

A Study of Agricultural Development in Parner Tahsil Using Z-Score and Composite Score from 1990-91 to 2022-23

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Abstract

This study investigates the agricultural development across eight circles in the Parner Tahsil, Ahmednagar District, by examining crop distribution patterns and their relationship with various physio-socio-economic factors. Utilizing land use patterns, the study ranks crops based on hectare coverage to understand their relative strength and growth dynamics. The study employs Weaver's and Bhatia's approaches to analyze crop combinations and diversification, respectively. Data spanning from 1990-1991 to 2022-2023 were analyzed using the Z-Score and Composite Score methods to assess agricultural development levels. The findings reveal significant regional variations, categorizing circles into high, medium, and low levels of agricultural development. This classification provides insights into the effectiveness of agricultural practices and innovations over time. The study utilizes data from the Ahmednagar District Gazetteer, Socio-Economic Abstract, and Census Handbook, supported by primary data collection and spot inquiries.

Keywords: *Agricultural Development, Crop Distribution, Land Use Patterns, Z-Score Method, Composite Score*

Introduction

The geographical distribution of different crops, their growth, and their responses to the physio-socio-economic circumstances within the district are highlighted through the study of land use patterns. Crop cultivation and growth are directly tied to decision-making, on the one hand, and to the adoption of agricultural innovations—such as the use of high-yielding varieties, more efficient equipment, and applications of chemical fertilizers and pesticides—on the other (Alexander et al., 2017). In the analysis of crop ranking within the region, the hectare area under each crop provides insights into its relative strength and a realistic picture of agricultural

land use. The ranks of the crops and their combinations provide spatial variation in the distribution patterns. Research on crop diversification and combination reveals the current agricultural situation.

Objective: To examine agricultural development using crop area, correlation, Z-scores, and the composite score method.

Data Source:

The sources of data for this study are the Ahmednagar District Gazetteer, the Socio-Economic Abstract of Ahmednagar District, and the Census Handbook of Ahmednagar District. Data were collected for various crops for the years 1990–1991 and 2022-2023 in both Kharif and rabbi crops from the Tahsil headquarters office. Numerous spot inquiries are added to it as a supplement. Crop areas have been translated to percentage (to net planted area), which is then used to rank crops and determine their relative potency.

Study Area

The Parner Tahsil is situated in the Ahmednagar District in western Maharashtra, between latitudes 19°00'18" North and longitude 74°26'34" East. By road, Pune is about 80 kilometers from Ahmednagar (40 km) and Ahmednagar (70 km). In Parner Tahsil, pomegranate and onion farms are very common. The tahsil has grown in popularity as a tourist attraction due to its stunning surroundings and pleasant, calm, and mild climate. Parner is unique due to its mythological, historical, social, and cultural significance. The hamlet is thriving on all fronts: industrial, political, social, and cultural. Parner Tahsil is the birthplace of numerous well-known people, such as Anna Hazare, Maharshi Parashar, and Semapati Bapat.

Methodology

Composite score method

The Z-score and Composite Score method has been applied to conduct a micro-level study of agricultural development. Thus each circle has been assigned a specific level of development from high to low level in increasing order. The agricultural development analysis is made for eight circles of Parner tahsil. Here in the present study, the “Z-Score method” has been used to integrate the multivariate data with common denominators. The method has been adopted to understand the levels of agricultural development of each circle.

The tables appended to the present chapter display Z-Score values of each circle for 12 variables in 1990-91 and 12 variables in 2022-23. The arithmetic average of Z-Scores has been considered as the composite score value for the circle. The

composite score shows the higher level of development in increasing order. For example, the Supa circle has the lowest value of composite score of -0.279 (Table 1) indicating that the circle has the lowest level of agricultural development, on the contrary, the Wadzire circle can be considered to have the highest level of agricultural development as it has shown the highest value (+0.519) of composite score in 1990-91 while Palshi circle has the lowest value of composite score as -0.499 (Table 2) meaning there by the circle has the lowest level of agricultural development, on the contrary, Nighoj circle recorded highest percentage value 0.626 of composite score in 2022-23. Thus, composite score values are computed and have been considered as a level of economic development. Considering these values for all circles, they are classified into three categories of level of economic development from 1990-91 to 2022-23.

The variables of agricultural development have been determined based on significant correlation in the Correlation matrix at 0.001 levels. They are as follows:

X1 = Percentage of the Net sown area to total geographical area, X2 = Percentage of Irrigation to net sown area, X3 = Agricultural density, X4 = Percentage of Jawar to NSA, X5 = Percentage of Bajra to NSA, X6 = Percentage of Wheat to NSA, X7 = Percentage of Oilseeds to NSA, X8 = Percentage of Pulses to NSA, X9 = Percentage of Vegetables to NSA, X10= Percentage of Fodder Crops to NSA, X11= Percentage of Onion to NSA and X12= Percentage of Maize to NSA

Using the data of the 12 variables above, the standard Z-Score was calculated using the following formula:

$$Z - \text{Score} = \frac{(X_i - X)}{S.D.}$$

Where, Z = Standard score of observation,

X_i = Original value of observation,

X = Average of all values of X,

S.D. = Standard deviation of X

With the help of Z-Score, the Composite Scores are calculated by using the following formula:

$$\text{Composite Score} = \frac{X_1 + X_2 + X_3 + X_4 + \dots + X_n}{N}$$

Where, X_1, X_2, X_3 are Z-scores,

N = Total no of variables

Thus each circle was assigned Z-Scores for each variable in 1990-91 and 2022-23 (Tables 1 and 2).

Levels of Agricultural Development

The regional pattern of agricultural development based on the composite score method shows a wide range of variations. All circles are grouped into three levels namely Low, Moderate and High according to their level of agricultural development. The table (Table 3) and the map (Map 1) present the levels of agricultural development in 1990-91 and 2022-23.

Table 1: Z-Score and Composite Score in 1990-91

Circle	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	Composite Score
Palshi	-2.19	-0.67	-0.42	-0.80	1.49	-1.01	2.06	-0.07	-0.08	-0.94	0.48	-0.69	-0.238
Takali Dhokeshwar	-0.43	1.11	-0.31	0.20	0.20	-0.34	0.53	-0.47	-0.07	-0.63	0.79	-0.73	-0.014
Wadzire	0.49	2.02	-0.50	-0.32	-0.46	-0.76	0.36	-0.49	1.71	1.24	0.81	2.12	0.519
Nighoj	0.54	-0.62	-1.48	-1.82	-0.07	1.96	0.10	-0.91	0.97	0.88	1.07	0.64	0.105
Wade Gavan	1.10	-0.42	-0.16	0.95	1.28	0.83	-0.69	-1.19	0.17	-0.02	-1.41	-0.74	-0.024
Supa	-0.03	-0.53	1.70	1.09	-0.77	-0.54	-0.89	0.86	-1.35	-0.96	-1.21	-0.72	-0.279
Parner	0.52	-0.46	0.00	-0.17	-0.16	-0.52	-0.76	0.45	-0.29	-0.87	-0.89	0.06	-0.257
Bhalavani	-0.01	-0.43	1.17	0.88	-1.51	0.38	-0.72	1.83	-1.08	1.30	0.37	0.07	0.189
S.D.	5.75	29.93	12.36	16.12	7.38	2.16	2.78	13.14	2.27	2.90	3.52	3.76	

(Source: Compiled by researcher)

Table 2: Z-Score and Composite Score in 2022-23

Circle	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	Composite Score
Palshi	-21.15	-14.05	-5.94	-7.56	10.37	-1.09	0.21	-0.67	-0.34	-3.32	6.22	-1.88	-0.499
Takali Dhokeshwar	-1.36	44.94	-1.09	-3.81	-1.68	0.26	0.61	-3.82	2.2	-0.43	-0.86	-0.99	0.155
Wadzire	-0.24	-2.75	1.16	2.54	3.99	-0.54	0.5	-3.4	1.71	3.01	-8.91	3.14	0.269
Nighoj	3.3	-9.15	6.44	-21.04	0.05	1.83	1.27	-10.07	2.84	4.54	18.51	1.92	0.626

Wade Gavan	1.42	-4.97	-3.18	6.43	-1.26	-1.3	-0.54	3.63	0.89	-1.14	-3.41	-1.28	-0.258
Supa	7.9	-9	1.27	15.15	-3.66	0.23	-0.61	2.54	-3.28	-2.12	-5.28	-1.45	-0.200
Parner	2.55	-5.32	-2.22	1.07	-0.18	0.08	-0.88	7.39	-1.6	-1.43	-2.42	-0.12	-0.155
Bhalavani	7.56	0.31	3.56	7.24	-7.6	0.51	-0.54	4.36	-2.39	0.87	-3.86	0.62	0.061
S.D.	9.17	18.68	3.94	10.99	5.33	0.99	0.76	5.62	2.26	2.66	8.63	1.78	

(Source: Compiled by researcher)

Table 3: Agricultural Development Regions based on Z-Score and Composite Score

Level of Development	Composite Score	1990-91		2022-23	
		Circles	Circles (%)	Circles	Circles (%)
Low	Below -0.200	Takali Dhokeshwar, Wade Gavhan	2.34	Supa, Parner	15.97
Medium	-0.200 to +0.200	Palshi, Nighoj, Supa, Parner, Bhalawani	65.72	Palshi, Wade Gavhan, Bhalavani, Takali Dhokeshwar	43.77
High	Above +0.200	Wadzire	31.94	Nighoj, Wadzire	40.26
Total		08	100	08	100

(Source: Compiled by researcher based on primary data)

1. Agricultural Development Levels in 1990-91

The levels of agricultural development in 1990-91 of the study region have been discussed according to the three groups of circles. The following information is denoted to discuss agricultural development.

A. High Level of Agricultural Development

The composite score above +0.2 is considered a high level of agricultural development. The Wadzire circle exhibits a high level of agricultural development. About 31.94% of the area recorded a high level of agricultural development. The regional pattern shows that high agricultural development is found in the middle part of the tahsil. The following variables of agricultural development characterize the high development circles in the tahsil.

1. The NSA of this circle exceeds 78% of the total geographical area.
2. Irrigation water facilities are available to farmers from the command areas of major, medium, and minor projects. Irrigation is also available from rivers and canals.
3. The area features a robust network of cooperative credit societies, agricultural market centers, and transportation infrastructure.

This means that these circles have already achieved a high level of development among the circles of the tahsil. It may be interesting to observe any change in this category in 1990-91.

B. Medium level of Agricultural Development

The composite score values between -0.2 to +0.2 are assumed as a medium level of agricultural development. The five circles namely, Parner, Nighoj, Palshi, Bhalavani and Supa having composite score values are assumed as medium development. These circles are scattered in some parts of the central and southern parts of tahsil. About 65.72 % of the area recorded a medium level of agricultural development. The study and field observations reveal that the following four factors may be influencing agricultural development.

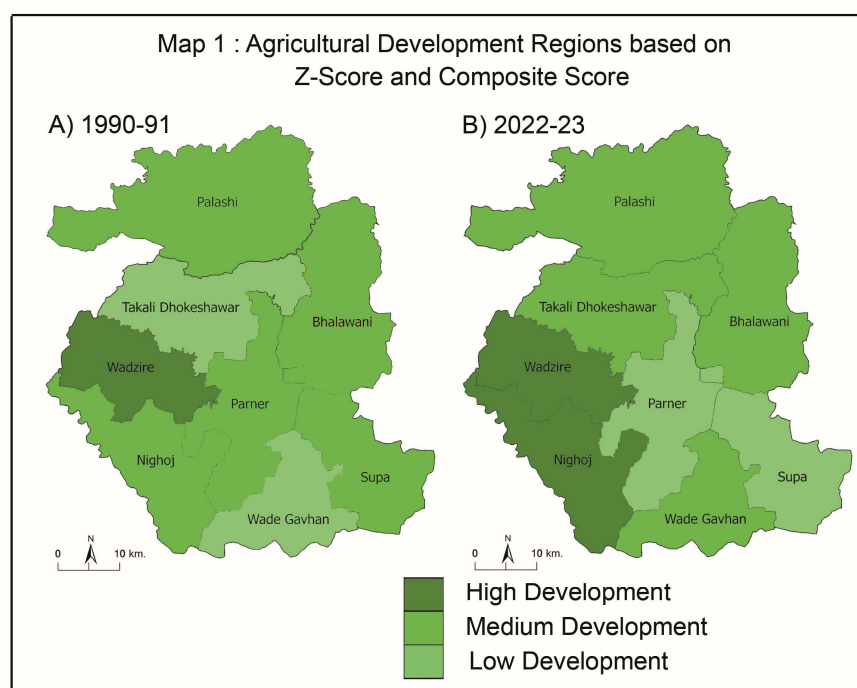
1. The NSA of these circles is between 73-82% of the total geographical area.
2. Irrigation water facilities for agriculture are available from the command areas of medium and minor projects, such as the Kalu, Mula, and Kukdi dam projects. Parner and Supa circles do not have any project which supplies water for irrigation purposes.
3. The region features a good network of cooperative credit societies and agricultural market centers, supported by a well-developed transportation network.
4. Soils are of medium to light varying properties and undulating terrains, especially Parner and Nighoj circles may limit economic development.

C. Low Level of Agricultural Development

A composite score below -0.2 has been considered a low level of agricultural development. Low agricultural development has been observed in circles like Takali Dhokeshwar and Wade Gavhan having composite scores of -0.014, and -0.024 respectively. These circles are scattered in the western and southern parts of tahsil. About 2.34% of circles have been classified as showing a low level of agricultural

development. It may be remarked here that factors of agricultural development may be responsible for the low-development regions in the tahsil.

1. The NSA of these circles is below 80% of the total geographical area. As a result, there is a reduction in crop production.
2. The circles having low agricultural development are characterized by the scarcity zones that receive 200 mm to 300 mm rainfall the entire circles fall under drought-prone areas of the tahsil.
3. Shallow soil, low irrigation intensity, relatively low fertilizer consumption, and undulating topography characterize the area.



2. Agricultural Development Levels in 2022-23

The level of agricultural development of the study region is given in Table 2 and Map 1.

A. High level of Agricultural Development

The two circles viz. Nighoj and Wadzire are characterized by high levels of agricultural development. The circle of Nighoj shifted from medium to high levels of agricultural development during the study periods. About 40.26% of circles attain a high level. The following variables of agricultural development characterize the high-development regions in the Tahsil.

1. The percentage of irrigation to net sown area of the Nighoj circle has increased during the study periods. Therefore, the percentage of irrigation to net sown area of this circle is recorded as Nighoj (5.66%).
2. The percentage of bajra of the NSA of this circle has increased during study periods. The bajra at an overall level of this circle has increased by 2.10% over the previous level. The recorded volume of change in percentage for the following circle is Wadzire (20.25%).
3. The percentage of wheat of the NSA of this circle has increased during study periods. The wheat at an overall level of this circle has increased by 1.22% over the previous wheat. The following circle is the recorded volume of change in percentage, Wadzire (4.34%).
4. The percentage of vegetables in the NSA of this circle has increased during study periods. The vegetables at an overall level of this circle have increased by 2.25% over the previous vegetables. The following circle is the recorded volume of change in percentage, Nighoj (7.83%).
5. The percentage of fodder crops of the NSA of this circle has increased during study periods. The fodder crops at an overall level of Wadzire and Nighoj circles have increased by 7.82% and 9.35% respectively over the previous fodder crops. The following circle records the volume of change in percentage, Wadzire (1.07%) and Nighoj (3.65%).
6. The percentage of onion of the NSA of this circle has increased during study periods. The onion at an overall level of Wadzire and Nighoj circles has increased by 8.79% and 36.21% respectively over the previous onion. The following circle records the volume of change in percentage, Wadzire (0.08%) and Nighoj (26.61%).
7. The percentage of maize of the NSA of this circle has increased during study periods. The maize at an overall level of Nighoj circle has increased by 0.17% over the previous year. The following circle is the recorded volume of change in percentage, Nighoj (5.51%).
8. The net sown area, irrigation facilities, agricultural density, jawar, bajra, oilseeds and pulses at the overall level of these circles have decreased during the study periods. The negative development of the circle-wise volume of percentage change, Nighoj and Wadzire was recorded during study periods.

B. Medium Level of Agricultural Development

There are five circles viz. Palshi, Wade Gavhan, Bhalavani and Takali Dhokeshwar, come under this category. No significant change in the level of Palshi and Bhalavani circles was observed. Supa and Parner circles have shifted from medium level to low level during study periods. About 43.77 % of the area recorded a medium level of agricultural development. It is revealed in the study and also in the field observation that the following twelve factors may be influencing the level of agricultural development.

1. The net sown area at the overall level of Takali Dhokeshwar and Bhalavani circles has increased by 73.33% and 82.25%% respectively during the study periods. The positive development of the circle-wise volume of change in percentage, Takali Dhokeshwar (0.23%) and Bhalavani (6.76 %) was recorded during the study periods.
2. The irrigation facilities at the overall level of Palshi, Takali Dhokeshwar, Wade Gavhan and Bhalavani circles have increased by 6.87%, 65.86%, 15.95% and 21.23% respectively during the study periods. The positive development of the circle-wise volume of percentage change, Palshi (2.23%), Takali Dhokeshwar (8.16), Wade Gavhan (3.98%) and Bhalavani (9.49%) were recorded during the study periods.
3. For the area under wheat, positive percentage changes were recorded in Palshi and Takali Dhokeshwar circles, with increases of 2.23% and 8.16%, respectively, during the study periods.
4. The vegetables at the overall level of the Palshi, Takali Dhokeshwar, Wade Gavhan and Bhalavani circles increased by 4.65%, 7.19%, 5.88% and 2.60% during the study periods. The positive development of the circle-wise volume of percentage change, Palshi (1.47%), Takali Dhokeshwar (3.97%), Wade Gavhan (2.12%) and Bhalavani (1.68%) circles in the tahsil during study periods.
5. The fodder crops at the overall level of the Palshi, Takali Dhokeshwar and Wade Gavhan circles increased by 1.08%, 3.06% and 0.57% during the study periods.
6. The Onion at the overall level of the Palshi, Takali Dhokeshwar, Wade Gavhan and Bhalavani circles have increased by 16.39%, 8.22%, 13.40% and 6.69% were recorded during the study periods.

7. The maize at the overall level of the Palshi, Takali Dhokeshwar, Wade Gavhan and Bhalavani circles have increased by 1.71%, 2.60%, 2.31% and 4.21% were recorded during the study periods. The positive development of the circle-wise volume of percentage change, Palshi (1.39%), Takali Dhokeshwar (2.43%), Wade Gavhan (2.17%) and Bhalavani (1.01%) circles in the tahsil during study periods.
8. The agricultural density, jawar, bajra, oilseeds and pulses at the overall level of these circles have decreased during the study periods. The negative development of the circle-wise volume of percentage change, Palshi, Takali Dhokeshwar, Wade Gavhan and Bhalavani were recorded during study periods.

C. Low level of Agricultural Development

The circles of Supa and Parner have a low level of agricultural development in the study region. There is no significant change in the level of Supa and Parner circles. About 15.97 % of the area recorded a low level of agricultural development. It is revealed in the study and also in the field observation that the following ten factors may be influencing the level of agricultural development.

1. The percentage of net sown area to a total geographical area of the Supa circle has increased during the study period. Therefore, the percentage of net sown area to the total geographical area of these circles was recorded for Supa as 7.22% in 2022-23.
2. The percentage of irrigation of the NSA of these circles has increased during study period. The irrigation at an overall level of the Supa and Parner circles has increased by 11.92% and 15.60% respectively in 2022-23. The following circles recorded the volume of change in percentage, Supa (3.09%) and Parner (4.84%).
3. The percentage of wheat of the NSA of these circles has increased during study period. The wheat at an overall level of the Supa and Parner circles has increased by 5.11% and 4.96% respectively in 2022-23. The following circles recorded the volume of change in percentage, Supa (1.52%) and Parner (1.32%).

4. The percentage of vegetables in the NSA of these circles has increased during study period. The vegetables at an overall level of the Supa and Parner circles have increased by 1.71% and 3.39% respectively in 2022-23. The following circle recorded the volume of change in percentage, Supa (1.40%) and Parner (0.67%).
5. The percentage of fodder crops of the NSA of these circles has increased during study period. The fodder crops at the overall level of the Supa and Parner circles have increased by 2.69% and 3.38% respectively in 2022-23. The following circle recorded the volume of change in percentage, Supa (2.32%) and Parner (2.75%).
6. The percentage of onion of the NSA of these circles has increased during study period. The onion at the overall level of the Supa and Parner circles has increased by 12.42% and 15.28% respectively in 2022-23. The following circle recorded the volume of change in percentage, Supa (10.83%) and Parner (12.56%).
7. The percentage of maize of the NSA of these circles has increased during study period. The maize at the overall level of the Supa and Parner circles has increased by 2.14% and 3.47% respectively in 2022-23. The following circle recorded the volume of change in percentage, Supa (1.92%) and Parner (0.32%).
1. The agricultural density, jawar, bajra, oilseeds and pulses at the overall level of these circles have decreased during the study period. The negative development of the circle-wise volume of percentage change, Nighoj and Wadzire was recorded during the study period.

Conclusion

Thus, it may be stated that the method of classification of circles according to levels of agricultural development as indicated by the composite score method based on primary data has been proved to be useful.

1. Some of the circles categorized as low level of development have remained low level during the study periods. They are Palshi and Bhalavani. This means that such circles require some other planning instruments to achieve development that has been stopped.

2. Takali Dhokeshwar and Wade Gavhan circles have been upgraded from low level to medium level of development. Micro-irrigation and agricultural development are responsible for these changes.
1. It is interesting to observe that the circle, viz. Nighoj, has achieved a higher level of development according to the values of the composite score. This may be because the number of agricultural development indicators has been on the higher side.

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