P-ISSN: 2618-0723
E-ISSN: 2618-0731

NAAS Rating: 5.04
www.extensionjournal.com

International Journal of Agriculture Extension and Social Development

Volume 7; SP-Issue 11; December 2024; Page No. 19-22

Received: 05-10-2024
Accepted: 09-11-2024

Indexed Journal
Peer Reviewed Journal

Crop diversification in north-eastern agro-climatic zones of Karnataka

[1]Abhilash, [1]Satishkumar M, [1]Amrutha T Joshi, [2]BS Reddy and [2]Manoj Kumar G

[1]College of Agriculture, Raichur, University of Agricultural Sciences, Raichur, Karnataka, India

[2]Zonal Agricultural Research Station Kalaburagi, University of Agricultural Sciences, Raichur, Karnataka, India

DOI: https://doi.org/10.33545/26180723.2024.v7.i12Sa.1430

Corresponding Author: Abhilash

Abstract

The present study was conducted in north eastern transition and dry agro-climatic zones of Karnataka. Two taluks representing irrigated and rainfed areas from each zone were selected for the study. The time series data pertaining to area under different crop groups from 2001-02 to 2023-24 was collected for each taluk and compiled accordingly for the analysis. The results revealed that in North Eastern Transition zone there was moderate extent of crop diversification in Aurad (rainfed) taluk with Herfindahl Index (HI) and Simpson Index (SI) values of 0.40 and 0.60 respectively. Comparatively higher extent of crop diversification was found in Humnabad (irrigated) taluk with HI and SI values of 0.31 and 0.69 respectively. While, in North Eastern Dry zone, there was low extent of crop diversification in Sedam (rainfed) taluk with HI and SI values of 0.61 and 0.39 respectively and higher extent of crop diversification in Devadurga (irrigated) taluk with HI and SI values of 0.34 and 0.66 respectively. Transition probability matrix across the zones revealed that there had been shift in the area under cultivation of traditionally grown less remunerative crops towards more remunerative high value crops.

Keywords: Agro-climatic zones, crop diversification, Herfindahl index, Simpson index, probability matrix

Introduction

Crop diversification is a process of reallocation of resources across crops based on their comparative advantage. It enhances farmers' adaptability to external shocks and promotes self-reliance and sustainability in agriculture. Diversification serves as a sole source of combating risk against climate and weather vagaries in both dry land agriculture and regions experiencing erratic rainfall. The significance of crop diversification becomes more pronounced in the WTO-led globalized regime that restricts the scope for prices as an incentive to increase production. Farmers will remain in a disadvantageous position unless they adapt to market signals.

The term "crop diversification" is used in different contexts. While defining diversification in a purely economic term, it is treated from two analytical perspectives; first, as a process of establishing at given prices, the optimal crop mix on a production possibility frontier and second as a mechanism for incorporating risk aversion into a farmer's decision-making process in which crop specialization may lead to highly unstable income due to variance in yield, production, or price for the particular crop (World Bank, 1988) [10]. In either case, diversification is highlighted due to two purposes -increases the income and decreases the risk- both aspects of the quality and quantity of diversification. The argument is that farmers must be in a position to produce high-value crops and secondly with increase in commercialization must also be able to maintain the diversity in the cropping pattern in order to deal with the risk in this sector. With this background, the present study aimed to analyze the nature and extent of crop diversification across north-eastern agro climatic zones of Karnataka.

Methodology

Study area

The study was conducted in north eastern agro-climatic zones *viz*., North Eastern Transition Zone (NETZ) and North Eastern Dry Zone (NEDZ) of Karnataka. Two taluks representing irrigated and rainfed areas, each from NETZ and NEDZ were selected based on percentage of net irrigated area to the net area sown. Accordingly, Aurad taluk representing rainfed area and Humnabad taluk representing irrigated area were selected from NETZ. Sedam taluk representing rainfed area and Devdurga taluk representing irrigated area were selected from NEDZ for deriving empirical evidences on nature and extent of crop diversification.

Nature and sources of data

The present study is mainly based on the secondary data obtained from District Statistical Offices (DSOs). The time series data related to area under different crop groups for a period from 2001-02 to 2023-24 was considered for the study. To assess the extent of crop diversification, the following indices were used.

Herfindahl Index (HI): It is the sum of square of the acreage proportion of each crop in the total cropped area.

$$\mathbf{HI} = \sum_{i=1}^{N} P_i^2$$

Where, P_i represents acreage proportion of the i^{th} crop in total cropped area.
With an increase in diversification, the sum of square of the proportion of activities decreases, so also the indices (HI). The Herfindahl index takes a value of one when there is complete specialization and approaches zero as N gets large, i.e. if diversification is perfect.

Simpson Index (SI): It is the most suitable index for measuring diversification of crops in a particular geographical region.

$$\mathbf{SI} = 1 - \sum_{i=1}^{N} P_i^2$$

Where, $P_i = A_i / \Sigma A_i$ is the proportion of the i^{th} activity in acreage. If SI is near zero, it indicates that the zone or region is near to the specialization in growing of particular commodity and if close to one, the zone is fully diversified in the commodities that it has grown.

Markov chain model
Markov chain analysis was used to study the shift in area between the crop groups which shows the changes in cropping pattern of crop groups. The estimation of the probability matrix (P) was central to this analysis and was done by LINGO software package. The elements P_{ij} of the matrix indicated the probability that area would switch from the i^{th} crop group to j^{th} crop over a period of time and the diagonal elements P_{ii} indicated the probability that the area share of a crop would be retained in successive time periods. Each row of the matrix sums to 1.00. The average area under a particular crop was considered to be a random variable which depended only on its past area of cultivation to that crop and which is denoted algebraically by:

$$A_{jt} = \sum_{i=1}^{n} A_{it-1} * P_{ij} + e_{jt}$$

i = 1,2,3,....n

Where,
A_{jt} = Area under j^{th} crop group during period t
A_{it-1} = Area under i^{th} crop group during t-1
P_{ij} = Probability of shifting area from i^{th} crop group to j^{th} crop group
e_{jt} = The error term which is statistically independent of e_{it-1}, and
n = Number of crop groups

The Transitional Probability Matrix (TPM) is estimated in the linear programming (LP) frame work using minimization of mean absolute deviation method solved using software package called "LINGO".

Results and Discussion
The diversification index serves as an indicator of whether there have been significant shifts in the overall concentration or dispersion within the cropping patterns in the study area. To comprehend the variations in crop diversification across the zones, diversification indices were calculated for two agro-climatic zones. While markov chain model captures the dynamics of area shift among crop groups over the years.

Extent of crop diversification across NETZ
The average values of the Herfindahl Index (HI) and Simpson Index (SI) were utilized to assess the level of crop diversification in the study areas. The indices were initially calculated for Aurad taluk, yielding average values of HI at 0.40 and SI at 0.60 (Table 1). A HI value approaching one indicates a higher degree of specialization, while a value closer to zero suggests greater diversification. Conversely, an SI value near one signifies diversification, whereas a value near zero indicates specialization. These indices revealed that Aurad taluk exhibited a moderate level of diversification, reflecting the demographic characteristics of the region, which support both specialization and diversification. The results align with the study conducted by Priyanga *et al.* (2023) [6].
The HI and SI values calculated for Humnabad taluk were 0.31 and 0.69, respectively (Table 1). These indices revealed a higher degree of crop diversification in Humnabad taluk compared to Aurad taluk, likely due to the greater number of crops grown, facilitated by the availability of irrigation in Humnabad taluk. Similar results were observed by Nahar *et al.* (2024) [5], where in majority of the farmers were moderately diversified in irrigated areas.

Extent of crop diversification across NEDZ
The crop diversification indices *viz*. HI and SI were also calculated for Sedam and Devdurga taluks, representing the North Eastern Dry Zone (NEDZ) of Karnataka. The average values for the HI and SI were 0.61 and 0.39, respectively, for Sedam taluk showed a low degree of diversification (Table 1). The findings align with Kalalnkar (2003) [4] study on agricultural output growth and diversification in Maharashtra, who reported a shift towards specialization in high-value crops.
In contrast, the values of HI and SI for Devdurga taluk were 0.34 and 0.66, respectively, revealed a higher degree of diversification compared to Sedam taluk (Table 1). Singh *et al.* (2006) [8] similarly reported this trend while analyzing the pattern of diversification across Indian states. Bhattacharya (2008) [2] further noted in his study on crop diversification in West Bengal that the increment in Simpson Diversity Index indicated a gradual shift in cropping patterns towards the production of high-value crops such as flowers, fruits and vegetables. It may be concluded from the analysis of secondary data for different indices that there had been diversification in both the NETZ and NEDZ and this was more pronounced in NETZ compared to NEDZ. Further, it may also be noted that the diversification was more towards pulse and oilseed crops at the expense of cereal crops.

Table 1: Crop diversification indices in North Eastern Agro-climatic Zones of Karnataka (2001-02 to 2022-23)

Sl. No.	Crop diversification indices	NETZ		NEDZ	
		Aurad (Rainfed)	Humnabad (Irrigated)	Sedam (Rainfed)	Devdurga (Irrigated)
1	Herfindahl Index (HI)	0.40	0.31	0.61	0.34
2	Simpson Index (SI)	0.60	0.69	0.39	0.66

Dynamics of area shift between different crop groups in North Eastern Agro-climatic Zones of Karnataka

Aurad taluk (rainfed area) of NETZ

Markov chain analysis was employed to analyze the structural change in dynamics of area shift between the crop groups. In the study, the dynamic nature of cropping patterns that is the gains and losses in area shares of crop groups was examined. Markov chain analysis involves developing a transitional probability matrix, whose elements indicate the probability of area shift switching from one crop group to another crop group over time. The diagonal elements measure the probability of a crop group retaining its area.

The results of transitional probability matrix for Aurad taluk representing rainfed area revealed that oilseed crops had the highest retention (93.90%) of area under cultivation, followed by pulse crops (91.79%), cereal crops (88.41%) and commercial crops (63.69%) retained a major share (Table 2). Cereal crops lost 9.09 per cent of their area share to pulse crops. Pulse crops lost 6.40 per cent of their area share to oilseed crops. Whereas, fruit crops and vegetable crops lost their entire share of area to oilseed crops. However, fruit crops gained 0.15 per cent of area share from oilseeds and vegetable crops gained an area share of 3.09 per cent from commercial crop groups. Satishkumar and Umesh (2017) [7] also observed similar trend of shift in area from various crops towards high value crops in the southern dry zone of Karnataka. Hence, the results of the transitional probability matrix are in line with the above study.

Table 2: Transitional probability matrix for area under different crop groups from 2001- 02 to 2022-23 in Aurad taluk (Rainfed) of NETZ

Crop groups	Cereal crops	Pulse crops	Oilseed crops	Fruit crops	Vegetable crops	Commercial crops
Cereal crops	0.8841	0.0909	0.0000	0.0000	0.0028	0.0221
Pulse crops	0.0083	0.9179	0.0640	0.0005	0.0012	0.0082
Oilseed crops	0.0000	0.0562	0.9390	0.0015	0.0033	0.0000
Fruit crops	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000
Vegetable crops	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000
Commercial crops	0.3322	0.0000	0.0000	0.0000	0.0309	0.6369

Humnabad taluk (Irrigated area) of NETZ

Transitional probability matrix for area under different crop groups in Humnabad taluk revealed that the cereal crop groups retained highest area (84.78%) over the years followed by pulse crop groups (80.71%), oilseed crops (79.10%) and commercial crops (63.57%). Whereas, fruit crops and vegetable crops retained an area share of 42.27 per cent and 37.60 per cent, respectively (Table 3). However, commercial crops gained 7.98 per cent of area share from cereals and 4.75 per cent of area share from pulse crop groups. Oilseed crops gained 8.24 per cent of area share from pulse crop groups. The results are on par with the study conducted by Devi *et al.* (2019) [3], wherein cereals area was observed to be more stable crop compared to other crop groups grown in Telangana.

Table 3: Transitional probability matrix for area under different crop groups from 2001- 02 to 2022-23 in Humnabad taluk (Irrigated) of NETZ

Crop groups	Cereal crops	Pulse crops	Oilseed crops	Fruit crops	Vegetable crops	Commercial crops
Cereal crops	0.8478	0.0724	0.0000	0.0000	0.0000	0.0798
Pulse crops	0.0454	0.8071	0.0824	0.0057	0.0120	0.0475
Oilseed crops	0.0000	0.2090	0.7910	0.0000	0.0000	0.0000
Fruit crops	0.0000	0.5773	0.0000	0.4227	0.0000	0.0000
Vegetable crops	0.0000	0.6240	0.0000	0.0000	0.3760	0.0000
Commercial crops	0.1211	0.2282	0.0000	0.0150	0.0000	0.6357

Sedam taluk (rainfed area) of NEDZ

Pulse crops were the major crops of the taluk as reflected by the probability of retention of 84.63 per cent over the years followed by vegetable crops (50.25%), cereals (49.15%), commercial crops (38.57%) and oilseed crops (35.70%). Whereas, fruit crops lost their entire share of area to oilseed crops (Table 4). However, it gained 0.59 and 0.53 per cent of area from oilseeds and cereal crops. Pulse crops gained highest area share of 63.71 per cent from oilseed crops followed by area share from commercial crops (61.43%), vegetable crops (49.75%) and cereal crops (46.38%). This study is consistent with the work of Arulpandiyan and Prabakaran (2020) [1], who explored shifts in cropping patterns in the Madurai district. The study revealed that there was maximum retention in the area shares of high value crops over the years.

Table 4: Transitional probability matrix for area under different crop groups from 2001-02 to 2022-23 in Sedam taluk (Rainfed) of NEDZ

Crop groups	Cereal crops	Pulse crops	Oilseed crops	Fruit crops	Vegetable crops	Commercial crops
Cereal crops	0.4915	0.4638	0.0388	0.0053	0.0006	0.0000
Pulse crops	0.1390	0.8463	0.0099	0.0007	0.0011	0.0031
Oilseed crops	0.0000	0.6371	0.3570	0.0059	0.0000	0.0000
Fruit crops	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000
Vegetable crops	0.0000	0.4975	0.0000	0.0000	0.5025	0.0000
Commercial crops	0.0000	0.6143	0.0000	0.0000	0.0000	0.3857

Devdurga taluk (irrigated) of NEDZ

The results of Transitional probability matrix for area under different crop groups in Devdurga taluk revealed that the oilseed crops retained highest area (88.49%) over the years followed by commercial crops (84.06%), cereal crops (73.79%), pulses (36.67%) and vegetable crops (28.96%). Whereas, fruit crops lost their entire share of area to oilseed crops (Table 5). However, fruit crops gained 0.80 per cent of area share from cereals and vegetable crops gained an area share of 3.11 per cent and 2.53 per cent from commercial crops and pulse crop groups, respectively. The findings are consistent with the research conducted by Vilas (2012) [9], who explored the dynamics of the horticultural sector and its impact on the livelihood security of farm households in Karnataka. The study revealed that the area under fruit crops retained 94 per cent of its share from the previous year, substantiating the hypothesis that farmers have progressively transitioned towards commercial and high-value cropping systems over time. This trend underscores the strategic shift in agricultural practices, favoring crops that offer higher economic returns and contribute to the long-term sustainability of farming households.

Table 5: Transitional probability matrix for area under different crop groups from 2001- 02 to 2022-23 in Devdurga taluk (Irrigated) of NEDZ

Crop groups	Cereal crops	Pulse crops	Oilseed crops	Fruit crops	Vegetable crops	Commercial crops
Cereal crops	0.7378	0.1828	0.0714	0.0080	0.0000	0.0000
Pulse crops	0.3623	0.3667	0.0000	0.0000	0.0253	0.2457
Oilseed crops	0.0554	0.0605	0.8842	0.0000	0.0000	0.0000
Fruit crops	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000
Vegetable crops	0.3956	0.0765	0.0000	0.0000	0.2896	0.2382
Commercial crops	0.1283	0.0000	0.0000	0.0000	0.0311	0.8406

Conclusion

The analysis of nature and extent of crop diversification across north-eastern agro-climatic zones of Karnataka revealed a moderate extent of crop diversification in rainfed area and comparatively higher extent of crop diversification in irrigated areas due to irrigation facility available to the farmers supported in incorporating multiple cropping patterns. The dynamics of area shifts shown reasonable shift in area under cultivation from traditionally grown less remunerative crops towards more remunerative high value crops. The varying levels of crop diversification across regions implies that region specific interventions, such as conducting awareness campaigns by strengthening the role of extension service providers, promoting on-farm research based recommendations and technologies are necessary to enhance crop diversification.

References

1. Arulpandiyan K, Prabakaran K. A statistical study on cropping pattern changes in Madurai District. Int J Agric Environ Res. 2020;6(3):512-517.
2. Bhattacharya R. Crop diversification: A search for an alternative income for farmers in the state of West Bengal, India. Int Conf Appl Econ. 2008;12(3):83-93.
3. Devi N, Prasher RS. Growth and diversification of mountain agriculture: A case study of Himachal Pradesh. Econ Aff. 2019;64(1):41-47.
4. Kalankar SS. Agricultural development and sources of output growth in Maharashtra state. Artha Vijnana. 2003;45(3):297-324.
5. Nahar N, Rahman MW, Miah MM, Hasan MM. The impact of crop diversification on food security of farmers in Northern Bangladesh. Agric Food Sec. 2024;13(1):9-21.
6. Priyanga V, Thilagavathi M, Selvaraj KN, Dhevagi P, Duraisamy MR. Land use changes and extent of crop diversification in North Western Zone of Tamil Nadu. J Exp Agric Int. 2023;45(1):9-20.
7. Satishkumar M, Umesh KB. Dynamics of cropping pattern and crop diversification in Southern Dry Zone of Karnataka: An econometric analysis. Mysore J Agric Sci. 2017;51(2):233-239.
8. Singh NP, Kumar R, Singh RP. Diversification of Indian agriculture: Composition, determinants, and trade implications. Agric Econ Res Rev. 2006;19:23-36.
9. Vilas J. Dynamics of horticultural sector and livelihood security of farm households under different farming systems in Karnataka: An econometric analysis. PhD Thesis, University of Agricultural Sciences, Bangalore, Karnataka, India; c2012.
10. World Bank. Diversification in rural Asia. Working Paper Series, No. 98. Agriculture and Rural Development Department, World Bank, Washington, D.C.; c1988.