

Study of Shift in Cropping Pattern in Selected Districts of Karnataka

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Abstract: The cropping pattern plays a vital role in determining the level of agricultural production and reflects the agricultural economy of an area or region. The present study was conducted to know the changes in the cropping pattern of the selected districts of Karnataka using Markov chain analysis. Crop yield data were collected from the District Statistical Office, Vijayapura and District Statistical Office, Dharwad for the period of 1981-82 to 2020-21. Markov chain analysis is used to study the changes that occurred in the cropping pattern of agricultural crops. In Vijayapura District, the study reveals notable retention in grape, jowar, and cotton cultivation, with grapes showing the highest retention rate at 66%. Conversely, maize exhibited minimal retention at 4%. Crop transitions indicated substantial losses from grapes to cotton and complete displacement of onion by maize. In Chikkaballapur District, maize, along with other crops, exhibited strong retention, while pomegranate showed no retention. Crop shifts demonstrated exchanges between various crops, with maize and other crops largely retaining their areas. These findings offer valuable insights for agricultural planning, highlighting the persistence and transformation of crop cultivation in response to climatic conditions and regional preferences over four decades.

Keywords: Cropping pattern, Markov chain analysis, Transitional probability

INTRODUCTION

Agriculture is an important sector for economic growth in India, as more than 54.6 per cent of the population is involved in agriculture and its allied activities for their livelihood. The technological development in crop varieties and other yield increasing factors of production influenced the farmers' behavior which has been reflected in the cropping pattern from the

cultivation of low-value crops to high value crops in most of the regions. A disproportionate amount of the negative effects of climate change fall on poor rural households, whose livelihoods mostly depend on agriculture and natural resources. As a result, farm income and profitability also decline (Ashalatha et al., 2013). Climate significantly influences agriculture, and crop diversification is an essential strategy for managing climate-related risks and promoting sustainability in farming practices. Farmers often need to adapt their crop choices and diversification techniques based on the specific climate and environmental conditions in their region.

Crop diversification gives farmers with wider choice in in the production of variety of crops in a area, so has to expand production and also minimise the possible risk and uncertainty against the climate change. Crop diversification is generally viewed as a shift from a traditionally grown less remunerative single crop to more remunerative to variety of crops. Diversification in agriculture as command as impact on socio-economic in condition and lifting of resource of farming community crop diversification generates income and employment of rural youth and ultimate benefit the farmers in the country. The main rainfed crops grown in Karnataka are rice, ragi, jowar, maize and pulses. Karnataka cultivates a variety of fruits including mango, grapes, banana, pomegranate, citrus fruits, guava, and sapota among others (Directorate of Economics and Statistics, 2022).

Methodology

Vijayapura

Vijayapura is located at a height of 592 meters above sea level. The prevailing climate in this area is classified as a local steppe climate and receives little rainfall throughout the year. BSh is the Koppen-Geiger classification for climate. The latitude and longitude of Vijayapura are 16.8302° N and 75.7100° E. It comes under the Northern Dry Zone of Karnataka. The major crops grown in the district are jowar, bajra, maize, grapes, pulses, oil seeds and vegetables.

Chikkaballapur

Chikkaballapur is located at a height of 915 meters above sea level. According to the Koppen-Geiger climate classification system, the climate of Chikkaballapur district falls under the category of Aw, which represents a tropical savanna climate. The latitude and longitude of Vijayapura are 13.4355° N and 77.7315° E. It comes under the Eastern Dry Zone of Karnataka. The district is well known for sericulture, mango, grapes, pomegranate, sapota, guava, papaya, banana and citrus and cut flower cultivation.

Nature and Sources of Data

Secondary data on various crop yield were collected from the District Statistical Office, Vijayapura and District Statistical Office, Dharwad for the period of 1981-82 to 2020-21.

Markov-Chain analysis

Markov chain analysis is used to study the changes that occurred in the cropping pattern of agricultural crops. The estimation of the transitional probability matrix, P is central to this analysis and is done by the LINGO software package (Shilpashree *et al.*, 2017). The elements (P_{ij}) of the matrix P indicate the probability that the area would switch from the i^{th} crop to j^{th} crop over a period of time, and the diagonal elements P_{ii} indicate the probability that the area share of a crop would be retained in successive time periods. Each row of the matrix sums to 1. The average area under a particular crop is considered to be a random variable which depends only on its past area of cultivation to that crop and which is denoted algebraically by:

$$A_{jt} = \sum_{i=1}^n A_i(t-1) * P_{ij} + e_{jt}, \quad (t = 1, 2, \dots, n)$$

Where,

A_{jt} = Area under j^{th} crop during period t

$A_{i(t-1)}$ = Area under i^{th} crop during t-1

P_{ij} = Probability of shifting area from i^{th} crop to j^{th} crop

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

n = Number of crops.

The transitional probability matrix had been calculated by taking area under cultivation of selected rainfed crops grown in Vijayapura and Chikkaballapur district, Karnataka.

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

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

$$\text{and } 0 \leq P_{ij} \leq 1.$$

To estimate the transitional probabilities (P_{ij}), the restricted least square estimator of the quadratic programming model of the following form was employed.

$$\text{Minimize } U[U = (Y - XP) / (y - Xp) = Y[Y - 2P[X]Y + P[X]XP,$$

subject to,

$$R \times P = e \quad P \geq 0.$$

Since the objective function in the equation is in quadratic form while constraints are in linear form, it is reduced to the following primal-dual programming problem.

$$\text{Maximize } \{X[Y - (X[X] P) / [P - e P]W \leq 0,$$

subject to,

$$R \times P = e \quad R[+ (X[X] P - W = X[YP, W > 0.$$

where,

R = A known coefficient matrix ($I_1, I_2, I_3, \dots, I_r$) with each $I_i = 1, 2, \dots, r$, an identity matrix.

e = Column vector with all entries equal to one

W = A set of non-negative slack variables

P = A matrix of unknown transition parameters to be estimated

Thus, the expected shift in area under cultivation of each crop during period 't' is obtained by multiplying the area under cultivation of crops in the previous period (t-1) with the transitional probability matrix.

RESULTS AND DISCUSSION

Markov chain analysis is used to study the changes that occurred in the cropping pattern of agricultural crops. The shift in cropping area was studied using the transitional probability matrix of the Markov chain model. This model is applied for selected major grown crops in the given study for both Vijayapura and Chikkaballapur districts. The diagonal elements indicate the probability of retention of the area. Whereas the row elements indicate the probability of loss in the area, the column elements indicate the probability of gain in the area from other crop in the purview of that district. The transitional probability matrix for Vijayapura and Chikkaballapur districts is presented in Table 1 and Table 2 respectively.

Table 1: Transitional probability matrix for the area of Vijayapura district

Gain	Shift				
	Grapes	Onion	Cotton	Maize	Jowar
Grapes	0.66	0.00	0.34	0.00	0.00
Onion	0.00	0.00	0.00	1.00	0.00
Cotton	0.01	0.43	0.50	0.06	0.00
Maize	0.00	0.09	0.00	0.04	0.87
Jowar	0.03	0.03	0.03	0.32	0.59

Table 2: Transitional probability matrix for the area of Chikkaballapur district

Gain	Shift					
	Grapes	Mango	Tomato	Maize	Pomegranate	Other
Grapes	0.64	0.00	0.08	0.26	0.02	0.00
Mango	0.00	0.51	0.00	0.49	0.00	0.00
Tomato	0.00	0.00	0.68	0.32	0.00	0.00
Maize	0.02	0.10	0.01	0.86	0.01	0.00
Pomegranate	0.00	0.00	0.55	0.41	0.00	0.04
Other	0.00	0.00	0.00	0.15	0.00	0.85

The transitional probability matrix for Vijayapura district as shown in Table 1 showed that the grapes crop was showing the highest retention of 66 per cent, followed by jowar with a retention of 59 per cent and the cotton crop was found to have a retention of 50 per cent. Maize was found to have a retention of only 4 per cent. Grapes lost major of their area . i.e., 34 per cent of its area to cotton, while onion lost all of its area completely to maize. On the other hand, cotton lost majorly 43 per cent of its area to onion, 6 per cent of its area to maize and 1 per cent to grapes. Least retention was observed in case of maize, where 87 per cent of the area was lost to jowar and 9 per cent of the area to onion. Finally, jowar lost a major chunk of the area to maize, 3 per cent each to grapes, onion and cotton respectively. From the overall point of view, it can be concluded that there was not much retention in the case of onion and maize.

It is evident from the transitional probability matrix for the Chikkaballapur district depicted in Table 2 that maize crop had the highest retention of 86 per cent, followed by other crops which include mulberry, flowers and coconut with 85 per cent retention and tomato with a retention of 68 per cent. Grapes had the retention of 64 per cent while mango had the least retention of 51 per cent. Whereas pomegranate was found to have no retention. It can be concluded that grapes lost 8 per cent of the area to tomato, 26 per cent of the area to maize and lastly 2 per cent of area to pomegranate. Meanwhile, mango lost a major chunk of its area, i.e., 49 per cent to maize. Tomato lost only 32 per cent of the area to maize and maize lost its 10 per cent of the area to mango, 2 per cent of the area to grapes followed by 1 per cent area each to tomato and pomegranate respectively. While pomegranate lost completely its area to tomato, maize and other crops by 55 per cent, 41 per cent and 4 per cent respectively. Lastly, other crops lost only 15 per cent of the area to maize. From the overall point of view, it is evident that there was not much shift in agricultural crops.

This study is on par with research conducted by Pavan *et al.* (2022) while studying the shift in cropping pattern in the Chithradurga district of Karnataka. From the study, (Table 1), reveals that for the Vijayapura district, overall, grapes and jowar showed more stable and highest retention of area followed by cotton among all the crops. Grapes was found to have highest retention may be possibly due to increased marketing facilities, better irrigation and suitable climatic conditions. There was no retention observed in onion crop as it lost all its area to maize possibly due to price drops and there was the least retention in case of maize. This signified a shift in almost all crops majorly in the district. Grapes had lost a major chunk of its area to cotton, whereas cotton lost half of its area to onion crop. However, it was found that maize lost a significant part of it to jowar. Overall, grapes and jowar were the most stable crops possibly due to the promising growth of this crops and minimal guaranteed returns respectively, whereas onion and maize were the most unstable crops.

It is evident from the table 2 that maize crop showed the highest retention and more stable followed by other crops which includes mulberry, flowers and coconut. Grapes lost part of it to tomato, maize and pomegranate. Whereas, the least retention was observed in the case of mango which lost half of its area to maize. Mango crop lost half of their area to maize, whereas

tomato lost only a considerable area to maize. It was also observed that maize crop lost a part of its area to grapes, mango, tomato and pomegranate. It depicted that there was not much shift in the area of maize crop, other crops, tomato and grapes crops owing to the reasons possibly good market facilities, dairy farming and large number of farmers follow sericulture. This study is on par with the study conducted by Arulpandiyan and Prabakaran (2020) who made an attempt to examine the changes in cropping pattern in the Madurai district. They showed that green gram, groundnut, and cotton crops retained the highest area in the range of 52 per cent to 62 per cent. Whereas sorghum and red gram retained less from 31 per cent to 37 per cent. This was probably because the cultivation of green gram, groundnut and cotton was more remunerative when compared to sorghum and red gram.

CONCLUSION

The present study was undertaken on the secondary data of weather parameters and yield of grapes for a period of 1981-82 to 2020-21 in Vijayapura and Chikkaballapur district. Secondary data on the grapes yield was collected from District Statistical Office, Dharwad and District Statistical Office, Vijayapura. The shift in the area of crops in the Vijayapura and Chikkaballapur district and observed by obtaining the transitional probability matrix using the Markov chain model. In Vijayapura district, grapes was found to have highest retention of 66 per cent followed by jowar and maize of retention of 59 and 50 per cent. Whereas, for Chikkaballapur district, maize crop was found to have highest retention of 86 per cent followed by other crops including flowers, mulberry and coconut and tomato with retention of 85 per cent and 68 per cent. Whereas grapes was having a retention of 64 per cent and mango with a retention of 51 per cent.

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