3645	0.0000	0.0000	0.0000	**0.0000**
Steady State Probability	**0.5983**	**0.0553**	**0.1151**	**0.0279**	**0.0857**	**0.1177**
Current Year Share (in Percentage)	**66.62**	**5.64**	**9.90**	**1.03**	**5.37**	**11.44**

CONCLUSIONS

The results on the changes in the cropping pattern in the study area, it is understood that the area under pulses and cash crops had an increasing trend over the decades and was proved from the crop diversification indices also. This clearly indicates the shift in the cropping pattern towards high remunerative crops and the awareness of the farmers on the profitability of crops and developments in the market infrastructure and urbanisation.

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