



Research Article

CROPPING PATTERN DYNAMICS IN BHADRA COMMAND AREA OF KARNATAKA: AN ECONOMIC ANALYSIS

JALIKATTI V.* AND PODDAR R.

Department of Agricultural Economics, College of Agriculture, University of Agricultural Sciences, Dharwad, 580 005, Karnataka, India

*Corresponding Author: Email - vinayak5255@gmail.com

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Abstract: Bhadra command area from middle region of the Karnataka state was selected for the purpose of analysing the changes in cropping pattern. The time series data on cropping pattern in the selected canal command area was collected for a period of 10 years (2009-10 to 2018-19) and analysed using First Order Markov Chain Approach. In Bhadra command, semi dry crops and *kharif* semi-dry crops like maize, finger millet, sorghum and cotton were stable crops. This indicates that the stability in the area under different crops in the study areas depends on availability of irrigation water, food and fodder requirement of the people and higher market price to the produce. In Bhadra Reservoir Project, area under paddy showed a positive growth of 3.41 percent per annum. The projected area of all the crops grown in Bhadra command area would remain constant for the projected period 2019 to 2021. In Cauvery command area the area under major crops was found out to be against the cropping patterns suggested by the CADA, thus the higher deviation from the suggested cropping pattern was found in Red gram (30%) followed by Finger millet (18.71%), Garden crops (12.75%) and Paddy (9.24%).

Keywords: *Cropping Pattern, Economic Analysis*

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Introduction

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. Introduction of new agriculture technologies has influenced the crop-mix which is more prominent in agriculture developed regions. A dynamic change has been witnessed in agriculture sector in our country, particularly during post-green revolution period. The technological advancement in crop varieties and other yield increasing factors of production influenced the farmers' behaviour which has reflected in the cropping pattern from cultivation of low value crops to high value crops in most of the regions. The long-term changes in the cropping pattern in any region could be due to the development of irrigation infrastructure, whereas the vagaries of nature including rainfall and other institutional factors led to short term fluctuations in the cropped area as well as productivity. These short terms and long-term fluctuations have implications on the economic returns to the farmer as well as on the environment. To assess the extent and gravity of the consequences of such situation, knowledge of the dynamics of cropping pattern is essential. The present study is an attempt to analyse the dynamics of cropping pattern in selected canal command areas of Karnataka state [1-7].

Materials and methods

The time series data pertaining to cropping pattern in the Bhadra command area was collected for a period of 10 years (2009-10 to 2018-19) from offices of the Command Area Development Authority (CADA), Irrigation department and State Agriculture Departments.

Compound growth rate analysis

Growth of any variable indicates its past performance

It clearly indicates the performance of the variable under consideration and hence it can be very well used for making policy decisions. The growth in the area of different crops in the Bhadra Command areas of Karnataka and its cropping pattern was estimated using the exponential growth function of the form:

$$Y_t = a + bU_t \quad (1)$$

Where,

Y_t : Dependent variable for which growth rate was estimated

a : Intercept

b : Regression coefficient

t : Years which takes values, 1, 2, ..., n

U_t : Error term for the year t

The equation was transformed into log linear form for estimation purpose and was estimated using Ordinary Least Square (OLS) technique. The compound growth rate (g) in percentage was then computed from the relationship,
 $g = (\text{Antilog of } \ln b - 1) \times 100$.

The significance of the regression coefficient was tested using the students' test.

Markov Chain Model

The direction of change in cropping pattern was analysed by using First Order Markov Chain Approach. The Lingo Software was used for the purpose. Markov Chain Analysis is the estimation of the transitional probability matrix 'P' whose elements, P_{ij} indicate the probability of shifting area from one crop 'i' to another crop 'j' over time. The diagonal element P_{ii} where $i=j$, measures the probability of a crop retaining its share. The average area shifted to a particular crop was considered to be a random variable which depends only on the area under past crop, which can be denoted algebraically as:

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

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

Where,

E_{jt} = Area of the crop shifted towards the particular j^{th} crop in the year t

$E_{i,t-1}$ = Area lost by i^{th} crop during the year $t-1$

P_{ij} = the probability the area lost will shift from i^{th} crop to j^{th} crop

e_{it} = The error term which is statistically independent of $E_{i,t-1}$

n = the number of crops.

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

Based on the results of Markov chain analysis, the Projections of area under different crops for the period (2019-2021) were made for all the canal Command areas by using:

$$B_t = B_0 \times T$$

$$B_{(t+1)} = B_{(t+1-1)} \times T$$

Where,

B_0 = Area under the crop in base year;

$B_{(t+1)}$ = Area under the crop in next year (prediction);

T = Transitional probability matrix.

Results and discussion

The Compound Annual Growth Rate (CAGR) of area under different crops in the command area is presented in [Table-1].

Table-1 Compound growth rates for area under different crops in Bhadra command area of Karnataka.

SN	Crops	BRP
1	Paddy	3.41*
2	Sugarcane	3.49 ^{NS}
3	Garden Crops	1.76 ^{NS}
4	Semi-Dry crops	0.6 ^{NS}

Note: 1. ***, **, * denotes significance at 1%, 5% and 10% level respectively

2. Garden crops includes Arecanut, Coconut and Banana.

3. Semi-Dry Crops includes Maize, Finger millet, Sorghum and Cotton.

In Bhadra Reservoir Project area under paddy shown a positive growth of 3.41 percent per annum. Dynamics of cropping pattern in Bhadra command area during *kharif* and summer season were studied and results are presented in [Table-2] and [Table-3] respectively.

Table-2 Transition probability matrix for different crops in Bhadra command area during *Kharif* season

Crops	Sugarcane	Paddy	Garden Crops	Semi-Dry Crops
Sugarcane	0	1	0	0
Paddy	0.3	0.639	0.061	0
Garden Crops	0	0.76	0.24	0
Semi-Dry Crops	0	0	0	1

Note: Garden crops includes Areca nut, Coconut and Banana

Semi-Dry Crops includes Maize, Finger millet, Sorghum and Cotton

Table-3 Transition probability matrix for different crops in Bhadra command area during summer season

Crops	Sugarcane	Paddy	Garden Crops	Semi-Dry Crops
Sugarcane	0.032	0.121	0.035	0.812
Paddy	0	0	0	1
Garden Crops	0.7	0	0.3	0
Semi-Dry Crops	0.111	0.068	0.02	0.8

Note: Garden crops includes Areca nut, Coconut and Banana

Semi-Dry Crops includes Maize, Finger millet, Sorghum and Cotton

It is observed from the [Table-2] that, during *kharif* season sugarcane, paddy, garden crops and semi-dry crops were grown predominantly in the command area. Under garden crops, areca nut, coconut and banana were included while under semi dry crops maize, finger millet, sorghum and cotton were grown. Among all these crops area under sugarcane was instable, while area under paddy, garden crops and semi dry crops was stable. It is revealed from the transitional probability matrix that, sugarcane lost 100 percent of its previous year share to paddy. However, it gained 30 percent area from paddy. Paddy retained 63.90 percent of its previous year share of area and lost about 6.10 percent area to garden crops. However, it gained 100 percent area from sugarcane and 76 percent area from garden crops. Garden crops retained 24 percent of its previous year share of area and lost 76 percent to paddy. However, it gained 6.10 percent area from paddy. The semi-dry crops had retained 100 percent of its previous year share of area. Since, paddy and finger millet are the staple food of the area, maize was grown for fodder purpose and cotton is a cash crop, the area under these

crops was found to be stable during the study period. In summer season also same crops as *kharif* i.e., sugarcane, paddy, garden crops and semi-dry crops were found prominent in cropping pattern of the command area. Sugarcane retained only 3.20 percent of its previous year's share of area and lost 12.10 percent, 3.50 percent and 81.20 percent area to paddy, garden crops and semi-dry crops respectively. However, it gained 70 percent area from garden crops and 11.10 percent area from semi-dry crops. The area under paddy was instable during the study period and it lost 100 percent of its area to semi-dry crops while it gained 12.10 percent area from sugarcane and 6.80 percent area from semi-dry crops. Garden crops retained 30 percent of its previous year's share of area and lost 70 percent area to sugarcane crop. However, it gained 3.5 percent area from sugarcane and 2 percent area from semi-dry crops. Semi-dry crops retained 80 percent of its previous year's share of area and lost 11.10 percent, 6.80 percent and 2 percent area to sugarcane, paddy and garden crops respectively. However, it gained 81.20% and 100 percent area from sugarcane and paddy respectively.

Area projections of different crops in Bhadra command area

The area projections of major crops grown in Bhadra command area of Karnataka was computed based on the transitional probability matrix and projections were made up to 2021 [Table-3] and [Table-4]. The projected area of all the crops grown in Bhadra command area would remain constant for the projected period 2019 to 2021.

Table-4 Projected area under different crops in Bhadra Command area (*Kharif*)

Year	Sugarcane	Paddy	Garden Crops	Semi-Dry Crops
2019	11997.60 (11.37)	39989.29 (37.88)	2437.91 (2.31)	51134 (48.44)
2020	11996.79 (11.37)	39984.67 (37.88)	2437.75 (2.31)	51134 (48.44)
2021	11995.40 (11.36)	39980.74 (37.88)	2437.47 (2.31)	51134.00 (48.45)

Note: Garden crops includes Areca nut, Coconut and Banana

Semi-Dry Crops includes Maize, Finger millet, Sorghum and Cotton

Figures in parenthesis indicates percentages

Table-5 Projected area under different crops in Bhadra Command area (summer)

Year	Sugarcane	Paddy	Garden Crops	Semi-Dry Crops
2019	12254.99 (11.21)	7469.49 (6.83)	2143.15 (1.96)	87495.09 (80.00)
2020	12246.04 (11.20)	7465.42 (6.83)	2141.99 (1.96)	87439.20 (80.00)
2021	12238.39 (11.20)	7460.51 (6.83)	2140.58 (1.96)	87383.13 (80.00)

Note: Garden crops includes Areca nut, Coconut and Banana

Semi-Dry Crops includes Maize, Finger millet, Sorghum and Cotton

Figures in parenthesis indicates percentages

Conclusion

In Bhadra command area under semi dry crops like maize, finger millet, sorghum and cotton were stable due to reason that maize crop was only grown for fodder purpose while cotton fetched high price, finger millet and sorghum were the staple food in the command area. This indicates that the stability in the area under different crops depends upon availability of irrigation water, food and fodder requirement and good market price to the produce. In Bhadra command area under paddy shown a positive growth of 3.41 percent per annum while no significant change was observed in the CAGR of area under different crops. The projected area of all the crops grown in Bhadra command area would remain constant for the projected period 2019 to 2021.

Application of research: The study helps in analyzing the dynamics of cropping pattern in Bhadra canal command area of Karnataka. The results can be used for policy regarding, farmers can plan their production and marketing of agricultural crops in canal command areas of Karnataka.

Research Category: Agriculture Economics

Abbreviations: BRP: Bhadra Reservoir Project

CAGR: Compound Annual Growth Rate

CADA: Command Area Development Authority

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Study area / Sample Collection: Secondary data collected from offices of CADA, Irrigation and Agricultural Departments, Bhadra Command Area of Karnataka

Cultivar / Variety / Breed name: Maize, Finger Millet, Sorghum and Cotton

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

Ethical Committee Approval Number: Nil

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