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Evaluating agricultural productivity in Chhatrapati Sambhajnagar District for 2021-2022: A Kendall's ranking coefficient approach

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Abstract

The purpose of this research is to assess the Chhatrapati Sambhajnagar District's agricultural output index for the 2021–2022 season with an emphasis on nine important crops: oilseeds, wheat, jowar, bajra, maize, pulses, sugarcane, cotton, and spices. Assessing regional differences in crop yield, determining the causes of these discrepancies, and offering a thorough examination of the district's agricultural performance are the goals of this study. The Department of Economics and Statistics, the Chhatrapati Sambhajnagar District Handbook, and the district's socioeconomic overview were among the secondary sources of the data. In order to provide a clear comparison of agricultural production across various tehsils, the crops were ranked based on their yield per hectare using the Kendall Ranking Coefficient Index. This approach makes it easier to identify regions with high, moderate, or poor agricultural output by enabling a consistent evaluation. Significant variations in agricultural output were found throughout the district, according to the research. In certain tehsils, the most productive crops were wheat, maize, and oilseeds, while sugarcane and spices were not as prevalent. Notably, low-productivity areas like Phulambri, Sillod, and Gangapur were limited by issues like low soil fertility, insufficient irrigation, and a limited adoption of advanced agricultural practices, whereas high-productivity regions like Paithan and Soegaon demonstrated favorable agricultural conditions.

Keywords: Productivity index, Kendall's ranking coefficient, crop yield, crop ranking

1. Introduction

The foundation and lifeblood of the Indian economy, agriculture is essential to the country's overall growth. One of the biggest success stories of independent India is the agricultural sector, which has advanced remarkably over the last 50 years. Agriculture and related industries continue to contribute the most to the GDP in areas like Chhatrapati Sambhajnagar. Additionally, about two-thirds of the workforce still depend on agriculture as their main source of income, underscoring the sector's significance in maintaining both food security and economic stability.

A number of initiatives targeted at increasing productivity have contributed to the rise in agricultural output. These include increasing the cultivated area, implementing superior seeds, enhancing irrigation systems, and implementing cutting-edge water management strategies. Growth in this industry has also been significantly fueled by the application of new farming techniques, the use of pesticides, and significant contributions from agricultural research. These developments not only increase food production but also fortify the rural economy, opening the door for sustainable farming methods and the country's general prosperity.

Nonetheless, the agricultural output from the Chhatrapati Sambhajnagar district varies greatly, necessitating a thorough examination. The productivity regions were classified as High Productivity Region, Medium Productivity Region, and Low Productivity Region based on the derived productivity index values. Because of the components employed in the calculation, the Agriculture Productivity would be useful for figuring out the productivity and appropriateness of agricultural crops as well as for figuring out their spatial distribution and pattern. Additionally, this approach is helpful in defining and recognizing Chhatrapati Sambhajnagar's agricultural region. By taking into account the results of the Agriculture Productivity, planners and policymakers will be able to make decisions that will improve the agricultural sector's performance in Chhatrapati Sambhajnagar.

2. Objective

The study outlined has several objectives focused on evaluating and understanding agricultural productivity in Chhatrapati Sambhajnagar District for the years 2021-2022. These objectives are:

1. To assess the agricultural productivity of nine key crops across different tehsils in the district.
2. To determine the regional agricultural productivity levels using Kendall's Ranking Coefficient Index.

3. Study Region

With the exception of a tiny area in the north and northwest that is under the Tapi drainage system, the majority of Aurangabad District, which is in the state's central elevated region, is located inside the Godavari Basin. In the southern

part of the district, the Godavari River and its tributaries define the area. Latitudes 19°17'N to 20°40'N and longitudes 74°39'E to 76°40'E are its geographic coordinates. The districts of Jalgaon to the north, Jalna to the east, Ahmednagar to the south and southwest, and Nashik to the west enclose it. It also has smaller borders with Buldhana district in the northeast and Beed district in the south. With a total size of 10,100 square kilometers, the district makes up 3.28 percent of Maharashtra. Just 1.40% of this is urban, with the rest 98.60% being rural. The population of Aurangabad district, as reported in the 2011 Census, is 3,695,928, which is equivalent to the population of Liberia. It is ranked 72nd out of 640 districts in India. The district's population increased by

Location Map

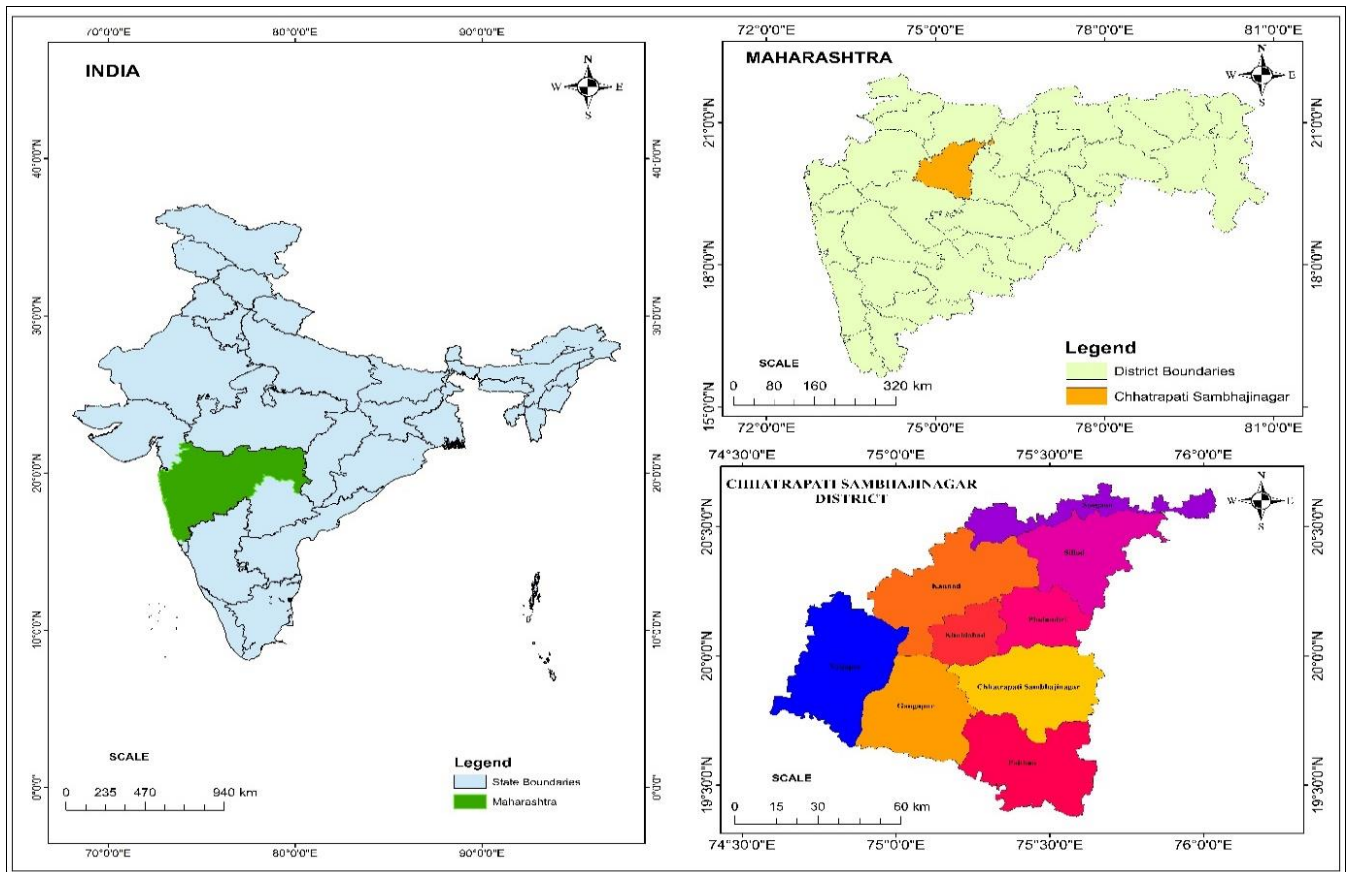


Fig 1: Geographical boundaries and administrative setup of the Chhatrapati Sambhajnagar District, situated in Maharashtra, India

4. Review of literature

Several researchers have attempted to examine agricultural productivity by recommending and enhancing various strategies, according to Stamp (1958) [19]. Shafi (1972) [15] chose a number of nations and a few key crops to determine agricultural productivity on a worldwide scale. The ranking coefficient and areal unit were calculated. Many others, according to Khusro's analysis in 1964, measured agricultural productivity in terms of grain equivalents per population. Measuring farming profitability in terms of the return for the whole amount of human labor or paid-out costs in relation to the output, as well as determining output in relation to input or output-input ratio.

According to Sapre-Deshpande (1964) [14] and Bhatia (1967) [2], productivity is determined by allocating weight to the ranking order of output per unit area with the percentage

share under each crop. Buck (1967) used his method to calculate Uttar Pradesh's agricultural efficiency. Furrow irrigation is widely used because it can be applied to a wide range of soil types and land slopes, according to Cantor's 1967 study. Both big and tiny streams of irrigated water can be used with it. According to Singh (1979) [18], land in emerging nations is too small to support any growth in the area under cultivation, and the growing population strain on available land forces geographers and agricultural scientists to consider ways to increase agricultural productivity.

The linked yield and concentration index ranking coefficient approach, developed by Jasbir Singh in 1976, assigns appropriate weight to the per hectare yield area occupied and ranks the many crops he also examined. Murthy asserts that irrigation, the fundamental input in the majority of our nation's farmed land, has been essential in increasing food

production because other inputs, such as fertilizers, improved seeds, etc., only give their fair share when a reliable supply of water is available. K.

5. Materials and Methods

Evaluating the district's agricultural output index for the years 2021–2022 is the main goal of this study. Nine of the main crops grown in the area were specifically selected for in-depth examination in order to accomplish this goal. Secondary sources provided the information used in this study. The Department of Economics and Statistics, the Chhatrapati Sambhajnagar District Handbook, and the district's socioeconomic overview were the specific sources of the data required for the research. These resources provide in-depth analyses of the productivity and agricultural performance of the chosen crops, guaranteeing a strong basis for the research. This method seeks to provide a precise evaluation of the district's agricultural production over the given time frame.

A straightforward and trustworthy way to evaluate agricultural output in a particular area is the Kendall Ranking Coefficient Index, which was first presented by M.G. Kendall in 1939. Using this method, crops are ranked according to their yield per unit area, and the average rank, also known as the ranking coefficient, is determined. The following is the formula for the ranking coefficient index:

$$\text{Ranking Coefficient Index} = \frac{r_1 + r_2 + r_3 + \dots + r_n}{N}$$

Whereas,

r = Ranking of Yield of Individual Crop

n = Number of Crops

By normalizing productivity metrics across several places, this method is especially useful for comparing different crops and geographical areas. It facilitates the discovery of trends, variances, and geographical disparities in agricultural output. Additionally, productivity variations over time can be monitored using Kendall's ranking coefficient, which provides information on long-term agricultural patterns and regional growth.

6. Results and Discussion

The agricultural productivity of nine tehsils in the Chhatrapati Sambhajnagar district for the year 2021–2022 is shown in the table. In order to show regional differences in productivity, it highlights the yield (in hectares) of important crops including wheat, jowar, bajra, maize, pulses, sugarcane, cotton, and oilseeds. Significant variations in agricultural performance are evident from the data, with certain tehsils outperforming others in particular crops. It also shows that at this time, spice production was not practiced in any tehsil, highlighting the emphasis on cash and basic crops.

Table 1: Crop-Wise Agriculture Productivity (hectares) in Chhatrapati Sambhajnagar District (2021-22)

Crops	Kannad	Soegaon	Sillod	Phulambri	Chhatrapati Sambhajnagar	Khulatabad	Vaijapur	Gangapur	Paithan
Wheat	2406	2028	2268	2279	2659	1752	1575	2161	1643
Jowar	1027	785	1246	890	892	839	507	607	696
Bajara	606	281	447	884	788	896	788	244	568
Maize	2036	1693	1794	2713	2681	1676	1880	1436	1396
Pulses	1046	1262	1296	1826	1373	753	1328	1104	946
Sugarcane	48	0	41	97	54	80	72	72	63
Cotton	588	490	580	490	731	443	489	496	501
Spices	0	0	0	0	0	0	0	0	0
Oil Seeds	1427	951	1573	2002	1603	2230	1456	2694	726

Source: Socio-Economic Abstract of Chhatrapati Sambhajnagar (2021-22)

Kannad produces a lot of maize (2036 hectares) and wheat (2406 ha). The production of oilseeds (1427 ha) and pulses (1046 ha) is moderate. Wheat and maize are the main crops in this tehsil, as evidenced by the poor productivity of jowar (1027 ha), bajra (606 ha), cotton (588 ha), and sugarcane (48 ha). Soegaon produces a significant number of oilseeds (951 ha), pulses (1262 ha), and wheat (2028 ha). Low productivity crops include cotton (490 ha), bajra (281 ha), maize (1693 ha), and jowar (785 ha). The sparse cultivation of sugarcane suggests that there is little crop diversity in this region.

Sillod reports strong oilseed (1573 ha) and pulse (1296 ha) productivity. Maize (1794 hectares) and wheat (2268 ha) are classified as moderately productive crops. The low productivity of bajra (447 ha), jowar (1246 ha), cotton (580 ha), and sugarcane (41 ha) highlights the importance of pulses and oilseeds. Phulambri highlights strong productivity in maize (2713 ha) and pulses (1826 ha), coupled with modest yields of wheat (2279 ha) and oilseeds (2002 ha). Due to the poor productivity of crops including bajra (884 ha), jowar (890 ha), cotton (490 ha), and sugarcane (97 ha), maize and pulses account for the

majority of agricultural production. High yields of oilseeds (1603 ha), maize (2681 ha), and wheat (2659 ha) are produced in this tehsil. While crops like jowar (892 ha), bajra (788 ha), cotton (731 ha), and sugarcane (54 ha) have poor yield, pulses (1373 ha) exhibit intermediate output. The principal crops still grown are maize and wheat.

Oilseed production in Khulatabad is high (2230 ha), whereas bajra (896 ha), maize (1676 ha), and pulses (753 ha) have moderate productivity. Low productivity is shown by cotton (443 ha), jowar (839 ha), and wheat (1752 ha). Because of the limited production of sugarcane (80 hectares), oilseeds are the most important crop in this area. Vaijapur reported high oilseed (1456 ha), pulse (1328 ha), and maize (1880 ha) yields. Cotton (489 ha), bajra (788 ha), and jowar (507 ha) produce lower yields than wheat (1575 ha), which has a reasonable level of productivity. The modest production of sugarcane (72 hectares) reflects a balance between oilseeds and grains.

While maize (1436 ha) and pulses (1104 ha) have intermediate yield, oilseeds (2694 ha) exhibit great production in Gangapur. While cotton (496 ha), jowar (607 ha), and bajra (244 ha) exhibit poor production, wheat (2161

ha) likewise fits into the intermediate group. The production of sugarcane (72 hectares) is moderate, while oilseeds predominate in agriculture. Paithan yields moderate amounts of wheat (1643 ha), bajra (568 ha), and pulses (946 ha), but it is highly productive in maize (1396 ha). A varied but modest agricultural production is shown in the low productivity of oilseeds (726 ha) and jowar (696 ha), while

sugarcane (63 ha) and cotton (501 ha) show reasonable yields. The tehsil-wise crop rankings for 2021–2022 are highlighted in this research, demonstrating the prominence and production of different crops throughout the district. The dominance of oilseeds, wheat, and maize reflects their capacity to adapt to the local soil and climate.

Table 2: Tehsil Wise Kendall's Ranking Crop Ranking Frequency 2021-22

Tehsils	I	II	III	IV	V	VI	VII	VIII	IX
Kannad	Wheat	Maize	Oil Seeds	Pulses	Jowar	Bajara	Cotton	Sugarcane	Spices
	26.20	22.17	15.54	11.39	11.18	6.60	6.40	0.52	0.00
Soegaon	Wheat	Maize	Pulses	Oil Seeds	Jowar	Cotton	Bajara	Sugarcane	Spices
	27.08	22.60	16.85	12.70	10.48	6.54	3.75	0.00	0.00
Sillod	Wheat	Maize	Oil Seeds	Pulses	Jowar	Cotton	Bajara	Sugarcane	Spices
	24.53	19.41	17.01	14.02	13.48	6.27	4.84	0.44	0.00
Phulambri	Maize	Wheat	Oil Seeds	Pulses	Jowar	Bajara	Cotton	Sugarcane	Spices
	24.26	20.38	17.91	16.33	7.96	7.91	4.38	0.87	0.00
Chhatrapati Sambhajanagar	Maize	Wheat	Oil Seeds	Pulses	Jowar	Bajara	Cotton	Sugarcane	Spices
	24.87	24.66	14.87	12.74	8.27	7.31	6.78	0.50	0.00
Khulatabad	Oil Seeds	Wheat	Maize	Bajara	Jowar	Pulses	Cotton	Sugarcane	Spices
	25.72	20.21	19.33	10.34	9.68	8.69	5.11	0.92	0.00
Vaijapur	Maize	Wheat	Oil Seeds	Pulses	Bajara	Jowar	Cotton	Sugarcane	Spices
	23.22	19.46	17.99	16.41	9.73	6.26	6.04	0.89	0.00
Gangapur	Oil Seeds	Wheat	Maize	Pulses	Jowar	Cotton	Bajara	Sugarcane	Spices
	30.57	24.52	16.29	12.53	6.89	5.63	2.77	0.82	0.00
Paithan	Wheat	Maize	Pulses	Oil Seeds	Jowar	Bajara	Cotton	Sugarcane	Spices
	25.13	21.35	14.47	11.10	10.64	8.69	7.66	0.96	0.00

Source: Computed by Researcher

Wheat

In Kannad (Rank I, 26.20%), Soegaon (Rank I, 27.08%), Sillod (Rank I, 24.53%), and Paithan (Rank I, 25.13%), wheat is the most prolific crop. Its importance across the district is further demonstrated by the notable productivity it possesses in Phulambri (Rank II, 20.38%), Chhatrapati Sambhajanagar (Rank II, 24.66%), Vaijapur (Rank II, 19.46%), and Gangapur (Rank II, 24.52%). With 20.21%, wheat is ranked second in Khulatabad, highlighting its consistent presence.

Maize

In Phulambri (Rank I, 24.26%), Chhatrapati Sambhajanagar (Rank I, 24.87%), and Vaijapur (Rank I, 23.22%), maize does particularly well. In Kannad (22.17%), Soegaon (22.60%), Sillod (19.41%), and Paithan (21.35%), it ranks second. It also has Rank III in Gangapur (16.29%) and Khulatabad (19.33%). The steady production of maize throughout the majority of tehsils demonstrates its resilience to a variety of soil types and temperatures.

Oilseeds

In Khulatabad (Rank I, 25.72%) and Gangapur (Rank I, 30.57%), oilseeds are the most important crop, demonstrating their significance in these areas. Oilseeds in Kannad, Sillod, Phulambri, and Vaijapur achieve Rank III with yields of 15.54%, 17.01%, 17.91%, and 17.99%, respectively. Oilseeds are ranked III in Chhatrapati Sambhajanagar and IV in Paithan. The dominance of oilseeds in some tehsils can be explained by the fact that they flourish in regions with semi-arid climates and black soils.

Pulses

In Soegaon (Rank III, 16.85%), pulses are the most popular

product. Phulambri (Rank IV, 16.33%) and Vaijapur (Rank IV, 16.41%) are next in line. While their contributions are minor, Kannad (Rank IV, 11.39%), Chhatrapati Sambhajanagar (Rank IV, 12.74%), and Gangapur (Rank IV, 12.53%) also place a strong emphasis on pulses. Because they may flourish in less fertile and drought-prone places, pulses score better in areas with well-drained soils.

Jowar

In Sillod (Rank V, 13.48%), Paithan (Rank V, 10.64%), and Kannad (Rank V, 11.18%), Jowar's productivity is mediocre. Lower yields are seen in some tehsils, such as Khulatabad (Rank V, 9.68%), Phulambri (Rank V, 7.96%), and Chhatrapati Sambhajanagar (Rank V, 8.27%). Jowar is less important than other crops like wheat and maize, but its ability to withstand drought makes it useful in semi-arid areas.

Bajara

Bajra has modest yields and scores highly in Khulatabad (Rank IV, 10.34%), Phulambri (Rank VI, 7.91%), and Paithan (Rank VI, 8.69%). It is ranked sixth (6.60%) in Kannad and seventh (7.31%) in Chhatrapati Sambhajanagar. Bajra is still less productive than other cereals like wheat and maize, but its resistance to drought helps it.

Cotton

Cotton ranks seventh in Paithan and Kannad with yields of 7.66% and 6.40%, respectively, while Soegaon (Rank VI, 6.54%) and Chhatrapati Sambhajanagar (Rank VII, 6.78%) have noteworthy yields. The lower cotton production at Khulatabad (Rank VII, 5.11%) and Gangapur (Rank VII, 2.77%) is indicative of the crop's varying adaptability for the soil and climate. Cotton may score lower in most tehsils because to its high-water requirements.

Sugarcane

The district's sugarcane output is still quite low, ranking eighth in every tehsil save Soegaon, where it is completely nonexistent. Paithan has the greatest yield (0.96%),

followed by Phulambri (0.87%), Vaijapur (0.89%), and Khulatabad (0.92%). The crop's overall poor ranking can be explained by its water-intensive nature and the lack of adequate irrigation infrastructure.

Table 3: Tehsil wise Crop Ranking, Sum of Ranks and Ranking Coefficient for 2021-22

Tehsils	Wheat	Maize	Oil Seeds	Pulses	Jowar	Bajara	Cotton	Sugarcane	Spices	Sum of Ranks	Number of Crops	Ranking Coefficient	Ranks
Kannad	2	5	6	8	2	6	4	6	0	39	8	4.88	4
Soegaon	1	4	8	1	4	8	3	0	0	29	7	4.14	7
Sillod	5	7	5	5	1	7	5	8	0	43	8	5.38	2
Phulambri	7	2	4	3	7	4	9	4	0	40	8	5.00	3
Chhatrapati Sambhajinagar	4	1	7	6	6	5	2	7	0	38	8	4.75	5
Khulatabad	8	8	2	9	5	1	8	2	0	43	8	5.38	2
Vaijapur	9	3	3	2	9	2	6	3	0	37	8	4.63	6
Gangapur	6	9	1	7	8	9	7	5	0	52	8	6.50	1
Paithan	3	6	9	4	3	3	1	1	0	30	8	3.75	8

Source: Computed by research

Table 4: Agriculture Productivity Regions based on Kendall's Ranking Coefficient 2021-22

Sr. No.	Ranking Coefficient Value	Productivity Levels	No. of Tehsils	Tehsils	% of Area
1	Below 4.14	High	02	Paithan Soegaon	22.22
2	4.15 to 4.88	Moderate	03	Vaijapur, Chhatrapati Sambhajinagar, Kannad	33.33
3	Above 4.89	Low	04	Phulambri, Sillod, Khulatabad, Gangapur	44.44

Source: Computed by Researcher

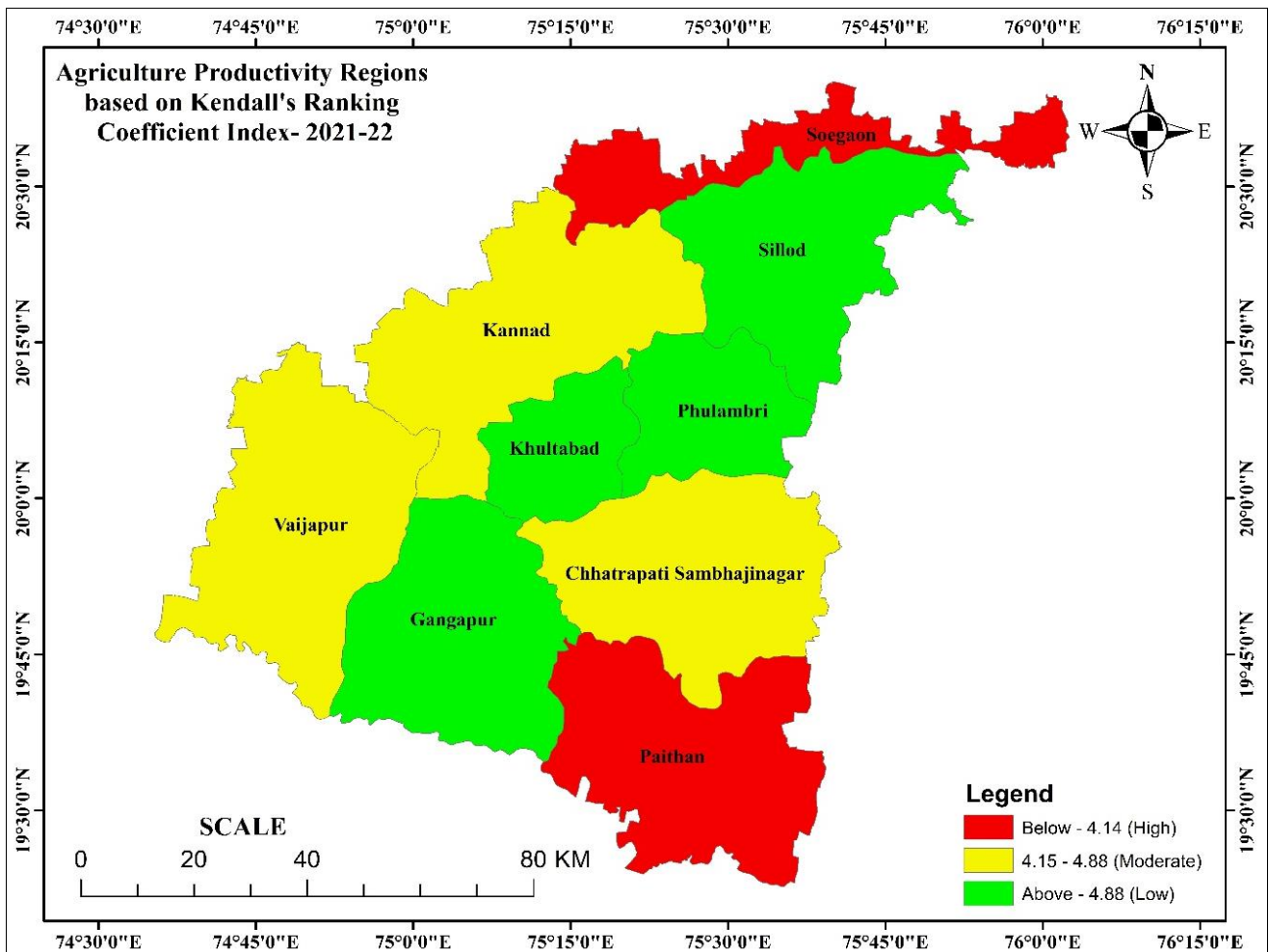


Fig 2: Agriculture productivity regions based on Kendall's ranking coefficient index- 2021-22

Significant variation among the tehsils is highlighted by the regional pattern of agricultural production in Chhatrapati Sambhajinagar District as determined by Kendall's index.

The district's production index ranges from a low of 3.75 to a high of 6.50, indicating that different agricultural techniques in the area are not all equally effective or

appropriate. The agricultural productivity by tehsil for 2021–2022 is shown in Table 5.1 and Figure 5.1.

High Productivity Level

Certain regions of the district have high agricultural output, as indicated by an index value below 4.14. This high-productivity zone makes up 33.33 percent of the total area of the included tehsils, or 17.74 percent of the district's net sown area. The excellent circumstances in these areas facilitate higher agricultural production. With an index value of 3.75 and 4.14, respectively, the Paithan and Soegaon tehsils are part of a clear belt of high agricultural output. These tehsils are classified as high-productivity zones because of a number of geographical advantages, including excellent soils, sufficient water supply, and a good climate.

Moderate Productivity Level

The range of an index value between 4.15 and 4.88 indicates moderate agricultural productivity. This category includes 33.33 percent of the total area of the included tehsils, or 40.44 percent of the district's net sown area. Due to the abundance of resources and the mild geographic conditions, these regions exhibit consistent agricultural output. The tehsils of Vaijapur (4.63), Chhatrapati Sambhajnagar (4.75), and Kannad (4.88) are all part of a belt of average agricultural production. Conditions like fairly rich soils and irrigation infrastructure are advantageous in these places, although not to the same degree as in high-productivity zones. Crop yields are constant but not particularly high as a result of these conditions.

Low Productivity Level

An index value greater than 4.89 is considered low agricultural production. This category makes up 44.44 percent of the total area of the included tehsils and 41.82 percent of the district's net sown area. These areas deal with serious issues that restrict agricultural productivity, frequently as a result of unfavorable geographic and infrastructure circumstances. The tehsils of Phulambri (5.00), Sillod and Khuldabad (5.38), and Gangapur (6.50) are all part of the low-productivity region. The main causes of poor production in these regions can include restricted adoption of new agricultural techniques, shallow or less fertile soils, and inadequate irrigation infrastructure.

7. Conclusion

Using nine major crops as its emphasis, this research assesses the agricultural production of the Chhatrapati Sambhajnagar district in 2021–2022. These include wheat, maize, oilseeds, pulses, jowar, bajra, cotton, sugarcane, and spices. The Department of Economics and Statistics, the Chhatrapati Sambhajnagar District Handbook, and the district's socioeconomic overview were among the secondary sources from which the data was gathered. In order to evaluate agricultural performance throughout the district's several tehsils, the crops were ranked according to their yield per unit area using Kendall's Ranking Coefficient Index. The results demonstrate notable differences in production, with oilseeds, wheat, and maize being the most productive crops in the majority of regions. Fertile soil and sufficient irrigation are two examples of the favorable geographic characteristics that define high-productivity zones, such as Paithan and Soegaon.

However, while having enough resources, moderately productive areas like Vaijapur, Chhatrapati Sambhajnagar, and Kannad have certain infrastructural and soil quality constraints. Lower agricultural yields are experienced in the low-productivity zones, such as Phulambri, Sillod, Khulatabad, and Gangapur, as a result of issues including shallow or less fertile soils, insufficient irrigation infrastructure, and a limited uptake of contemporary farming methods. The study comes to the conclusion that in order to increase productivity in low-output regions and support balanced regional agricultural growth, certain agricultural reforms and better infrastructure are required. The district may enhance its agricultural performance and accomplish more sustainable growth in the future by tackling these issues.

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