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Perceptual Structure of Crop Variegation in Tamil Nadu - A Methodological Approach

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A B S T R A C T

Changes in cropping pattern can be seen as the changes in proportion of acreage or the value of production under different crops to total agricultural area or production. The present study has analysed the nature of crop diversification in terms of the changes in cropping pattern with respect to acreage and production distribution. It is observed that share of major crops like paddy, groundnut and cumbu has decreased over the years in the state. However, share of minor crops like maize, black gram, green gram, coconut and fruits and vegetable increased over the years. Different Index like Herfindahl Index (0.42), Simpson Index (0.58) and Entropy Index (1.13) for different crops from 1980-81 to 2014-15 have found fair diversification among crop groups over different time period. Results from transitional probability matrix indicated that the highest retained area is cereals (76 per cent) and lowest retained area share is under cash crops (17 per cent) and this area is diversified towards fruit and vegetable crops to the total cropped area in last ten years.

Introduction

Crop variegation is a scientific method that deals with spatial relationship of crops in association with each other. Thus, crop variegation simply refers rising of various crops. It leads to a progress of low value agriculture to high value agriculture and this is an important way to enhance agricultural output (Dutta, 2012). Traditionally, Agriculture was practiced in rudimentary way that leads to degrading consequences. Now, impact of modernization brings the situation in the best practices for proper utilization, resisting soil erosion, retarding soil depletion and enhancing good production which will ultimately led to agricultural sustainability. The progress of human civilization mainly depends on agriculture. The most necessary thing in human life is food which is derived through agriculture. The quality and the culture of the man are the dominating role in the utilization of natural resources in different environmental conditions.

To strengthen the economic conditions of the farmers, an attempt was made to diversify the cropping pattern through introduction of

commercial crops. In addition, it was also proposed to encourage contract farming, agri-business houses and consortia (Chand, 2003). The experience from South-East Asia, Middle-East and North-Africa corroborates those policy makers and planners are crescent focusing on agricultural diversification to promote agricultural development (Petit and Barghouti, 1992). Several researchers have argued that agricultural diversification can be used as an instrument to raise farm income, generate employment opportunities, alleviate poverty and for conservation of natural resources (Von Braun, 1995; Pingali and Rosegrant, 1995; Ryan and Spencer, 2001; Birthal *et al.*, 2005).

Agriculture is an important sector in Tamil Nadu state economy. It contributed 13 per cent to the state income. Nearly 56 per cent of population in the state is depending on agriculture. It has the net cropped area of 5.12 million hectares and nearly 56 per cent of the area is irrigated by various irrigation sources. It has seven agro climatic zones which are suitable for various crops. Tamil Nadu stands first in productivity of sugarcane and third in groundnut in the country. Crop diversification is helpful for sustainability of agriculture. Mono cropping affects soil health and creates biotic and abiotic stress to the soil. Introduction of green revolution in late 60's and early 70's to meet the food shortage in the country had adversely affected the cropping pattern in the country. Introduction of fertiliser responsive and high yielding varieties in rice and wheat had converted many states as a mono crop state. After attaining self-sufficiency in food grain production central and State Government introduced many schemes to diversify cropping pattern to maintain food security. The crop composition further changed by the changes in prices, rainfall and labour availability. In this context, the present study is an attempt to find the pattern of crop diversification in Tamil Nadu State level with following objectives; to examine the growth rate of area and production under different crops in Tamil Nadu to study the nature and extent of crop diversification in the state and to assess the dynamism in direction of area under crops.

Materials and Methods

The present study is based on secondary data. Time series data on the area and production of selected crops have been collected from the Season and Crop Reports released every year by the Directorate of Economics and Statistics (DES), Government of Tamil Nadu, for the period 1980-81 to 2014-15 (35 Years). For the rigorous analysis, the whole period is divided into a number of sub-periods (Decade). For the present study area and production under major crops (Paddy, Cholam, Cumbu, Ragi, Maize, Sami, Bengalgram, Redgram, Blackgram, Greengram, Horsegram, Banana, Castor, Coconut, Cotton, Gingelly, Groundnut, Mango, Sugarcane, Sunflower, Tapioca, Turmeric, Chillies, Onion, Potato) were selected and used for further findings. Since these crop area accounts for more than 80 per cent of the total cropped area.

The growth in area under different crops in Tamil Nadu were analysed through the compound growth function. The extent and nature of crop diversification was tested by using different indices like Herfindahl Index, Simpson Index and Entropy Index were used.

Markov chain analysis

To assess the dynamism in direction of area under crops during 1980-81 to 2014-15, transitional probabilities were calculated based on linear programming (LP) approach using LINDO software. To know the shift in cropping pattern, different crop groups like cereals, pulses, cash crops, oilseeds, fruits, vegetables and spices crops were considered.

Markov chain analysis develops a transitional probability matrix 'P', whose elements P_{ij} indicate the probability (share) of crop group switching from the i^{th} crop group to the j^{th} crop group over time. Its diagonal elements represent retention share of respective crop group in terms of area under crops. This can be algebraically expressed as

$$E_{jt} = \Sigma\ [E_{it} - 1]\ P_{ij} + e_{jt}$$

i=1,...,n

Where,

E_{jt} = Area under crop to the j^{th} crop group in year't'

E_{it-1} = Area under crop of I^{th} crop group during the year 't-1'

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

e_{jt} = The error-term statistically independent of E_{it-1}, and

n = The number of crop groups.

The transitional probabilities P_{ij} arranged in (m × n) matrix have the following properties:

$$\Sigma\ P_{ij} = 1 \text{ and } 0 \leq P_{ij} \leq 1$$

i=1,...,n

The transitional probability matrix (T) based on LP framework is estimated using Minimization of Mean Absolute Deviation (MAD).

Min, OP* + I e
ST
X P* + V = Y
GP* = 1
P* > 0

Where,

P* is the transitional probability matrix, '0' is the zero vector, 'I' is an appropriately dimensional vector of areas, and 'e' is the vector of absolute errors.

Results and Discussion

Changes in cropping pattern of important crops in Tamil Nadu

Share of area under major crops to total cropped area in the state, in terms of percentage over the period (1980-81 to 2014-15) were analysed and presented in Table 1.

It could be observed from the Table 1 that paddy has the highest share of nearly 36 per cent in total cultivated area followed by groundnut, cotton, cholam, coconut, sugarcane, black gram, green gram, cumbu, ragi, maize and horse gram over 35 years. Share of the major cereals has decreased over the years except maize in the state. The share of paddy has decreased marginally from 37.25 per cent in 1980-81 to 36.05 per cent in 2014-15. However, the share of maize has increased from 0.38 per cent in 1980-81 to 2.68 per cent in 2014-15. The main reason could be the increase in demand of maize for animal feed in the state. Among the pulses, area under all crops has decreased except black gram and green gram. Share of black gram area has increased from 3.26 per cent in 1980-81 to 4.26 per cent in 2014-15. Similarly the share of green gram has also increased from 1.57 per cent in 1980-81 to 2.26 per cent in 2014-15. Share of other major pulses like horse gram and bengal gram and groundnut has decreased nearly 50 per cent over the years. Share of chillies and onion has slightly improved over the years. Share of sugarcane has increased from 3.34 per cent to 4.86 per cent. The main reason could be the increase in the number of sugar mills and procurement

price of sugarcane over the years. Share of mango has doubled in the study period. However, share of groundnut, gingelly and caster has decreased in the same period. In contrast, share of coconut has doubled in the study period. Share of cotton has decreased from 3.49 per cent in 1980-89 to 2.95 per cent in 2014-15.

It is clear from the above discussion that the share of major crops like paddy, groundnut and cumbu has decreased over the years in the state. However, share of minor crops like maize, black gram, green gram, coconut and mango has increased over the years in the state. This showed that state is moving towards crop diversification rather than specialization.

Growth in area under important crops in Tamil Nadu

The growth in area under different crops over the period of 35 years (1980-81 to 2014-15) was analyzed using the compound growth function.

It is observed from the Table 2 that the annual area growth rate of all cereals except maize has grown negatively in the state. Growth rate of maize has positive growth of 10.01 per cent growth over the study period. It's the highest growth rate of all other crop. Area under cumbu, ragi and cholam has grown negatively in the study period. Among the pulses, black gram and green gram have grown positively and the growth rate is increasing over the decades.

Growth of area under bengal gram has turned positive in the recent years. Growth rate of sugarcane has increased 2.13 per cent in 80's to -4.7 per cent in 1014-15 and over 35 years it showed the positive growth of 1.85 per cent. Similarly, Area under mango has grown 4.36 per cent, 7.71 per cent and 2.42 per cent in 80's, 90's and 2000-10 respectively and banana also showed increase in area over the study period. Area under groundnut has decreased nearly 4.1 per cent in recent years and castor also showed the reduced area over the study period. Area under coconut has increased positively over the years and it has grown 4.23 per cent over the years. But, the area under cotton has decreased in past two decades and area has reduced 2 percent over the 35 years.

Based on the area growth rates of crops in the state, it is evident that the crops are having the major shares like paddy, groundnut, castore and cholam have grown negatively in the state. The crops are having the least share like maize, sugarcane, coconut, mango and green gram have grown positively over the years. This gives further clear picture of crop diversification in the State.

Growth rate of production of important crops in Tamil Nadu

The growth in production of different crops over the period of 35 years (1980-81 to 2014-15) was analyzed using the compound growth function.

It is clear that production growth rate of major crops showed the positive trend in growth and crops like millets, red gram, horse gram, castor, cotton, groundnut and chillies showed negative growth over the study period. Maize production showed the significant positive growth rate compared with all other crops. It has 7.13 per cent, 10.26 per cent, 27.71 per cent and 21.74 per cent in 80^{s} 90^{s}, 2000 and 2010-15 respectively.

Crops like banana, mango, sugarcane, coconut and tapioca showed the positive growth rate of production (4.42 per cent, 3.9 per cent, 2.09 per cent, 2.96 per cent and 3.21 per cent respectively).

Table.1 Area share of important crops in Tamil Nadu (per cent)

Year	1980-81 to 1989-90	1990-91 to 1999-2000	2000-01 to 2009-10	2010-11 to 2014-15	1980-81 to 2014-15
Paddy	37.35	35.79	37.18	36.05	36.66
Cholam	11.71	7.42	6.32	5.78	8.23
Cumbu	5.24	3.41	1.87	1.03	3.26
Ragi	3.21	2.35	2.28	1.85	2.53
Maize	0.38	0.83	3.58	6.15	2.09
Samai	2.12	1.04	0.68	0.39	1.19
Bengal Gram	0.14	0.14	0.13	0.16	0.14
Red Gram	1.50	1.54	0.83	1.00	1.27
Black Gram	3.26	3.79	4.92	6.37	4.26
Green Gram	1.57	2.01	2.73	3.59	2.26
Horse Gram	2.46	1.71	1.37	1.47	1.82
Banana	0.97	1.33	1.89	2.04	1.46
Castor	0.22	0.49	0.24	0.12	0.30
Coconut	2.47	3.99	7.31	8.62	4.99
Cotton	3.49	5.56	2.31	2.95	3.75
Gingelly	1.90	2.04	1.41	1.00	1.70
Groundnut	15.80	16.58	11.34	7.29	13.79
Mango	0.72	1.33	2.43	2.90	1.63
Sugarcane	3.34	4.70	6.02	6.48	4.86
Sunflower	0.26	0.45	0.35	0.20	0.34
Tapioca	0.95	1.44	2.29	1.95	1.58
Turmeric	0.15	0.31	0.52	0.91	0.40
Chillies	0.53	1.22	1.33	0.99	1.01
Onion	0.18	0.45	0.57	0.59	0.42
Potato	0.07	0.09	0.10	0.10	0.09

Source: Calculated based on the data collected from the season and crop report of Tamil Nadu.

Table.2 Growth rate of area of important crops in Tamil Nadu (per cent)

Crops	Time Period				
	1980-81 to 1989-90	1990-91 to 1999-2000	2000-01 to 2009-10	2010-11 to 2014-15	1980-81 to 2014-15
Paddy	-2.5	1.37	0.21	-2.2	-0.8
Cholam	-1.2	-5	-3.6	16.3	-3.4
Cumbu	-2.6	-6.2	-11.4	4.61	-6.6
Ragi	-1.9	-4.7	-1	10.05	-2.5
Maize	1.9	4.7	9.53	10.05	10.01
Samai	-2.4	-10.2	-10.3	0.3	-6.7
Bengal Gram	8.58	1.41	1.51	5.8	-0.5
Red Gram	5.28	-6.3	-10.3	19.17	-3.1
Black Gram	8.58	1.41	1.51	5.8	1.97
Green Gram	3.03	-1.4	1.82	7.55	2.14
Horse Gram	-5.3	-9.4	-9.8	15.83	-3.3
Banana	0.5	4.82	5.04	-4.3	2.26
Castor	8.46	-0.2	-20.8	-2.8	-3
Coconut	5.13	5.94	2.24	1.06	4.23
Cotton	8.24	-7.1	-3.2	10.24	-2
Gingelly	5.22	-4.5	-5.8	8.46	-2.9
Groundnut	2.48	-3.7	-4.2	-4.1	-3.2
Mango	4.36	7.71	2.42	0.27	4.74
Sugarcane	2.13	3.62	1.9	-4.7	1.85
Sunflower	5.46	-9.2	17.1	-4.9	-0.7
Tapioca	2.23	1.09	4.25	-8.5	2.49
Turmeric	-7.4	10.75	3.7	-21	3.65
Chillies	-3.2	3.48	-2.5	-6.8	-0.8
Onion	6.63	3.44	1.46	-5.9	1.25
Potato	0.17	0.21	2.1	2.85	-1.6
Total Area	0.38	-1.1	-0.2	1.45	-0.7

Source: Calculated based on the data collected from the season and crop report of Tamil Nadu.

Table.3 Growth rate of production of important crops in Tamil Nadu

Crops	Time Periods				
	1980-81 to 1989-90	1990-91 to 1999-2000	2000-01 to 2009-10	2010-11 to 2014-15	1980-81 to 2014-15
Paddy	3.59	1.66	-0.004	7.8	0.33
Cholam	4.97	-5.8	-1.9	2.25	-2.6
Cumbu	1.9	-3.3	-7.7	6.87	-4.4
Ragi	1.9	-4.5	1.52	9.06	-1.2
Maize	7.13	10.26	27.71	21.74	13.71
Samai	4.89	-11.6	-8.6	7.78	-4.6
Bengal Gram	-2.6	1.57	1.1	-2.8	-0.5
Red Gram	7.33	-4.9	-9.3	3.04	-2.3
Black Gram	8.8	-2.4	-1.5	6.94	1.85
Green Gram	8.73	-1.2	-3.3	8.6	3.09
Horse Gram	-2.2	-4.5	-9.9	7.16	-2.4
Banana	7.21	6.73	7.73	-6.7	4.42
Castor	3.73	-0.04	-21.1	-1.2	-3.5
Coconut	1.85	-1.4	8.5	-6.2	2.96
Cotton	8	-2.4	2.72	2.49	-1.1
Gingelly	6.52	0.03	-5.6	13.76	1.2
Groundnut	4.04	-0.8	-2	-0.8	-0.4
Mango	-7.9	3.52	2.36	1.46	3.9
Sugarcane	3.28	4.41	1.13	-5.8	2.09
Sunflower	-0.004	4.41	19.02	-4.9	2.24
Tapioca	5.78	2.57	4.24	-10.8	3.21
Turmeric	-16.5	12.09	6.31	-30.9	2.74
Chillies	-2.8	3.61	-5.9	-1.7	-1.9
Onion	4.86	3.58	1.52	-8.9	1.06
Potato	-0.04	-3.3	-2.1	7.46	-2
Total Production	3.77	3.54	1.88	-2.3	2

Source: Calculated based on the data collected from the season and crop report of Tamil Nadu.

Table.4 Indices for area under different crops in Tamil Nadu, 1980-81 to 2014-15

INDEX	1980-81 to 1989-90	1990-91 to 1999-00	2000-01 to 2009-10	2000-01 to 2009-10	1980-81 to 2014-15
Harfindhal Index	0.46	0.41	0.40	0.43	0.42
Simpson Index	0.53	0.59	0.60	0.57	0.58
Entropy Index	1.04	1.16	1.15	1.15	1.13

Source: Calculated based on the data collected from the season and crop report of Tamil Nadu.

Table.5 Transitional probability matrix for area under different crop groups in Tamil Nadu 1995-96 to 2014-15

1985-86 to 1994-95							
	Cereals	Pulses	Oil Seeds	Cash Crops	Vegetables	Fruits	Spices
Cereals	0.79	0.04	0.12	0.03	0.00	0.02	0.02
Pulses	0.35	0.39	0.00	0.26	0.00	0.00	0.00
Oil seeds	0.05	0.40	0.41	0.00	0.06	0.04	0.04
Cash crops	0.00	0.17	0.59	0.13	0.06	0.00	0.00
Vegetables	0.11	0.00	0.00	0.80	0.09	0.00	0.00
Fruits	0.00	0.00	0.00	0.87	0.02	0.11	0.00
Spices	0.00	0.72	0.20	0.00	0.00	0.00	0.08
1995-96 to 2004-05							
	Cereals	Pulses	oil seeds	cash crops	vegetables	fruits	spices
Cereals	0.58	0.20	0.13	0.07	0.00	0.01	0.02
Pulses	0.26	0.15	0.47	0.00	0.00	0.05	0.06
Oil seeds	0.66	0.00	0.35	0.00	0.00	0.00	0.00
Cash crops	0.43	0.00	0.00	0.57	0.00	0.00	0.00
vegetables	0.53	0.00	0.00	0.18	0.21	0.08	0.00
fruits	0.00	0.00	0.16	0.00	0.15	0.69	0.00
spices	0.01	0.00	0.00	0.00	0.94	0.00	0.05
2005-06 to 2014-15							
	Cereals	Pulses	oil seeds	cash crops	vegetables	fruits	spices
Cereals	0.76	0.00	0.00	0.14	0.02	0.06	0.03
Pulses	0.20	0.72	0.08	0.00	0.00	0.00	0.00
oil seeds	0.19	0.00	0.68	0.00	0.13	0.01	0.00
cash crops	0.36	0.47	0.00	0.17	0.00	0.00	0.00
vegetables	0.00	0.00	0.58	0.00	0.27	0.16	0.00
fruits	0.53	0.05	0.00	0.00	0.00	0.42	0.00
spices	0.00	0.00	0.00	0.00	0.00	0.65	0.35

Source: Calculated based on the data collected from the season and crop report of Tamil Nadu.

Variations in different indices of crop diversification across different time periods for Tamil Nadu

The extent and nature of crop diversification has been tested by using different indices like Herfindahl Index, Simpson Index and Entropy Index and the results are presented in Table 4.

Herfindahl index for area under different crops

The Herfindahl Index would decrease with increase in diversification. The results (Table 4) indicated that values of Herfindahl Index were less for over three decades as well as 35 years in the state, thereby implying diversification. Among these time periods 1980-81 to 1989-90 period having high index value (0.46) is less diversification and 2000-01 to 2009-10 period having lower index value (0.40) is more diversification.

Simpson index for area under different crops

The calculated average values of Simpson Index for different crops for different time periods were 0.53 for 1980-81 to 1989-90 period, 0.59 for 1990-91 to 1999-00 and 0.60 for 2000-01 to 2009-10. Bhattacharya (2008) has indicated that Simpson Diversity Index moved up from 0.52 in 1997-98 to 0.59 in 2004-05 implying a gradual shift in cropping pattern towards high-value crops like flowers, fruits and vegetables in West Bengal

Entropy index for area under different crops

The Entropy Index increases with increase in diversification and vice versa. The results have clearly shown that Tamil Nadu state cropping pattern diversifying over the years. Among the different time periods 1980-81 to 1989-90 having less index value (1.04) indicates less diversification and 1990-91 to 1999-00, 2000-01 to 2009-10 and 2000-01 to 2009-10 period having more index value (1.16, 1.15,and 1.15 respectively) indicates increased diversification in the state.

Transitional probability for area under different crops

The change in the area under crops in Tamil Nadu was analysed using Markov chain, capturing the shift in the area under crops. For the analytical purpose crops were divided into major crop groups (Cereals, Pulses, Oil Seeds, Fruits Vegetables, and Spices). Markov chain analysis yields transitional probability matrix 'P' whose diagonal elements indicate the retention probability and off-diagonal elements represent switching-over probability (Atkin and Blandford, 1982).

Transitional probability matrix results (Table 5) revealed that among the seven crop groups, cereals group retained a higher share (72%) in 1985-86 to 1994-95. The oil seed and pulses groups retained a higher share compared with fruits, vegetables and spices crop groups. In 1995-96 to 2004-05 fruit crops retained higher share (69%) followed by cereals, cash crops, and oil seed crops. During last ten years (2005-06 to 2014-15) cereal group has highest retained share of 76 per cent followed by pulses oilseed fruits and spices crop groups. In this period cash crop group has the lowest retained share 17 per cent. The analysis revealed that there was an overall shift towards horticultural crops at the cost of other crops.

Findings of the study revealed that the proportion of major crops like paddy, groundnut and cumbu has decreased over the years in the state. However, proportion of crops like maize, black gram, green gram, coconut and fruits and vegetable increased over the years. It showed that state is moving

towards crop diversification rather than specialisation. It is evident that, based on the compound growth rate of cropped area of major crops like paddy, groundnut and cumbu has shown negative growth rate, whereas crops like maize, sugarcane, coconut and green gram have shown positive growth over the years. Herfindahl Index, Simpson Index and Entropy Index for different crops from 1980-81 to 2014-15 have found fair diversification among crop groups over different time period. Results from the transitional probability matrix indicate the share of fruits and vegetables in the total cropped area has increased significantly. Hence, it is concluded that crop diversification has been taking place in the state over the years.

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