

## STRUCTURAL CHANGES IN CROPPING PATTERN

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**Abstract:** The present investigation was undertaken to study the structural changes in cropping pattern in selected tahsils of Wardha district. The study was based on secondary data for the period of 10 years from 2005-06 to 2014-15 for the tahsils viz., Arvi, Ashti, Devali and Samudrapur. Markov chain analysis was used to study the structural changes in cropping pattern. Results showed that area under cotton and soybean were most stable and area under kharif jowar and mung showed most instability. Cotton and soybean were highest gainer of area share.

**Keywords:** Cropping, pattern, structural change, markov chain.

### INTRODUCTION

The cropping pattern of a region reveals the proportion of area of land under different crops at a point of time, the rotation of crops and the area under different crops. The cropping pattern plays a vital role in determining the level of agricultural production and reflects the agricultural economy of an area or region. Cropping pattern is defined as a combination of agricultural crops that are grown in a particular geographical area. Cropping patterns are the yearly sequence of crops grown and the spatial arrangement of crops. A change in cropping pattern implies a change in proportion of area under different crops. It has significant bearing on widening the geographical inequalities in income distribution. A dynamic change has been witnessed in agricultural scene in our country, particularly during post-green revolution period. Cropping pattern refers to adoption of particular type of crops by the farmers in a particular region. It is expressed at macro level, that is, district, tahsil or village level. Hence, present study was conducted with the specific objective to analyze the structural changes in cropping pattern over the years in selected tahsils of Wardha district.

### MATERIALS AND METHODS

For the present study four tahsils of Wardha district viz., Arvi, Ashti, Deavli and Samudrapur were selected purposively. The study was based on secondary data collected from various Government publications for a period of 10 years i.e. from 2005-06 to 2014-15.

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Kharif crops viz., kharif jowar, mung, tur, cotton, soybean and other crops were selected for present study.

### Markov Chain Analysis

For the estimation of structural changes of cropping pattern, Markov Chain Analysis was used for time period from 2005-06 to 2014-15 for selected tahsils of Wardha district. Kammar and Basvaraja (2012) also have used similar model to study the structural changes in cropping pattern in northern transitional zone of Karnataka.

### The Markov Probability Model:

A stochastic process is one analyze a set of trials or experiments probabilistically. For stochastic process if  $N$  assumed that the movements (transitions) of objects from one division (possible outcome) to another are governed by a probability mechanism or system. A finite Markov process is a stochastic process whereby the outcome of a given trial  $t$  ( $1=1,2,.. T$ ) depends only on the outcome of the preceding trial ( $t-1$ ) and this dependence is the same at all stage in the sequence of trials. Consistence with this definition, let

$S_i$ ; represent the  $r$  tehsil or possible outcomes;  $i = 1,2,...r$ .

$W_{it}$  represents the probability that tehsil  $S_i$  occurs on trial  $t$  or the proportion observed in trial  $t$  in alternative outcome tehsil i.e. of a multinomial population based on a sample of size  $n$ , i.e.  $\Pr(S_{it})$ .

$P_{it}$  represent the transitional probability that which denotes the probability that if for any time  $t$  the process is in state  $S_i$  it moves on the next trial to division  $S_j$  i.e.  $\Pr(S_{jt} + 1/S_{jt}) = P_{ij}$ .

$P = (P_{ij})$  represent the transitional probability matrix which denotes the transitional probability for every pair of tehsil ( $i, j = 1,2 \dots r$ ) and has the following properties.

$$0 < P_{ij} < 1 \dots\dots\dots (1)$$

and

$$\sum P = 1, \text{ for } i = 1,2,\dots\dots\dots r \dots\dots\dots (2)$$

Given this set of notations and definitions for a first order Markov chain the probability of a particular sequence  $S_i$  on trial  $t$  and  $S_t$  on trial  $t+1$  may be represented by  $\Pr(S_{it} S_{it} + 1) = \Pr$

$$(S_{it}) \Pr(S_{it} + 1 / S_{it}) = W_{it} P_{jt} \dots\dots\dots (3)$$

and the probability of being in division  $j$  at trial  $t+1$  may be represented by

$$\Pr(S_{j, t+1}) = \sum W_{it} P_{it} \text{ or } i$$

$$W_{it} \quad t + 1 = \sum W_{it}P_{ij} \dots\dots\dots (4)$$

The data for the study are the proportion of area under selected crops. These proportions change from year to year as result of the factors like weather, technology, price and other institutional change. It is reasonable to assume that the combined influence of these individually systematic forces approximate to a stochastic proceeds and the propensity of farmers to move from one crop to another differs according to the crop involved in tehsil. If these assumptions are acceptable, then the process of cropping pattern change may be described in the form of a matrix p of first order transitional probabilities. The element of  $P_{ij}$  of the matrix indicates the probability of a farmer in crop division in one period will move to crop division j during the following period. The diagonal element  $P_{ij}$  measures the probability that the proportion share of  $j^{th}$  category of crop were maintained.

**Estimation of Transition Probability Matrix:**

Equation (4) as a basis for specifying the statistical model for estimating the transition probabilities. If errors are incorporated in equation (4) to account for the difference between the actual and estimated occurrence of  $(W_j \ t+1)$ , the sample observations assumed to be generated by the following Linear Statistical Model.

$$W_{jt} = \sum W_{t-1} P_{ij} + U_{jt} \dots\dots\dots (5)$$

Or in Matrix form it can be written as

$$Y_j = X_j P_j + U_j \dots\dots\dots (6)$$

Where -

$Y_j$  is a  $(T \times 1)$  vectors of observations reflecting the proportion in cropping pattern j in time t,  $x_j$  is a  $(T \times R)$  matrix of realized values of the proportion in cropping pattern i in time t-1,  $P_j$  is a  $(r \times 1)$  vector of unknown transition parameters to be estimated and  $U_j$  is a vector of random disturbances.

**RESULTS AND DISCUSSION**

**1 Structural changes in cropping pattern in Arvi tahsil of Wardha district**

The results of the transition probability matrix for crops in Arvi tahsil of Wardha district for the period of 2005-06 to 2014-15 are presented in the Table 1. The crops considered in the study were kharif jowar, tur, mung, cotton, soybean and other crops.

**Table 1: Structural changes in cropping pattern in Arvi tahsil of Wardha district**

Crops	Kh Jowar	Tur	Mung	Cotton	Soybean	Other crops
Kh Jowar	<b>0.0000</b>	0.0000	0.0022	0.0000	0.9422	0.0556
Tur	0.0000	<b>0.2318</b>	0.0000	0.7682	0.0000	0.0000
Mung	0.0000	0.0000	<b>0.0092</b>	0.0000	0.9908	0.0000
Cotton	0.0000	0.1766	0.0000	<b>0.6649</b>	0.1585	0.0000
Soybean	0.0490	0.1696	0.0031	0.0000	<b>0.7782</b>	0.0001
Other crops	0.0000	0.0000	0.0000	0.0000	1.0000	<b>0.0000</b>

It is inferred from the Table 1 that kharif jowar and other crops have shown instability. Kharif jowar has lost about 0.22 per cent of its previous years' share to mung, 94.22 per cent to soybean and 5.56 per cent to other crops. Tur has retained 23.18 per cent of its previous years' share of area and lost about 76.82 per cent to soybean. However, tur gained 17.66 per cent area from cotton and about 16.96 per cent from soybean. Mung has retained only 0.92 per cent of its previous years' share of area and lost about 99.08 per cent of its previous years' share to soybean. But it gained its share of 0.31 per cent from soybean. Cotton retained about 66.49 per cent of its previous years' share and lost about 17.66 per cent of its area to tur and about 15.85 per cent to soybean. Cotton gained about 76.82 per cent of area share from tur. Soybean has shown highest stability by retaining 77.82 per cent of its previous years' share. Meanwhile it has lost its area share to kharif jowar (4.90 per cent), tur (16.96 per cent), mung (0.31 per cent) and other crops (0.10 per cent). Other crops failed to retain their previous years' area share. They lost their previous years' share to soybean (100.00 per cent). But they gained about 5.56 per cent area share from kharif jowar and about 0.01 per cent from soybean.

## **2. Structural changes in cropping pattern. in Ashti tahsil of Wardha district**

The results of the transition probability matrix for major crops in Ashti tahsil of Wardha district for the period of 2005-06 to 2014-15 are presented in the Table 2 The crops considered in the study were kharif jowar, tur, mung, cotton, soybean and other crops.

**Table 2: Structural changes in cropping pattern in Ashti tahsil of Wardha district**

Crops	Kh Jowar	Tur	Mung	Cotton	Soybean	Other Crop
Kh Jowar	<b>0.0000</b>	0.0000	0.0000	0.0000	1.0000	0.0000
Tur	0.0000	<b>0.0300</b>	0.0000	0.0000	0.9700	0.0000
Mung	0.0000	0.0000	<b>0.0000</b>	0.0000	1.0000	0.0000
Cotton	0.0025	0.1543	0.0000	<b>0.8432</b>	0.0000	0.0000
Soybean	0.0019	0.1549	0.0047	0.0963	<b>0.7323</b>	0.0099
OtherCrop	1.0000	0.0000	0.0000	0.0000	0.0000	<b>0.0000</b>

The results in the Table 2 revealed that kharif jowar, mung and other crops have shown instability. Kharif jowar lost its majority of area share to soybean (100.00 per cent). However it has gained mainly from cotton (0.25 per cent), soybean (0.19 per cent) and other crops (100.00 per cent). Tur has retained only 3.00 per cent of its previous years' share and lost about 97.00 per cent of its previous years' area share to soybean. Mung was unable to retain its previous years' acreage and lost about 100.00 per cent of area to soybean. Cotton as one of the major commercial crop has shown stability by retaining 84.32 per cent of its previous years' share. Meanwhile it has lost its previous years' area share to kharif jowar (0.25 per cent) and tur (15.43 per cent). Soybean retained 73.23 per cent of its previous years' area share and gained about 100.00 per cent of area from kharif jowar, 97.00 per cent from tur and 100.00 per cent from mung. Other crops failed to retain their previous years' share. But it gained 0.99 per cent area share from soybean and lost about 100.00 per cent of its previous years' are to kharif jowar.

### **3 Structural changes in cropping pattern in Devali tahsil of Wardha district**

The results of the transition probability matrix for crops in Devali tahsil of Wardha district for the period of 2005-06 to 2014-15 are presented in the Table 3. The crops considered for the study were kharif jowar, tur, mung, cotton, soybean and other crops.

From the Table 3, it is observed that kharif jowar retained about 33.99 per cent of its previous years' share and lost about 0.90 per cent of its previous years' area share to mung, about 64.63 per cent to soybean and about 0.48 per cent to other crops.

**Table 3: Structural changes in cropping pattern in Deavli tahsil of Wardha district**

Crops	Kh Jowar	Tur	Mung	Cotton	Soybean	Other crops
Kh Jowar	<b>0.3399</b>	0.0000	0.0090	0.0000	0.6463	0.0048
Tur	0.0000	<b>0.0000</b>	0.0000	1.0000	0.0000	0.0000
Mung	1.0000	0.0000	<b>0.0000</b>	0.0000	0.0000	0.0000
Cotton	0.0000	0.3616	0.0000	<b>0.5175</b>	0.1209	0.0000
Soybean	0.0104	0.1062	0.0004	0.0000	<b>0.8830</b>	0.0000
Other crops	0.6614	0.0000	0.0000	0.0000	0.0000	<b>0.3386</b>

It has gained about 100.00 per cent of area share from mung, 1.04 per cent from soybean and 66.14 per cent from other crops. Tur was unable to retain its previous years' area share. However, it has lost about 100.00 per cent of area to cotton and gained about 36.16 per cent of area from cotton and 10.62 per cent from soybean. Mung has shown instability. It has lost about 100.00 per cent of area share to kharif jowar and gained only about 0.90 per cent of area from kharif jowar and about 0.04 per cent from soybean. Cotton has retained about 51.57 per cent of its previous years' area share and gained about 100.00 per cent of area share from tur. But it has lost about 36.16 per cent of its area share to tur and 12.09 per cent to soybean. Soybean has shown highest stability by retaining 88.30 per cent of its previous years' area share. Meanwhile it has gained 64.63 per cent of area from kharif jowar and about 12.09 per cent from cotton and lost about 1.04 per cent to kharif jowar and about 0.04 per cent to mung. Similarly other crops retained about 33.86 per cent of their previous years' area share and gained about 0.48 per cent of area share from kharif jowar. But they lost their area to kharif jowar (66.14 per cent).

#### **4 Structural changes in cropping pattern in Samudrapur tahsil of Wardha district**

The results of the transition probability matrix for crops in Samudrapur tahsil of Wardha district for the period of 2005-06 to 2014-15 are presented in the Table 4. The crops considered for the study were kharif jowar, tur, mung, cotton, soybean and other crops.

The results in the Table 4 indicated that kharif jowar shown instability. It was unable to retain its previous years' area share. It had lost about 100.00 per cent of its previous years' area share to tur and gained only 0.04 per cent of area share from soybean. Tur retained about 26.79 per cent of its previous years' area share. However it has gained about 100.00 per cent of area share from kharif jowar, about 13.54 per cent from mung and 17.57 per cent soybean. But it has lost about 73.19 per cent of its previous years' area share to soybean and about 0.02

per cent to other crops. Mung retained only 9.19 per cent of its previous years' area share. It has gained area from cotton (0.03 per cent), soybean.

**Table 4: Structural changes in cropping pattern in Samudrapur tahsil of Wardha district**

Crops	Kh Jowar	Tur	Mung	Cotton	Soybean	Other crops
Kh Jowar	<b>0.0000</b>	1.0000	0.0000	0.0000	0.0000	0.0000
Tur	0.0000	<b>0.2679</b>	0.0000	0.0000	0.7319	0.0002
Mung	0.0000	0.1354	<b>0.0919</b>	0.7727	0.0000	0.0000
Cotton	0.0000	0.0090	0.0003	<b>0.9893</b>	0.0000	0.0014
Soybean	0.0004	0.1757	0.0002	0.0000	<b>0.8237</b>	0.0001
Other crops	0.0000	0.0000	0.0432	0.8769	0.0000	<b>0.0799</b>

(0.02 per cent) and other crops (4.32 per cent). Mung has lost its area share to tur (13.5 per cent) and cotton (77.27 per cent). Cotton as one of the major commercial crop has highest stability by retaining about 98.93 per cent of its previous years' area share. Meanwhile it has lost its area share to tur (0.90 per cent), mung (0.03 per cent) and other crops (0.14 per cent). However it has gained about 77.27 per cent of area from mung and about 87.69 per cent from other crops. Soybean has retained about 82.37 per cent of its previous years' area share and it has gained about 73.19 per cent of area from tur. But it has lost its area share to kharif jowar (0.04 per cent), tur (17.57 per cent), mung (0.02 per cent) and other crops (0.01 per cent). Similarly other crops have retained about 7.99 per cent of their previous years' area share. It has gained area from tur (0.02 per cent), cotton (0.14 per cent) and soybean (0.01 per cent). Meanwhile they have lost their area to mung (4.32 per cent) and cotton (87.69 per cent).

### Conclusion

Area under cotton and soybean were most stable and area under kharif jowar and mung showed most instability. The analysis of structural changes in cropping pattern in selected tahsils of Wardha district revealed that cotton and soybean retained their previous years' area share. They are also highest gainer of area share. Majority of area of kharif jowar, mung and other crops were gained by cotton and soybean. Cotton and soybean were highest gainer of area share. Cotton retained about 77.82 per cent of its previous years' area share in Arvi, about 84.32 per cent in Ashti, about 51.75 per cent in Devali and about 98.93 per cent in Samudrapur. Cotton retained about 66.49 per cent of its previous years' area share in Arvi,

about 73.23 per cent in Ashti, about 88.30 per cent in Devali and about 82.37 per cent in Samudrapur. Area of kharif jowar, mung and other crops have been shifted to cotton and soybean.

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