Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; SP1: 955-957

NL Pavithra
Department of Agricultural Statistics, University of Agricultural Sciences, Dharwad, Karnataka, India

KV Ashalatha
Department of Agricultural Statistics, University of Agricultural Sciences, Dharwad, Karnataka, India

GR Manjunatha
Department of Agricultural Statistics, University of Agricultural Sciences, Dharwad, Karnataka, India

Correspondence
NL Pavithra
Department of Agricultural Statistics, University of Agricultural Sciences, Dharwad, Karnataka, India

Estimation of change in food grain production patterns in Karnataka State-Markov chain approach

NL Pavithra, KV Ashalatha and GR Manjunatha

Abstract
Markov chain models have been used to evaluate the structural change in food grain production pattern in Karnataka state. Depending on the contribution of area of the individual food grain to the cultivated area in the state twelve food grains have been selected. The changing of the food grain production pattern was estimated by obtaining the transitional probability matrices for the area under each food grain of the period of 1990-2014. Sorghum and paddy showed highest retention in food grain area. Major food grains like chickpea and maize have lost its area to other crops.

Keywords: Markov chain models, transitional probability matrix

Introduction
Agriculture remains as the heart of the economy of the state. It also has a considerable weight in the composition of the State's Gross Domestic Product (GSDP). Agriculture in Karnataka has occupied around 12.31 million hectares of land, this comes to 64.6 per cent of the total area. The state is one of the major producers of paddy among all other states in India. Karnataka has large rainfed areas next only to Rajasthan as the future of agriculture growth in the state depends on this factor which accounts for more than 75 per cent of the cropped area.
About 70 per cent of the people of the state live in villages and 71 per cent of the total population in villages is agriculture dependent. The state is also a major producer of finger millet. The major crops grown in the state are paddy, finger millet, sorghum, maize, pulses besides oilseeds and number of other cash crops.
The share of agriculture in the state GDP is around 16 per cent which is higher than the current national average of all the states in India. Karnataka is the state to come up with a separate agriculture budget.
Karnataka's food grain production is set to witness a marginal dip of 2.3 per cent to 13 million tonnes for the 2014-15 over the previous year. The fall in production is mainly due to a deficit rainfall and dry spell. Major crops that were affected included pigeon pea, soyabean, maize, green gram, groundnut, finger millet, pearl millet, sunflower, cotton and sugarcane (Anon., 2014) [1].
The sustainable use of natural resources in agricultural sector is a challenging issue around the world before policy makers to accomplish the tasks of food security for the growing population and to achieve a desirable level of development. In transforming countries like India, natural resources are coming under increasing pressure from agriculture and the competition for land and water from rapidly growing urban populations and non agricultural sector. India will have 41 per cent of its population living in cities and towns by 2030 AD from the present level of 28 per cent (Hazra, 2001) [3].
The average size of the operational holding is steadily declining and it came down to 1.2 ha in 2005-06 from 1.8 ha in 1980-81 (Anon., 2012). These challenges of managing natural resources is critical for India, which has a large population (around 18 per cent of the world population) and is relatively less endowed with land and natural resources (2 per cent of the world arable land). The low land man ratio, a high proportion of net sown area and emerging trend of a shift in agricultural land to non-agricultural uses are causes of concern for the sustainability of agricultural production in the region and consequently for food security.

Materials and methods
Markov chain models are particularly useful to researchers concerned with problems of movement, both in terms of movement from one district to another district, in this context land use. The Markov Chain Analysis is an application of dynamic programming to the solution of stochastic decision.

The structural change in land use and food grain production pattern was examined by employing a first order finite Markov chain model which captured the net effect in changes in the food grain production pattern over a period of time. There is a growing awareness of the usefulness of this technique for analysis and forecasting in many areas including production pattern, particularly when the process is constant but has a gradual change (Eswarprasad *et al.*, 1997) [2].

In this paper, the structural change in food grain production pattern in Karnataka state in terms of area under major food grains retention and switching is examined by using the Markov chain approach. The estimation of the transitional probability matrix (P) is central to this analysis. The element P_{ij} of the matrix indicated the probability that the area would switch from the i^{th} food grain to j^{th} food grain over a period of time. The diagonal elements P_{ij} indicated the probability that the area share of a food grain would be retained in the successive time periods. Each row of the matrix sums to 1.00. The average area to particular crop is considered to be a random variable which depended only on its past area of cultivation to that crop and which is denoted algebraically.

$E_{jt} = \Sigma E_{jt-1} * P_{ij} + e_{jt} (i = 1,2,.....n)$

Where,

i and j are food grains, t is time period

E_{jt} = Area under j^{th} food grain during period t

E_{it-1} = Area under i^{th} food grain during period t-1

P_{ij} = Probability of shifting area from i^{th} food grain to j^{th} food grain.

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

n= Number of crops.

The transitional probabilities P_{ij} which can be arranged in a (c*r) matrix, had the following properties;

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

$0 \leq P_{ij} \leq 1$

Thus, the expected area shares of each food grain during particular period 't' is obtained by multiplying the area to the selected food grain during the previous period (t-1) with the transition probability matrix (P).

In the context of the current application of methodology, the data of Karnataka was used. Depending on the contribution (share) of area of individual crop to total food grain production in the state, the twelve crops have been selected (shown in the table 1) which has been grouped and finally selected for the analysis. The Percentages were used.

Results and discussion

The changing food grain production pattern was estimated by obtaining the transitional probability matrix for the area under each crop for the period 1990 to 2014. The major crops of Karnataka were sorghum, maize, paddy, finger millet, pearl millet, wheat, chickpea, pigeonpea, green gram, black gram, horse gram and field bean have been considered and presented in Table 1 and Fig 1. It is evident from the Table 1 that in case of area, sorghum (21.69 %) showed highest contribution followed by paddy (19.01 %) and maize (12.25 %), finger millet (12.06 %), chickpea (8.00 %), pigeonpea (7.96 %). Whereas, lowest contribution was observed in field bean 1.05 per cent.

Structural change of food grains production pattern in Karnataka in terms of area under food grains was studied by estimating the transitional probability matrix using the stochastic model (Markov chain frame work). The transitional matrix for area was presented in the Table 2 and Fig. 2 depicted a broader idea of change of the direction of area over a study period. The top five crops were selected in the Table 1 out of which, three from cereals and two were from the pulses. Five major crops like sorghum, maize, paddy, chickpea, pigeonpea was selected among the food grains in Karnataka, remaining food grains were grouped under 'others'. The diagonal elements in a transitional probability matrix indicated the probability that the area share of a crop would be retained in successive time periods and the column elements indicate the probability of gain in area from other crops.

It is revealed from the Table 2 and Fig. 2 that the highest retention of area was noticed in others (87.18 %) followed by sorghum (74.73 %), paddy (56.08 %), maize (49.03 %), chickpea (26.81 %) and there is a less retention of area was noticed in pigeonpea (21.48 %). To retain their share, paddy have gained 47.01 per cent from pigeonpea and 9.56 per cent from others food grains and at the same time paddy has lost 17.88 per cent to sorghum and 15.26 per cent to pigeonpea. Maize have gained 33.40 per cent from chickpea and 31.51 per cent from pigeonpea and at the same time 50.97 per cent lost to chickpea. Chickpea has lost 33.40 per cent to maize and 39.79 per cent to pigeonpea. Pigeonpea has gained 15.26 per cent from paddy. Chickpea has gained 50.97 per cent from maize. Maize has gained 31.51 per cent from pigeonpea.

The table 1 revealed that sorghum showed highest contribution to area of food grains during the study period. Nearly 16 to 30 per cent of the area of sorghum is under rainfed conditions. Field bean showed lowest contribution to area of food grains.

Table 1: Percentage contribution of area of selected crops

Crops	Area
Sorghum	21.69
Paddy	19.01
Maize	12.25
Finger millet	12.06
Chickpea	8.00
Pigeonpea	7.96
Pearl millet	4.75
Green gram	4.56
Horse gram	3.48
Wheat	3.40
Black gram	1.81
Field bean	1.05

Table 2: Transitional probability matrix of food grains in Karnataka

Shift →

Crops	Sorghum	Paddy	Maize	Chickpea	Pigeonpea	Others
Sorghum	0.7473	0.0000	0.0000	0.0000	0.0001	0.2525
Paddy	0.1788	0.5608	0.0824	0.0254	0.1526	0.0000
Maize	0.0000	0.0000	0.4903	0.5097	0.0000	0.0000
Chickpea	0.0000	0.0000	0.3340	0.2681	0.3979	0.0000
Pigeonpea	0.0000	0.4701	0.3151	0.0000	0.2148	0.0000
Others	0.0158	0.0956	0.0099	0.0000	0.0070	0.8718

Gain ↓

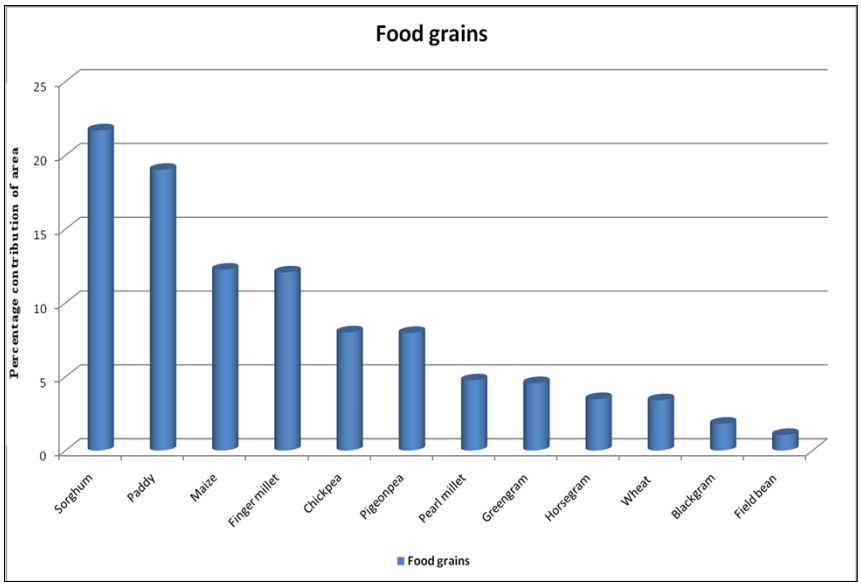

Fig 1: Percentage contribution of area of selected crops

Conclusion

It is evident from the research that, the change of area of food grains in Karnataka state was studied by estimating the transitional probability matrix using the stochastic model (Markov chain frame work). sorghum could retain its maximum area because of reduction of rainfall as crop can withstand moisture stress conditions and considered as best option in rainfed conditions.

Paddy and maize could retain half of its share because of varietal improvement, improvement cultural practices, disease control measures and irrigation facilities. The market factors like price have played a significant role in shifts in area from cereals to pulses and might be due to the importance given to pulses crops under different subsidy programmes of the government. Pigeonpea lossed its area because of the lack of incentives, remunerative prices as well as failure to disseminate production enhancing techniques, better agronomic practices and quality seeds.

References

1. Anonymous. Annu. Rep. (2013-14). Department of Planning, Programme Monitoring and Statistics, Karnataka, 2014, 849.
2. Eswaraprasad Y, Achoth L, Radha Y. Farm technology in relation to changing structure of landholding. Agric. Econ. Res. Rev. 1997; 10(2):78-87.
3. Hazra CR. Diversification in Indian agriculture. Agric. Situ. India. 2001; 48(9):409-522.
4. Sarawathi PA, Basavaraja H, Kunnal LB, Mahajanshetti SB, Bhat ARS. Growth in area production and productivity of major crops in Karnataka. Karnataka J Agric. Sci. 2012; 25(4):431-436.