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Geographical Study of Crop Concentration and Crop Diversification in Tungabhadra River Basin of Kurnool District, Andhra Pradesh

B. Appanna*[1] and Y. Sujatha[2]

[1-2] Department of Geography, S. V. University, Tirupati - 517 502, Andhra Pradesh, India

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Abstract

The aim of the Present study is to analyze the spatial distribution of agricultural crops in the Tungabhadra River basin of Kurnool district using statistical techniques such as Crop Concentration and Crop Diversification. The study focuses on the mandal level, covering a total of 30 mandals within the basin. The data used in this study is secondary data obtained from the Chief Planning Office of Kurnool District (C.P.O) and the Handbook of Statistics, Kurnool District, for the year 2019-20. A total of seventeen crops were considered for this study. The Bhatia's Location Quotient method (1965) was employed to calculate the crop concentration, while the Gibbs and Martin's Quantitative technique (1962) was used to compute the crop diversification index. To visually represent the cropping patterns across the entire basin, the mandal was chosen as the base unit for areal mapping. Among the seventeen crops analyzed, Cotton (37%), Groundnut (15%), Bengal gram (13%), and red gram (9%) were found to be the most widely cultivated crops in the basin. The diversification of crops was found to be high in three mandals, moderate in fourteen mandals, and low in thirteen mandals.

***Key words*:** Cropping pattern, Crop concentration, Crop diversification, Bhatia's location quotient method, Gibbs and Martin's quantitative technique, Arc GIS 10.4

The Tungabhadra River basin, located in the western part of the Kurnool district, is characterized by its unique agricultural landscape. More than 75% of the region comprises Pedi plains, with 45% of the soil being cotton-rich black soils and 30% being red soils due to its geological connection to granite and gneisses. The primary mode of agriculture in this region is rain-fed, and agriculture stands as the predominant land use. Over 70% of the population relies on agriculture for their livelihoods. However, the agricultural system here is primarily based on traditional practices and operates at a subsistence level due to the limited availability of irrigation facilities and the prevalence of marginal and small landholdings. A significant portion of the working population is engaged in agricultural labour.

In this context, the study of crop concentration and diversification becomes essential to assess the state of crops in terms of their distribution across the area, the number of crops grown, spatial variations, and agricultural practices. [1] brought out the patterns of Crop concentration and Diversification in India. This information is critical for regional agricultural planning [2-3]. Crop concentration refers to the density variation of a particular crop in a specific area at a given point in time, while crop diversification represents the opposite, indicating a balanced mix of crops within a region [4]. Both these aspects not only provide insights into areas dominated by specific crops but also play a pivotal role in bolstering the agrarian economy and aiding in land-use planning [5]. The spatial variations in the degree of crop concentration in the area are influenced by various factors, including topography, climate, hydrology, socio-economic conditions, and technological factors. These interactions shape the agricultural landscape of the region, making it crucial to consider these factors when devising strategies for sustainable agricultural development [6]. The studies Crop concentration and crop diversification has been widely studied and mapped by various researchers in India. Among them who have studied crop concentration and diversifications are [7-17].

MATERIALS AND METHODS

Study area

The study area of the Tungabhadra River basin is in the north-western region of the Kurnool district in the state of Andhra Pradesh, India. It lies Between North Latitude 15° 15ˈ00” to 16° 0ˈ00” and East longitude 77° 0ˈ00” to 78° 15ˈ00”. The area falls within the survey of India (SOI) Toposheet No 57E/ 1 to 57E/16 and 57I/1 to 57 I/5. The total area of the basin is 6,934 square kilometers. The basin consists of 30 mandals, with 21 mandals fully covered and the remaining 9 mandals partially covered. The basin receives an average annual rainfall of 670 mm and experiences temperatures ranging from 26°C to 46°C in the summer and 12°C to 31°C in the winter. The northwestern portion, which includes Adoni, Peddakadubur, Alur, Aspari, Chippagiri, Halaharvi, Holagunda, Pathikonda, Devanakonda, Krishnagiri, Veldurthy, Kodumur, and Kallur mandals, has a desolate appearance with vegetation mostly limited to small pockets of reserve forests. This portion of the basin covers an area of 41,712 hectares, which accounts for

***Correspondence to:** B. Appanna, E-mail: bestaappanna@gmail.com

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4.46% of the total geographical area. The terrain in this region slopes from south to north and is drained by the river Hundri, which joins the river Tungabhadra at Kurnool. The soils in the north-western parts traversed by the river Hundri are black cotton, while the south-eastern parts are predominantly pure red soils. Geologically, the basin is underlying by the crystalline rock of the Peninsular Gneissic complex (PGC), which includes the Granitic Gneisses and Granite in the western and southern parts of the basin.

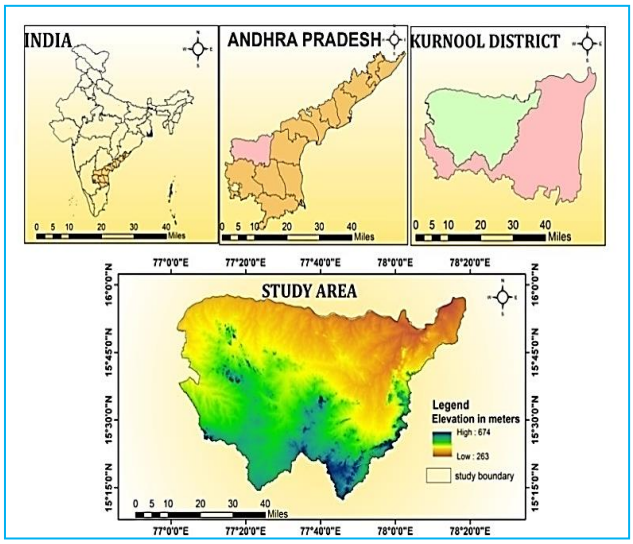

Fig 1 Location map of the study area

The present study utilized secondary data obtained from the Chief Planning office of Kurnool District (C.P.O) and the Handbook of Statistics, Kurnool District, 2019-20. Additionally, relevant information pertaining to physiographic, climate, and soil characteristics was collected from the Andhra Pradesh Satellite Application Centre (APSAC) Manuals and survey reports. To analyze the crop concentration index at the mandal level and its regional variations, Bhatia's Location Quotient Method was employed. This method considers the index values to be directly proportional to the levels of crop concentration.

$$\text{Crop concentration index (CCI)} = \frac{a/b}{a'/b'}$$

Where, a is the area of particular crop in the unit area
b is the total cropped area in the unit area
a' is the area of crop in the entire region
b' is the area of all crops in the entire region

(B). for the delineation of Crop Diversification regions in the study area, Gibbs and Martin Technique (1962) has been used which is Expressed as follows:

$$\text{Crop diversification index} = 1 \frac{\Sigma X^2}{(\Sigma X^2)}$$

Where;
X is the percentage of total cropped area occupied an individual crop.

RESULTS AND DISCUSSION

Spatial patterns of crop concentration in Tungabhadra River Basin of Kurnool district in 2019-20

The index of concentration of paddy, jowar, bajra, maize, total minor millets, red gram, Bengal gram, other pulses, chillies, condiments and spices, fruits and vegetables, cotton, ground nut, sunflower, castor, other oil seeds, tobacco crops for the year 2019-20 has been worked out adopting Bhatia method. The basin comprises of 30 mandals, out of which 21 mandals are fully covered while the remaining 9 mandals are partially covered. Consequently, we have collected complete data from the 9 mandals that were fully covered. so, the total geographical area is 935665 ha [18-19].

Paddy

The total cultivated land area within the basin for the given year amounts to approximately 643,521 hectares, representing 68.77% of the basin's total geographical area. Amongst this, 16,696 hectares are specifically allocated for the cultivation of Paddy, accounting for 2.59% of the overall cropped area. The crop concentration index reveals that there are fourteen mandals with a high concentration of crops, three mandals with a medium concentration, and eleven mandals with low concentration and two mandals are no concentration. Spatial distribution analysis indicates that the northern and north western mandals within the basin exhibit a high concentration of crops. In contrast, the eastern and southern regions of the basin demonstrate a low concentration. Notably, three mandals, namely Orvakal, Miduthur, and Krishanagiri, display a medium level of crop distribution. The Spatial distribution of crop concentration is shown in the (Fig 2, Table 1).

Jowar

The Jowar crop encompasses a total cropped area of approximately 15,319 hectares, representing 2.38% of the overall cropped area. Analysis of the crop concentration index reveals that there are eleven mandals exhibiting a high concentration of Jowar cultivation, while ten mandals display a medium concentration, and nine mandals exhibit a low concentration. Spatial distribution patterns indicate that Jowar cultivation is predominantly concentrated in the north-eastern and south-eastern regions of the basin, with a medium concentration observed in the western and southern areas. Conversely, the central and north-western mandals of the basin exhibit a low concentration of Jowar cultivation. The Spatial distribution of crop concentration is shown in the (Fig 3, Table 1).

Bajra

The present study reveals that the total cropped area under bajra cultivation in the basin is approximately 7023 hectares, which accounts for 1.09% of the total cropped area. The concentration index analysis indicates that the bajra crop concentration is high in eight mandals, medium in seven mandals, and low in twelve mandals of the basin. Notably, the concentration is found to be nil in Kurnool, Miduthur, and J. Bunglow. The spatial distribution analysis further reveals that the concentration of bajra cultivation is high in the north-central and a few mandals in the south, while it is of medium concentration in the central part of the basin. Conversely, the low concentration of bajra cultivation is observed in the eastern, north-western, and south-western mandals of the basin. The Spatial distribution of crop concentration is shown in the (Fig 4, Table 1).

Maize

The present study reveals that the total cropped area dedicated to Maize cultivation in the basin is approximately 24,263 hectares, which accounts for 3.77% of the total cropped area. The concentration index analysis indicates that there are nine mandals with high concentration, two mandals with medium concentration, and fourteen mandals with low

concentration. Additionally, five mandals exhibit no concentration. The spatial distribution analysis reveals that the Maize cultivation concentration is high in the north-eastern part of the basin. Furthermore, the medium concentration is observed in two mandals, namely Kodumur and Yemmiganur mandals, while the low concentration is found in the north-western, central, and western parts of the basin. The spatial variation in maize cultivation within the Tungabhadra River basin indicates significant differences. The Spatial distribution of crop concentration is shown in the (Fig 5, Table 1).

Table 1 Mandal wise crop concentration Iin Tungabhadra River basin of Kurnool district

S.no	MANDAL	RICE	JOWER	BAJRA	MAIZE	MINOR MILLETS	RED GRAM	BENGAL GRAM	OTHER PULSES	CHILLIES	CONDIMENTS AND SPICES	FRUITS AND VEGITABLES	COTTON	GROUND NUT	SUNFLOWER	CASTOR	OTHER OILSEEDS	TOBBACCO
1	Kurnool	1.28	1.85	0.00	2.30	0.67	0.53	2.26	0.33	0.85	0.60	2.40	0.61	0.15	1.43	0.61	0.00	6.67
2	Kallur	0.23	3.46	0.08	1.79	1.39	0.93	1.23	0.14	0.02	0.95	1.44	1.04	0.21	5.25	0.70	3.38	1.79
3	Orvakal	0.61	2.26	0.03	1.51	1.15	1.40	2.04	0.60	0.12	1.37	1.38	0.64	0.09	4.60	0.60	1.12	10.03
4	Kodumur	0.36	1.69	0.94	0.53	2.08	0.70	1.90	0.04	0.00	0.51	1.33	1.04	0.55	2.87	0.78	0.22	0.06
5	Gudur	0.03	2.05	0.32	0.02	0.20	0.14	1.70	0.01	0.25	0.26	0.51	1.72	0.16	0.28	0.12	0.06	0.31
6	C.Belagal	1.75	0.74	0.59	1.56	0.54	0.22	0.29	0.02	0.86	0.58	3.53	1.32	0.38	0.44	0.08	0.61	0.00
7	Dhone	0.14	0.51	0.92	0.00	1.88	4.42	0.21	0.21	0.05	0.22	1.39	0.06	2.25	0.93	2.53	0.35	0.00
8	Bethamcherla	0.42	0.72	2.76	0.44	11.52	6.25	0.57	0.69	0.00	0.80	1.06	0.04	0.30	6.61	0.53	3.75	0.00
9	Veldurthy	0.09	1.66	0.15	0.24	2.27	3.14	0.50	0.15	0.79	0.80	0.56	0.78	1.06	1.44	2.09	0.17	0.17
10	Krishnagiri	0.51	0.35	1.11	0.11	0.27	1.25	0.25	0.00	0.00	0.18	0.76	0.58	3.07	0.34	3.36	0.84	0.02
11	Peapully	0.11	1.04	3.84	0.04	2.14	3.87	0.14	0.23	0.00	0.56	1.01	0.18	2.20	0.92	2.13	0.56	0.00
12	Nandikotukur	1.59	0.25	0.01	9.66	0.53	0.66	2.69	4.44	0.00	0.45	1.16	0.05	0.06	0.36	0.02	0.50	2.48
13	Miduthur	0.81	1.17	0.00	3.69	1.37	0.88	2.18	1.34	3.20	1.35	0.61	0.63	0.01	0.04	0.08	1.03	12.48
14	Pagidayala	5.44	0.35	0.02	11.98	0.07	0.58	1.10	9.31	0.68	0.32	0.36	0.09	0.11	6.35	0.01	0.18	0.95
15	J.Bunglow	1.78	0.53	0.00	9.62	0.14	1.34	1.38	6.17	0.31	0.36	0.89	0.33	0.06	0.94	0.03	0.00	0.93
16	Adoni	1.51	0.75	0.67	0.01	0.28	0.09	0.30	0.25	1.99	1.26	0.50	1.71	0.97	1.06	0.19	1.50	0.00
17	Kowthalam	2.25	0.70	0.28	0.01	0.21	0.07	0.12	0.17	3.18	1.13	0.33	2.07	0.17	0.26	0.14	0.08	0.00
18	Kosigi	2.90	0.24	0.82	0.03	0.08	0.12	0.01	0.31	2.46	0.89	1.36	1.63	0.84	0.00	0.75	0.05	0.00
19	Peddakadubur	3.34	0.01	0.30	0.18	0.22	0.08	0.04	0.20	4.76	1.24	0.95	1.56	0.95	0.00	0.31	0.32	0.00
20	Yemmiganur	1.26	0.63	1.49	0.62	0.83	0.16	0.17	0.48	2.53	0.98	1.29	1.63	0.61	0.18	1.02	0.00	0.00
21	Nandavaram	2.98	0.41	1.46	0.49	1.11	0.15	0.42	0.43	2.14	1.58	0.72	1.76	0.13	0.00	0.18	0.05	0.00
22	Mantralayam	2.59	0.43	0.27	0.02	0.12	0.17	0.27	0.49	1.74	0.56	0.59	2.08	0.07	0.00	0.11	0.00	0.00
23	Alur	0.01	1.94	0.31	0.00	0.45	0.04	3.28	0.20	0.27	1.67	0.21	1.08	0.32	0.28	0.15	0.03	0.00
24	Aspari	0.08	0.93	0.65	0.03	0.76	0.09	1.91	0.44	0.32	1.38	0.74	1.25	0.77	0.13	0.14	8.68	0.00
25	Holagunda	2.64	2.77	0.20	0.01	0.04	0.04	0.67	0.06	1.46	0.34	0.08	1.88	0.24	1.70	0.00	0.52	0.00
26	Pattikonda	0.00	0.73	0.36	0.00	0.10	0.34	1.61	1.52	0.37	0.77	1.01	0.88	1.85	0.00	1.12	0.87	0.00
27	Devanakonda	0.16	0.34	0.89	0.01	0.32	0.27	0.17	0.97	0.28	0.39	1.18	1.06	2.63	0.04	1.75	0.03	0.00
28	Tuggali	0.00	0.61	3.15	0.00	0.16	1.30	0.63	3.83	0.24	0.17	0.37	0.52	2.69	0.00	3.44	0.00	0.00
29	Maddikera	0.05	1.04	3.57	0.00	0.21	0.73	2.79	2.83	0.27	5.45	0.47	0.17	1.23	0.05	1.40	0.16	0.00
30	Gonegandla	1.15	0.42	1.72	1.08	0.93	0.36	0.21	1.62	1.64	0.94	2.45	1.11	1.04	0.07	1.73	0.31	0.00

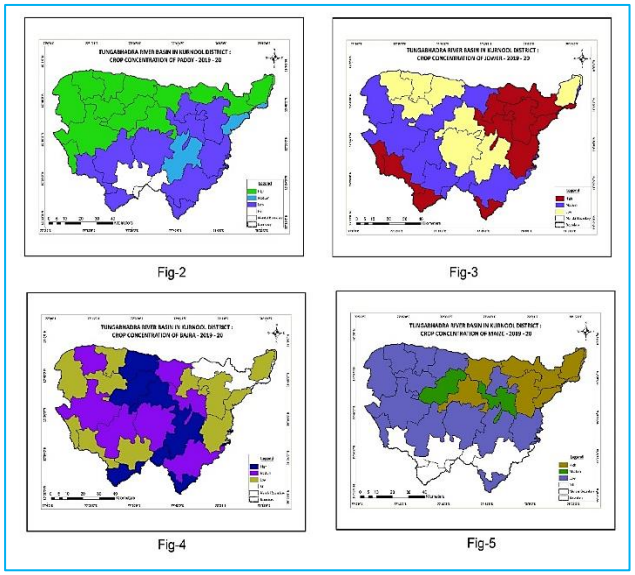

Fig-2 Fig-3

Fig-4 Fig-5

Minor millets

The minor millets exhibit a total cropped area of approximately 3,888 hectares, representing a mere 0.60% of the overall cultivated land. The concentration index analysis reveals a significant concentration of minor millets in nine mandals, a moderate concentration in six mandals, and a low concentration in fifteen mandals within the basin. Spatially, the eastern mandals of the basin exhibit a high concentration of minor millets, while the western and central mandals display a lower concentration. The Spatial distribution of crop concentration is shown in the (Fig 6, Table 1).

Red gram

The red gram crop encompasses a total cultivated area of approximately 60,564 hectares, representing 9.41% of the overall cultivated land within the basin. The concentration index reveals that red gram cultivation exhibits high concentration in eight mandals, medium concentration in seven mandals, and low concentration in fifteen mandals across the basin. Spatial analysis further indicates that the highest concentration of red gram cultivation is observed in the eastern and south-eastern regions of the basin, while the north-eastern region exhibits a medium concentration. Conversely, the western, northern, and central mandals of the basin display a low concentration of red gram cultivation. The Spatial distribution of crop concentration is shown in the (Fig 7, Table 1).

Bengal gram

The Bengal gram crop covers a total area of approximately 82,620 hectares, which accounts for 12.84% of the overall cropped area. The index of concentration reveals that this crop exhibits a high concentration in thirteen mandals, a medium concentration in four mandals, and a low concentration in thirteen mandals within the basin. The spatial distribution analysis indicates that the highest concentration of Bengal gram is observed in the north-eastern and south-western regions of the basin. Additionally, a medium concentration is observed in four specific mandals, namely Bethamcherala, Veldurthy, Holagunda, and Tuggali, within the basin. Conversely, the concentration of Bengal gram is low in the northwestern central and south-eastern parts of the basin. The Spatial distribution of crop concentration is shown in the (Fig 8, Table 1).

Other pulses

The total cultivated area dedicated to other pulses amounts to approximately 6,553 hectares, representing 1.02% of the overall cultivated area. The concentration index reveals that a significant concentration is observed in eight mandals, while a moderate concentration is found in three mandals, and a low concentration is recorded in eighteen mandals within the basin. Notably, no concentration is observed in the Krishanagiri mandal. The spatial distribution analysis indicates that the concentration is high in the mandals located in the north-east and southern regions of the basin. Additionally, a moderate concentration is observed in three mandals, namely Orvakal, Bethamcherla, and Devanakonda, with in the basin. Conversely, the concentration is low in the mandals situated in the north-western and eastern areas of the basin. The Spatial distribution of crop concentration is shown in the (Fig 9, Table 1).

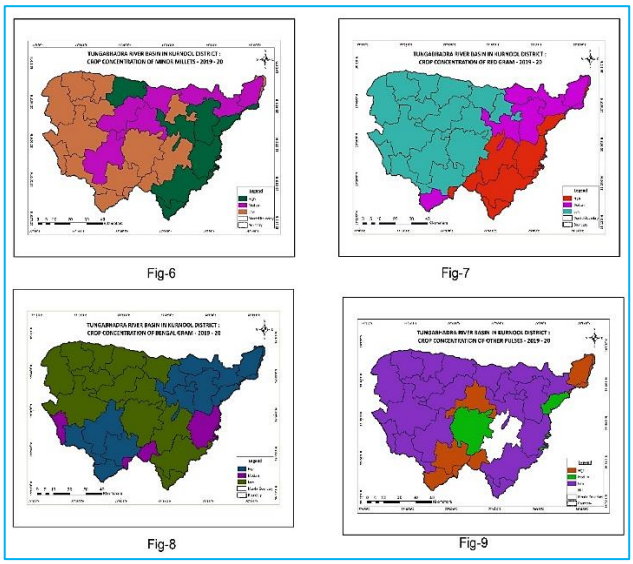

Fig-6 Fig-7

Fig-8 Fig-9

Chillies

The total cultivated area dedicated to chillies crops in the studied region amounts to approximately 7,427 hectares, representing 1.15% of the overall cultivated area. The concentration index reveals that chillies cultivation is highly concentrated in ten specific administrative divisions, moderately concentrated in four divisions, and minimally concentrated in ten divisions within the basin. Furthermore, the spatial distribution analysis indicates that chilli cultivation is predominantly concentrated in the western region of the basin. Additionally, moderate concentrations of chillies cultivation are observed in the mandals of Kurnool, C.Belagal, Veldurthy, and Pagidayala within the basin. Conversely, chili cultivation exhibits low concentrations in the southern and a few mandals in the eastern part of the basin. The Spatial distribution of crop concentration is shown in the (Fig 10, Table 1).

Condiments and spices

The total cultivated area dedicated to the cultivation of Condiments and Spices amounts to 19,230 hectares, representing 2.99% of the overall cultivated area. The distribution of this crop exhibits a high concentration in nine mandals, a medium concentration in twelve mandals, and a low concentration in nine mandals within the basin. Spatially, the condiments and spices crop concentration are notably high in the western and a few eastern mandals of the basin. Additionally, the concentration of this crop is of medium intensity in the northern, north central and southern mandals of the basin. Conversely, the southern mandals of the basin display a low concentration of Condiments and Spices cultivation. The Spatial distribution of crop concentration is shown in the (Fig 11, Table 1).

Fruits and vegetables

The aggregated cultivated land area dedicated to the cultivation of fruits and vegetables amounts to 41,850 hectares, representing 6.50% of the overall cultivated land area. The concentration index reveals that a significant concentration is observed in fourteen mandals, while a moderate concentration is found in ten mandals, and a low concentration is recorded in six mandals within the basin. Geographically, the concentration is spatially prominent in the mandals situated in the north-east, central, and southern regions of the basin. Conversely, the concentration is moderate in the mandals located in the western and eastern parts of the basin. Furthermore, the concentration is relatively low in the western and south-western mandals of the basin. The Spatial distribution of crop concentration is shown in the (Fig 12, Table 1).

Cotton

The total cultivated land area dedicated to Cotton is 40,182 hectares, representing 37.32% of the overall cultivated land area. The concentration index reveals that this crop exhibits a high concentration in sixteen mandals, a medium concentration in seven mandals, and a low concentration in seven mandals within the basin. Spatial analysis indicates that the highest concentration of Cotton is observed in the western, northern, and central regions of the basin. In the eastern mandals, the concentration of this crop is moderate. Conversely, the north-eastern and southern mandals of the basin exhibit a low concentration of cotton cultivation. The Spatial distribution of crop concentration is shown in the (Fig 13, Table 1).

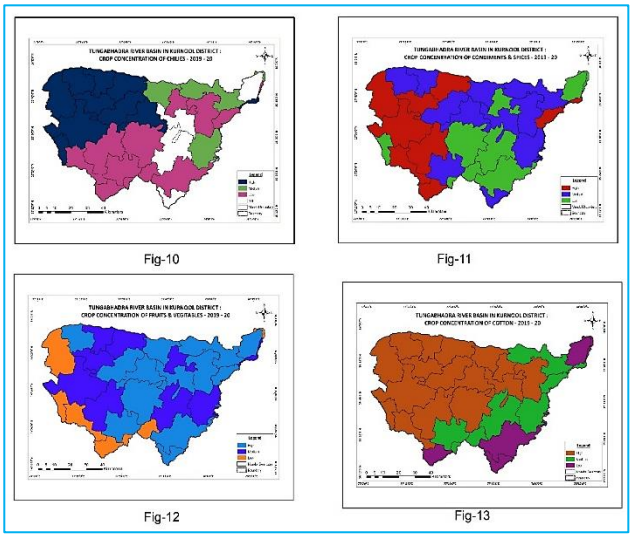

Fig-10 Fig-11

Fig-12 Fig-13

Groundnut

The cumulative cultivated land area within the Ground is measured at 95,239 hectares, representing 14.80% of the overall cultivated land area. The distribution of this crop exhibits a high concentration in nine mandals, a medium concentration in six mandals, and a low concentration in fifteen mandals within the basin. Spatial analysis reveals that the southern and central regions of the basin exhibit a high concentration of ground nut cultivation. Conversely, the western mandals of the basin demonstrate a medium concentration, while the northern, north-eastern, and select south-western mandals exhibit a low concentration of ground nut cultivation. The Spatial distribution of crop concentration is shown in the (Fig 14, Table 1).

Sunflower

The total cultivated area dedicated to sunflower cultivation amounts to 925 hectares, representing a mere 0.14% of the overall cultivated area. The distribution of sunflower cultivation exhibits a high concentration in nine mandals, a medium concentration in three mandals, and a low concentration in twelve mandals within the basin. However, sunflower cultivation is completely absent in six mandals. The spatial analysis reveals that the eastern and certain western mandals exhibit a high concentration of sunflower cultivation, while the central and north-eastern regions of the basin display a low concentration. Furthermore, sunflower cultivation is nonexistent in the north-western and certain southern mandals of the basin. The Spatial distribution of crop concentration is shown in the (Fig 15, Table 1).

Castor

The total cultivated area dedicated to castor is 16,067 hectares, representing 2.50% of the overall cropped area. The distribution of Castor cultivation varies across the basin, with high concentrations observed in ten mandals, medium concentrations in six mandals, and low concentrations in thirteen mandals. Notably, the mandal of Holagunda does not engage in Castor cultivation. Spatially, the southern and central mandals of the basin exhibit a high concentration of Castor cultivation, while the north-eastern part of the basin demonstrates a medium concentration. Conversely, the western and northern regions of the basin display a low concentration of Castor crop cultivation. The Spatial distribution of crop concentration is shown in the (Fig 16, Table 1).

Other oil seeds

The total cultivated area dedicated to other oil seeds is 2,078 hectares, which accounts for 0.32% of the overall cultivated area. The index of concentration reveals that this crop exhibits high concentration in six mandals, medium concentration in five mandals, and low concentration in fourteen mandals within the basin. Approximately five mandals do not cultivate this crop at all. The spatial distribution analysis indicates that the highest concentration of other oil seeds is found in the mandals of Kallur, Orvakal, Bethamcherla, Miduthur, Adoni, and Aspari within the basin. On the other hand, the concentration of other oil seeds crops is medium in C. Belagal, Krishnagiri, Peapully, Holagunda, and Pattikonda mandals of the basin. The concentration of other oil seeds crops is low in the central, north-western, and a few mandals in the eastern and south-western regions of the basin. The Spatial distribution of crop concentration is shown in the (Fig 17, Table 1).

Tobacco

The total cultivated area dedicated to tobacco cultivation in the basin amounts to 3,595 hectares, representing a mere 0.56% of the overall cultivated area. The index of concentration reveals that tobacco cultivation is highly concentrated in five mandals, moderately concentrated in two mandals, and has a low concentration in four mandals within the basin. Approximately nineteen mandals do not engage in tobacco cultivation. The spatial distribution analysis indicates that tobacco cultivation is highly concentrated in the mandals of Kurnool, Kallur, Orvakal, Nandikotukur, and Miduthur. The concentration of tobacco cultivation is moderate in Pagidayala and J.Bunglow mandals. Conversely, the mandals of Kodumur, Gudur, Veldurthi, and Krishnagiri exhibit a low concentration of tobacco cultivation within the basin. The Spatial distribution of crop concentration is shown in the (Fig 18, Table 1).

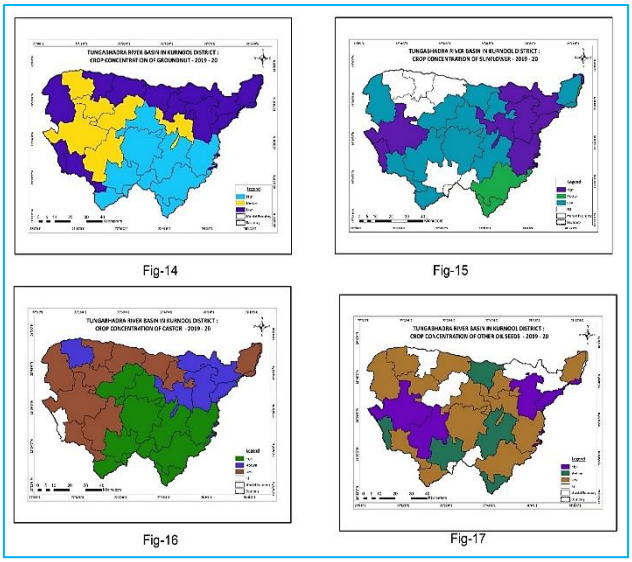

Fig-14 Fig-15

Fig-16 Fig-17

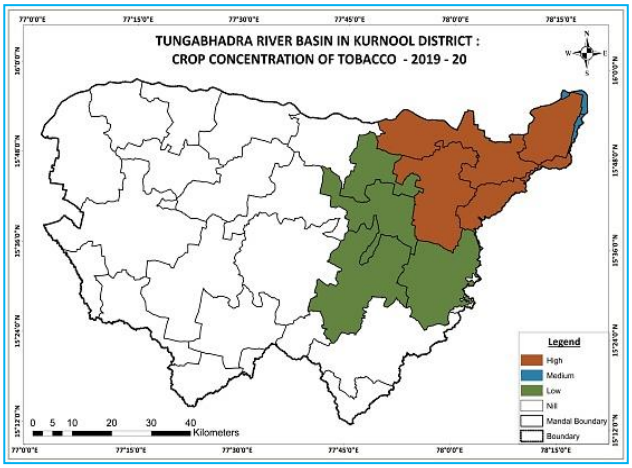

Fig 18

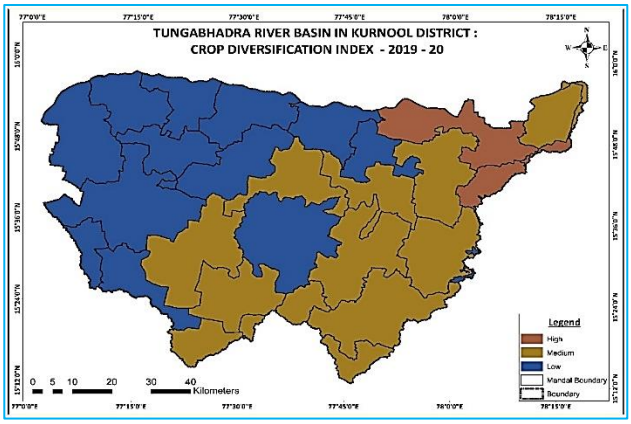

Fig 19

Crop diversification

Crop diversification plays a crucial role in enhancing agricultural productivity and sustainability. Identifying areas with high, moderate, and low levels of diversification can help policymakers and farmers implement targeted strategies to promote diversification and improve overall agricultural outcomes.

Areas with high crop diversification (> 0.80)

High level of crop diversification is found in Kurnool (0.82), Orvakal (0.84) and Miduthur mandal (0.83). Spatially these mandal are in North eastern part of the basin. The Spatial distribution of crop concentration is shown in the (Fig 19, Table 2).

Moderate crop diversification (0.70-0.80)

The mandals in the index exhibit a moderate level of diversification, ranging from 0.70 to 0.80. These mandals include Maddikera (0.80), J.Bunglow (0.80), Kallur (0.79), Veldurthi (0.79), Kodumur (0.77), Pattikonda (0.77), Tuggali(0.77), Gonegandla (0.77), Peapully (0.75), Pagidayala (0.74), Nandikotukur (0.73), Dhone (0.70), Krishnagiri (0.72), Aspari (0.70). The spatial distribution reveals that moderate diversification is observed in the eastern, southern, and a few mandals in the central part of the basin. The Spatial distribution of crop concentration is shown in the (Fig 19, Table 2).

Low crop diversification (>0.70)

The observation of a low level of crop diversification has been made in thirteen mandals, namely Gudur (0.54), C. Belagal (0.69), Devanakonda (0.68), Alur (0.65), Bethamcherla (0.63), Peddakadubur (0.62), Yemiganur (0.61), Mantralyam (0.61), Kosigi (0.60), Adoni (0.57), Nandavaram (0.55), Holagundra (0.49), and Kowthalm (0.39). The spatial distribution of these mandals indicates that they are situated in the north-western and western regions of the basin. The Spatial distribution of crop concentration is shown in the (Fig 19, Table 2).

Table 2 Mandal wise crop diversification index in Tungabhadra River basin of Kurnool district (2019-20)

S. No.	Name of the mandal	CDI	S. No.	Name of the mandal	CDI	S. No.	Name of the mandal	CDI
1	Kurnool	0.82	11	Peapully	0.75	21	Nandavaram	0.55
2	Kallur	0.79	12	Nandikotkur	0.73	22	Mantryalam	0.39
3	Orvakal	0.84	13	Midthur	0.83	23	Alur	0.65
4	Kodumur	0.77	14	Pagidayala	0.74	24	Aspari	0.70
5	Gudur	0.54	15	J. Bunglow	0.80	25	Holagunda	0.49
6	C.Belagal	0.69	16	Adoni	0.57	26	Pattikonda	0.77
7	Dhone	0.70	17	Kowthalam	0.39	27	Devanakonda	0.68
8	Bethamcherla	0.63	18	Kosigi	0.60	28	Tuggali	0.77
9	Veldurthy	0.79	19	Peddakadbur	0.62	29	Maddikera	0.80
10	KrishnaGiri	0.72	20	Yemmiganur	0.61	30	Gonegandla	0.77

CONCLUSION

The spatial variation of major crops in the basin indicates that the contrast is due to topography, climate, socio-economic, and technological factors. It can be observed that the cropping pattern in the Tungabhadra River basin is primarily focused on commercial crops, particularly cotton and groundnut, with food grains such as Bengal gram, red gram, fruits, and vegetables also being cultivated. Cotton is the dominant crop in this region, limiting agricultural diversification. As a result, most of the mandals in the area have a low to moderate index of diversification, with only three mandals, namely Kurnool, Orvakal, and Miduthur, exhibiting high crop diversification. More than 75% of the basin area consists of pediplains, and 70% of the population relies on agriculture for their livelihood. Therefore, crop diversification can be utilized as a tool to improve the economic conditions of small and marginal farmers. The traditional cropping pattern can lead to issues such as decreased productivity and soil fertility. To address these problems, crop rotation, intercropping, and the implementation of micro irrigation technologies such as drip, trickles, and sprinklers are effective measures to enhance soil health, minimize water usage, and reduce soil and water pollution. It is important to carefully manage surface and subsurface water resources and improve irrigation facilities by constructing check dams, percolation ponds, and interlinking canals and tanks to promote good agricultural production. Tungabhadra River basin's agricultural landscape is currently dominated by cotton and groundnut, with limited diversification. By adopting crop rotation, intercropping, and advanced irrigation techniques, and by improving water management infrastructure, the region can enhance its agricultural sustainability and improve the economic conditions of its farming community.

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