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Dynamics of crop diversification in Andhra Pradesh: A District-Level Analysis

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Abstract

Agriculture, a critical component of the state's economy, engages over 70% of its population and contributes significantly to the Gross State Domestic Product (GSDP). Despite its importance, the sector faces challenges due to the predominance of small and marginal farmers, whose holdings are often unviable in both local and global markets. The study investigates the existing level of crop diversification across the districts. The data was collected from the Directorate of Economics and Statistics, Government of Andhra Pradesh from 2013-14 to 2021-22, employing methods like Gibb's and Martin's, Herfindahl, Simpson's, and Entropy indices. The findings revealed significant variations in crop diversification levels across different districts of Andhra Pradesh. In the Kharif season, Kurnool and Prakasam districts show the highest crop diversification with index values of 0.8, while Srikakulam exhibits the lowest at 0.1. Moderate diversification levels are seen in Chittoor and Nellore. In the Rabi season, Kadapa, Kurnool, and Anantapur show the highest diversification with an index value of 0.9. Nellore has the lowest at 0.03, with moderate levels in Chittoor, Krishna, and West Godavari. Overall, Kurnool and Prakasam maintain high diversification levels across seasons.

Keywords: GSDP, Crop diversification, Andhra Pradesh, Level Analysis, population

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 share of agriculture in the country's Gross Domestic Product (GDP) has fallen from 20 percent in 2003-04 to 18.8 percent in the year 2021-22. With the advancement of the green revolution, a drastic change has been witnessed in the agricultural sector in our country. This technological development in crop varieties and other yield-increasing factors of production influenced the farmers' behaviour which has been reflected in the cropping pattern from the cultivation of low-value crops to high-value crops in most regions (Reddy *et. al.*, 2022) [6].

In Andhra Pradesh, more than 70% of the population relies mostly on agriculture for their living. Approximately one-fourth of the state's GDP comes from it. Even though the state was declared a "food surplus state," over 8.8 million people, or 11% of the total population, lived in poverty in 2004-05. Small and marginal farmers dominate the agriculture industry. Their percentage of all holdings climbed from 65% in the 1970s to 81% in 2000, rendering these holdings unfeasible for both local and international competitiveness. Agriculture plays a crucial role in the economy of Andhra Pradesh and contributes 34.12 percent of the total Gross State Domestic Product (GSDP) at the current price and 29.51 percent at the constant price 2020-21. A large segment of the population is dependent on the agriculture sector for employment and income. About 66 percent population of Andhra Pradesh lives in rural areas and depends on agriculture and the rural non-farm sector.

The term "diversification" has been derived from the word "diverge" which means to move or extend in a direction different from a common point. Diversification is an important part of the changing economy (Bansal *et al.*, 2020) [2]. In Agriculture, diversification can be defined as a shift from the regional dominance of one crop (like rice) to another crop (like oilseeds), or from one enterprise (like crop-based) to another enterprise (like livestock) or to engage in other complimentary activities (Vyas, 1996) [8]. From the theoretical point of view, Agricultural diversification may be considered as diversification of resources from low-income generating crops to high-income generating crops.

Diversification is also viewed as an uncertain precaution to reduce unemployment and variability in income, preventing farm income from falling below some minimum level. Farm diversification is also practiced for profit maximization through reaping gains of complementary relationships. Crop diversification nowadays has emerged as an important remedy to mitigate production risks, to meet the challenges of a globalizing market, and to satisfy the changing needs of the population. (Singh, 2015) [7].

Broadly, the concept of diversification carries different meanings to different scholars at different levels. For instance, define diversification as "a movement from low-value crops to high-value crops for the betterment of the agricultural system". It simply refers to the cultivation of multiple crops in a particular region at a given time. The diversification of crops towards high-value commodities ensures better income opportunities and employment generation and offers better nutrition security and

sustainability of natural resources (Ansari and Rahaman, 2024) [1]. Apart from the innovation of institutional, infrastructural, and technological facilities, different policies at macro and micro level planning pace up the diversified cropping pattern in a region.

Diversification is a continuous process that changes over time and space. A proper understanding of diversification patterns and their limitations will help initiate appropriate policies and schemes that would benefit large numbers of marginal and small landholders. Thus, conducting such studies using aggregate and disaggregated data for different regions of the country is essential.

1. To assess the existing level of crop diversification across the districts of Andhra Pradesh.

Study Area

Andhra Pradesh's agriculture is largely reliant on rainfall, with monsoons and seasonal conditions playing a pivotal role in production. The total area under agriculture, including fish ponds, constitutes 35.13% of the state's land. The gross area sown represents the total area cultivated under all food and non-food crops, including the area sown more than once during the agricultural year.

The gross area sown or gross cropped area during 2021-22 is 73.28 lakh hectares as against 74.07 lakh hectares in 2020-21, showing a decrease of 1.07 percent. The gross area sown in the year 2021-22 is 73.28 lakh hectares from 74.07 lakh hectares in the previous year 2020-21 showing a decrease of 1.07%. The gross area sown in the Kharif 2021-22 is 48.11 lakh hectares while it is 47.60 lakh hectares in the Kharif. The gross area sown in the Rabi 2021-22 is 25.17 lakh hectares.

Net area sown represents the total area sown with the crops and orchards taking into calculation the area sown more than once in the same year shows only once. The net area sown during 2021-22 is 60.38 lakh hectares representing 37.05 percent of the total geographical area. This includes an area of 1.77 lakh hectares under fish ponds. The whole study is based on secondary data collected from the seasonal crop report of Andhra Pradesh published by the Directorate of Economics and Statistics (DES), Government of Andhra Pradesh. To analyze crop diversification, data is collected on the area under selected crops grown in 13 districts for both *Kharif* and *Rabi* seasons from the period 2013-14 to 2020-22.

Crop Diversification

The index of crop diversification in this study has been worked out by using four different methods namely, Gibb's and Martin's method, Entropy index, Simpson's index, and Herfindahl method.

Gibbs and Martin's method (GMI): Gibbs and Martin's (1962) technique is employed to assess the crop diversification index in the present study because it considers the percentage of the areal extent of all the crops out of the total cropped area. This index is useful for measuring the extent of diversification in cropping patterns in an area and is given by:

$$GMI = 1 - \frac{\sum_{i=1}^{N} P_i^2}{(\sum P_i)^2}$$

Where '*N*' is the total number of crops cultivated and P_i accounts for the land share of the *i*th crop in total cropped area.

Herfindahl Index (HI): In the overall cropped area, it is the sum of squares of the acreage proportion of each crop. We can express this index mathematically as follows. Theil utilized this index to gauge the geographical concentration of industries for the first time in 1967. Diversification would lead to a decline in the Herfindahl Index. Thus, it has an indirect connection to diversity. Complete concentration is indicated by an index value of one, and "perfect" diversification is shown when the number approaches zero. Thus the range of index is 0 to 1.

The Herfindahl index is a measure of concentration. The degree of crop diversification in a region could be assessed using the Herfindahl index. Index was computed by taking the sum of square of area proportion of each crop in the gross cropped area of the farm.

This index was worked out by the following formula

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

Where, N = Total number of crops Pi = Ai / ΣAi, Average proportion of the i[th] crop in gross cropped area, is the proportion of the ith activity in acreage or income to the total activities In the above formula N is the total number of crops and Pi represents area proportion of the ith crop in total cropped area.

With increase in diversification, the index decreases. The index takes a value of 1 when there is a complete specialization and approach to 0 i.e. diversification is perfect.

Simpson Index (SI): Simpson Index of diversification (SI) was used and it considered as the most suitable index for measuring dispersion of enterprises in a particular geographical region (Joshi, 2003) [5]. The Simpson Index (SI) is also a suitable index of measuring diversification in a particular geographical region.

Mathematically, SI is defined as

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

Where, $Pi = A_i / \Sigma A_i$ is the proportion of the i[th] activity in acreage.

The Simpson Index of Diversification (SID) ranges from zero to one. If the estimated SID is close to zero, it means that the district is close to a specialized crop-growing area. The district has cultivated a wide variety of crops if the value is near to one. The Simpson index was calculated annually for each district, and the decennial averages were calculated to monitor the average shift toward specialization or diversification.

Entropy index (EI): Lastly, the EI assesses diversification by calculating the information entropy based on probabilities of each crop's presence. The EI approaches 0 when the farm is specialized and takes a maximum value when there is perfect diversification.

$$EI = (- \sum_{i=1}^{N} P_i \times \log P_i)$$

Results and Discussion

The level of crop diversification in Indian agriculture has been divided in three categories i.e. low, moderate, and high based on index value of crop diversification computed by above-mentioned methods shown in the table 1

According to Gibb's and Martin's formula, the highest index value of crop diversification in the *Kharif* season in Andhra Pradesh agriculture is 0.8 in Kurnool district, Prakasam (0.8), Guntur (0.7), Y.S. R Kadapa (0.7) and Anantapur (0.7). Its index value varies from 0.1 in Srikakulam to 0.8 in Kurnool and Prakasam. A moderate level of crop diversification has covered the Chittoor and Nellore whereas a lower level of crop diversification is in Srikakulam, Vizianagaram, Krishna, Visakhapatnam East Godavari, and West Godavari.

According to Herphindal's formula, the highest index value was 0.97 in Srikakulam (lowest crop diversification) whereas the lowest index value was 0.3 in Prakasam and Kurnool with the highest crop diversification. A higher level of crop diversification has been recorded in Kurnool and Prakasam. The diagrammatic representation of Crop diversification of districts of Andhra Pradesh in the Kharif season in Figure 1.

Table 1: Crop diversification of districts of Andhra Pradesh in Kharif season

S. No	District	GMI	HI	SDI	EI
1.	Srikakulam	0.1	0.97	0.03	0.2
2.	Vizianagaram	0.24	0.8	0.2	0.3
3.	Visakhapatnam	0.4	0.7	0.3	0.3
4.	Eastgodavari	0.4	0.7	0.2	0.3
5.	Westgodavari	0.4	0.7	0.3	0.3
6.	Krishna	0.25	0.8	0.2	0.3
7.	Guntur	0.7	0.5	0.5	0.5
8.	Prakasam	0.8	0.3	0.7	0.7
9.	S.P.S. Nellore	0.6	0.5	0.5	0.5
10.	Y.S.R. Kadapa	0.7	0.5	0.5	0.5
11.	Kurnool	0.8	0.3	0.7	0.7
12.	Ananthapur	0.7	0.6	0.4	0.5
13.	Chittoor	0.6	0.6	0.4	0.4

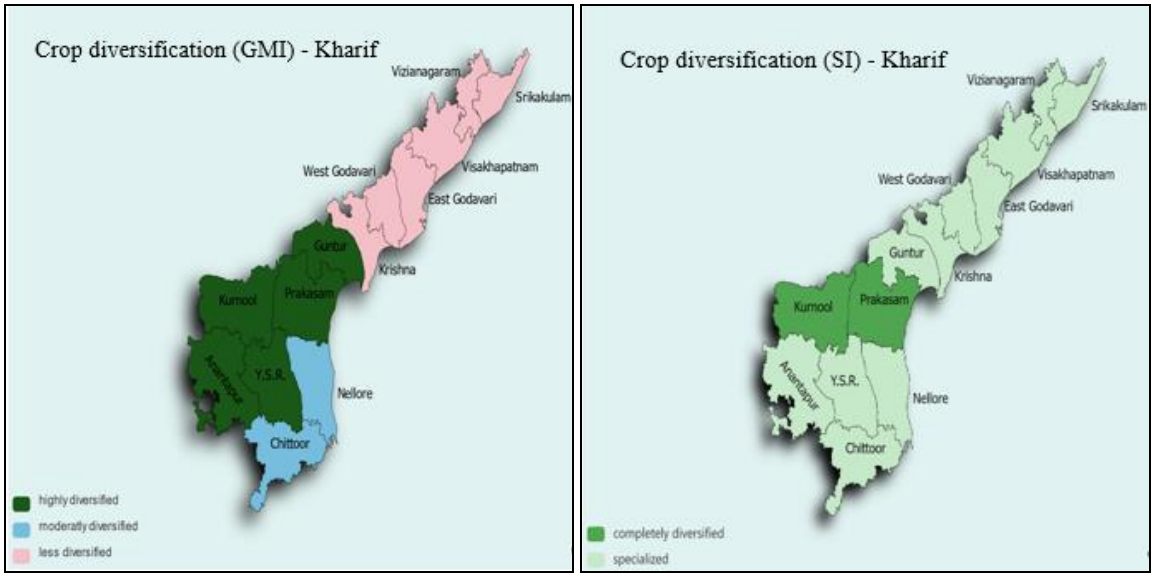

Fig 1: Diagrammatic representation of crop diversification of districts of Andhra Pradesh in the Kharif season

The level of crop diversification in Indian agriculture has been divided into three categories i.e. low, moderate, and high based on the index value of crop diversification computed by the above-mentioned methods showed in the Table 2.

According to Gibb's and Martin's formula, the highest index value of crop diversification in the *Rabi* season in Andhra Pradesh agriculture is 0.9 in Kadapa, Kurnool, and Anantapur followed by Prakasam (0.8), Guntur (0.8), Srikakulam (0.8) and Vizianagaram (0.8). Its index value varies from 0.03 in Nellore to 0.8 in Kurnool and Kadapa. A moderate level of crop diversification has covered the Chittoor, Krishna, and West Godavari whereas a lower level of crop diversification is in Nellore and East Godavari.

According to Herfindahl formula, the highest index value was 0.94 in Nellore which reflects the lowest crop diversification whereas the lowest index value is 0.3 in Guntur, Kadapa, Anantapur, and Kurnool with the highest crop diversification. The diagrammatic representation of Crop diversification of districts of Andhra Pradesh in the Kharif season is in Figure 2.

Table 2: Crop diversification of districts of Andhra Pradesh in Kharif season

S. No	District	GMI	HI	SDI	EI
1	Srikakulam	0.8	0.4	0.6	0.6
2	Vizianagaram	0.8	0.4	0.6	0.6
3	Visakhapatnam	0.7	0.5	0.5	0.5
4	Eastgodavari	0.2	0.8	0.2	0.3
5	Westgodavari	0.5	0.6	0.4	0.4
6	Krishna	0.5	0.6	0.4	0.5
7	Guntur	0.8	0.	0.6	0.7
8	Prakasam	0.8	0.4	0.6	0.6
9	S.P.S. Nellore	0.03	0.94	0.06	0.2
10	Y.S.R. Kadapa	0.9	0.3	0.7	0.7
11	Kurnool	0.9	0.3	0.7	0.7
12	Ananthapur	0.9	0.3	0.7	0.6
13	Chittoor	0.6	0.5	0.5	0.5

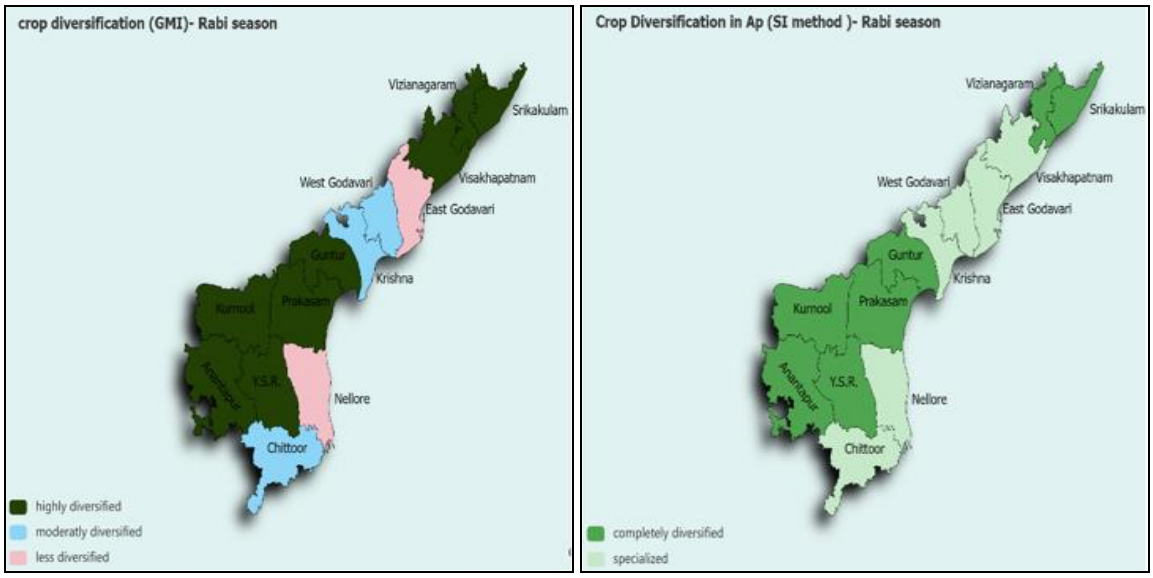

Fig 2: Diagrammatic representation of crop diversification of districts of Andhra Pradesh in the Rabi season

The level of crop diversification in Indian agriculture has been divided into three categories i.e. low, moderate, and high based on the index value of crop diversification computed by the above-mentioned methods shown in Table 3.

According to Gibb's and Martin's formula, the highest index value of crop diversification in the overall seasons in Andhra Pradesh agriculture is 0.9 in Kurnool district, Prakasam (0.8), Guntur (0.8), Y.S.R Kadapa (0.8) and Anantapur (0.8). Its index value varies from 0.3 in Srikakulam to 0.9 in Kurnool and Prakasam

Moderate level of crop diversification has covered Chittoor (0.6), Krishna (0.5) Visakhapatnam (0.5), and Vizianagaram (0.5) whereas a lower level of crop diversification is in Srikakulam, Nellore, East Godavari, and West Godavari. The diagrammatic representation of the Crop diversification of districts of Andhra Pradesh in the Kharif season is in Figure 3.

Table 3: Crop diversification of districts of Andhra Pradesh in overall seasons

S. No	District	GMI	HI	SDI	EI
1	Srikakulam	0.3	0.7	0.3	0.4
2	Vizianagaram	0.5	0.6	0.4	0.5
3	Visakhapatnam	0.5	0.6	0.4	0.4
4	Eastgodavari	0.3	0.8	0.2	0.3
5	Westgodavari	0.4	0.7	0.3	0.4
6	Krishna	0.5	0.7	0.3	0.5
7	Guntur	0.8	0.4	0.6	0.7
8	Prakasam	0.8	0.4	0.6	0.8
9	S.P.S. Nellore	0.2	0.8	0.2	0.4
10	Y.S.R. Kadapa	0.8	0.4	0.6	0.8
11	Kurnool	0.9	0.3	0.7	0.9
12	Ananthapur	0.8	0.4	0.6	0.6
13	Chittoor	0.6	0.5	0.5	0.5

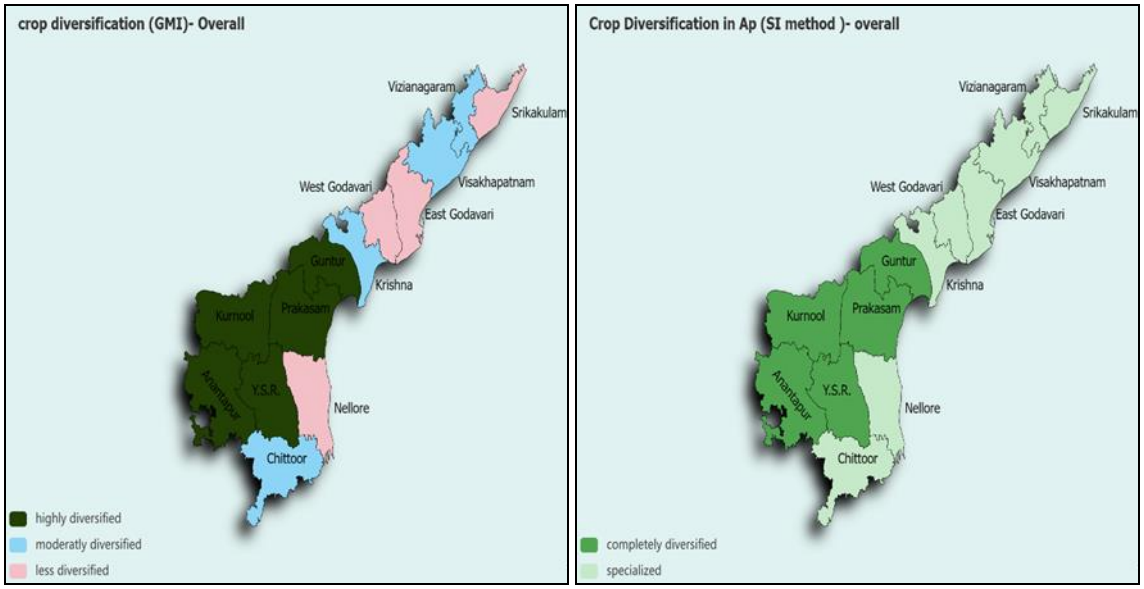

Fig 3: Diagrammatic representation of crop diversification of districts of Andhra Pradesh in overall seasons

Conclusion

Crop diversification in Indian agriculture is classified into low, moderate, and high levels based on index values. The highest index value in Kharif season in Andhra Pradesh agriculture is 0.8 in Kurnool district, followed by Prakasam, Guntur, Y.S. R Kadapa, and Anantapur. Moderate crop diversification is found in Chittoor and Nellore, while lower levels are found in Srikakulam, Vizianagaram, Krishna, Visakhapatnam East Godavari, and West Godavari. Herphindal's formula shows higher levels of crop diversification in Kurnool and Prakasam. In Kadapa, Kurnool, and Anantapur, the highest index value for the Andhra Pradesh Rabi season is 0.9. Prakasam, Guntur, Srikakulam, and Vizianagaram are next in line. West Godavari, Krishna, and Chittoor have moderate degrees of agricultural diversification, whilst Nellore and East Godavari have lower levels. According to Herfindahl's formula, Nellore has the least amount of crop diversification (0.94), whereas Guntur, Kadapa, Anantapur, and Kurnool have the most. The highest levels of crop diversification in Andhra Pradesh agriculture are found in Kurnool district, Prakasam, Guntur, Y.S.R. Kadapa, and Anantapur, followed by Chittoor, Krishna, Visakhapatnam, and Vizianagaram, and lower levels in Srikakulam, Nellore, East Godavari, and West Godavari, according to Gibb's and Martin's formula. Since small and marginal farmers dominate the sector, policies should prioritize financial assistance, credit access, crop insurance, and technology support to improve their viability in local and global markets. In order to encourage diversification, low-diversification districts like Srikakulam and Nellore need incentives for crop rotation, input subsidies, and better irrigation infrastructure, while high-diversification districts like Kurnool and Prakasam should concentrate on improving market access and value chain development for high-value crops. With an emphasis on tackling monocropping in Srikakulam during the Kharif season and poor diversification in Nellore during the Rabi season, season-specific methods are crucial. In water-scarce areas like Anantapur, encouraging drought-tolerant crops might increase climate risk resistance. Additionally, regional crop specialization and export promotion should be encouraged in high-diversification districts to tap into global markets. To encourage diversity across districts, investments in rural infrastructure such as transportation, storage, and irrigation are essential. Smallholders can also be encouraged to embrace a variety of cropping patterns through farmer training programs and awareness campaigns about the financial and environmental advantages of diversity. Through the resolution of these issues, the state may strengthen its agricultural sector, guaranteeing resilience, sustainability, and higher farmer earnings.

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