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SPATIO-TEMPORAL DIFFERENTIATION AND FUTURE TRENDS ANALYSIS OF AGRICULTURAL PRODUCTIVITY IN HATHRAS DISTRICT, UTTAR PRADESH

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Abstract: *The agriculture sector has gone through different phases of growth, embracing a wide variety of institutional interventions, technology and policy regimes in India. It is important to assess whether the past, present and future trends of agricultural productivity are compatible with the growing demand of people. This paper analyzes the spatio-temporal differentiation and future trends of agricultural productivity in Hathras district, Uttar Pradesh. This study is based on secondary sources of data for the period 2000-01 and 2014-15. Yang's Crop Yield Index (CYI), Standard Deviation (SD) and Data Projection techniques have been used in this work. The study reveals that the whole district has made reasonable enhancements in their agricultural productivity from 2000-01 to 2014-15 which are varied over space and time. The future trends of agricultural productivity for the year 2030-31 indicate that the study area has continuously boosted its productivity since 2000-01. It concludes that the problems which are needed to address are accessibility, invention, and equal delivery mechanism of government-sponsored schemes, programs, policies and projects like irrigation, capacity building programs, farmer sensitization issues and others.*

Keywords: Agricultural Productivity, Crop Yield Index, Differentiation, Future Trends

Introduction

The United Nations Food and Agriculture Organization estimates food requirements will more than double by 2050. The increasing demand for food is driven by global population growth and higher living standards in developing economies calling for higher quality and a greater variety of food for human consumption. This can be only possible by increasing agricultural productivity (Fischer, 2009). Productivity measures the efficiency with which inputs are converted into outputs. Productivity performance is largely controlled by technological progress (Nossal and Gooday, 2009). Agriculture has been an integral part of development in most countries. Undoubtedly, it is the largest livelihood provider in India, especially in the vast rural areas. About seventy per cent of the country's population directly or indirectly depends upon agriculture. It is the central pillar to India's socio-economic development that contributes 19.9 per cent to the total GDP and employs more than fifty percent of the country's workforce (Socio-Economic Survey 2021-22). Indian agriculture has transformed owing to scientific utilization of land as well as governmental efforts, which significantly contributes to national development (Ahmad, 2002). This has made us self-sufficient and taken us from being a begging bowl for food after independence to a net exporter of agricultural products (Kumar and Sharma, 2022; Sharma, 2022).

Despite high levels of production, agricultural productivity in India is lower than in other large producing countries. The yield of rice has increased by more than two times since 1970 and was 40,577 kg per hectare in 2019-20. However, India's yield of rice is low when compared to countries such as China, Japan, Brazil, Vietnam, Indonesia and Bangladesh (FAO, 2020). The reasons for low yield per hectare as compared to developed countries are small landholdings, illiterate farmers, unscientific use of fertilizers, lack of credit facility, less use of technology and poor infrastructure (Nattagh, 1986; Sharma and Sharma, 1993). It is generally agreed that the yield per acre/hectare may be considered to represent the agricultural productivity in a particular region and that other factors of production be considered as the possible causes for the variation while comparing it with the other regions (Usmani, 1994). Pandit (1983) has stated the connotation of productivity in these words, "Productivity is defined in economics as the output per unit of input the art of securing an increase in output from the same input or getting the same output from a smaller input". productivity is a physical relationship between output and the input which gives rise to that output (Saxon, 1965). Stamp (1958) while attempting to measure crop productivity per unit area emphasized, that areal differences in productivity are the result partly of natural advantages of soil, and partly of farming efficiency. Farm efficiency refers to the properties and qualities of various inputs, how they are combined and utilized in production. There are many different concepts of productivity and still more ways for computing it. The productivity of agriculture so far has been looked at from different points of view, such as productivity of land, labour and capital. These are the best-known partial productivity measures (OECD, 2008). Attention may especially be focussed on the productivity of land because it is the most permanent and fixed among the three conventional categories of inputs (land, labour and capital) and in recent times it has assumed special importance with the population explosion (Anríquez and Stamoulis, 2007; FAO, 2017). Productivity of land is obviously of primary importance in a country like India with a high density of population. Where land resources are limited, the principal means of raising production to keep pace with the growth of population and demand for improved diets is by raising yield per hectare (Ahmad and Islam, 2017; Islam, 2020).

Objectives

The objective of the present study is to find out the spatial and temporal differentiation and future trends of agricultural productivity in Hathras district of Uttar Pradesh.

Selection of the Study Area

The Hathras district is situated between 27°20'0'' north and 27°50'0'' north latitudes and 77°40'0'' east and 78°40'0'' east longitudes. Hathras, a newly created district (1997) of Uttar Pradesh curved out from Aligarh, Agra, Mathura and Etah are located in the western part of the state. It covers an area of 1840 square km in the state of Uttar Pradesh. The total population in the district is 15,64,708 out of which 12,32,015 are living in rural areas and 3,32,693 are in urban areas. A total of 71.52 per cent of people are literate, of which 83.48 per cent are male and 57.74 per cent are female in the study area. Nearly 90 per cent of areas of the district have been devoted to agriculture activities (Chandramouli and General, 2011; *Agriculture Census,* 2015). The climatic character of hot summer and dry winter with unpredictable rainfall in the monsoon season creates a major hurdle for the farmers. This district of western Uttar Pradesh comes under the influence of the green revolution since the 1960s. It is located in the Ganga-Yamuna Doab region has a flat surface, fertile alluvial soil and better irrigation facilities that offer agricultural practices throughout the year. Hathras district plays an important role in the development processes of the state. The river Ganga and Yamuna make up the east and west borders of the district respectively. The other tributaries are Kali, Sengar and Karwar have played a significant role in the fashioning of the district (*District Census Handbook,* 2011).

Material and Methods

Data Sources

The ongoing research work is based on secondary sources of data obtained from District Statistical Bulletin (2001 & 2015), Census of India, Agricultural Census of India and Block Development Offices of Hathras for 2000-01 and 2014-15.

Productivity Measurement

Though there are several measures of agricultural productivity, but the method suggested by W.Y. Yang's (Crop Yield Index method, 1965) is most applied and the best measure of agricultural productivity, particularly land productivity (Shafi, 1984; Siddiqui, Rehman and Siddiqui, 1984; Munir, 1992; Ahmad, 2002; Rehman, 2003; Aktar, 2016; Islam, 2020; Liu *et al.*, 2020; Rahaman, 2020). The present study used W.Y. Yang (1965) methods to compute productivity because of convenience. He has used the 'Crop Yield Index' for assessing agricultural productivity. It considers the yield of all crops in a farm computed with the average yield of crops in the region. Then calculate the crop yield in the farm as the percentage to the region and the obtained value is multiplied by the area of each crop in the farm. By adding all values obtained by this was divided by the sum of the area occupied by each crop on the farm. Finally, the average desired crop index is obtained for any particular farm (Table 01).

Table 01: Method of Calculating Crop Yield Index (W.Y. Yang's 1965)

Name of the crop	The area under crops in the block	Average Yield		Crop yield in the block as the percentage to the district	Percentage multiply by area (in hectares)
		District	Block		
Rice	206	21.47	24.73	86.818	17884.43
Wheat	14063	34.49	33.32	103.511	1455680.88
Barley	1930	27.52	27.82	98.922	190918.76
Millet	6579	17.72	16.98	104.358	686571.73
Maize	582	19.9	22.2	89.640	52170.27
Total	23360				2403226.08/23360
Computation of Crop Yield Index for Sasni Block, 2000-01					102.88

Source: Calculated by Researcher

All of the major crops grown in the district have been taken into account for calculating crop yield index. Then, all the seventeen crops are classified into four major groups (Table 2):

Table 02: Classifications of Major Crops

#	Major Category	Crops
1	Cereal Crops	Rice, Wheat, Barley, Millet and Maize
2	Pulses Crops	Masur, Gram, Pea, Arhar, Urad and Moong
3	Oilseeds Crops	Sarson, Til and Sunflower
4	Cash Crops	Sugarcane, Potato and Cotton

Source: Computed by Author Based on DSB, Hathras

Future Trends Analysis

The data projection technique has been applied to predict agricultural productivity for 2030-31. The projection formula has been used as follows:

$$\mathbf{PP = P_1 + \frac{n}{N}\ (P_2 - P_1)}$$

Where,

PP = Projected figure
P_1 = Figure of the previous year
P_2 = Figure of the succeeding year
N = Number of years between periods
n = Number of years between the previous years and the year for which data or figure would be projected.

Spatial Differentiation

To analyze spatial differentiation of agricultural productivity for 2000-01 and 2014-15, the productivity indices have been grouped into high, medium and low categories. For this, the mean and standard deviation (SD) of the composite scores are calculated. Then SD is divided by 2. Half of the SD is added to the mean of composite score to form high category and half of the SD is subtracted from the mean to form low category and the rest of the values lying between high and low category limit have been under the medium category. ArcGIS 10.2 software has been used for mapping purposes.

Results and Discussion

Productivity Differentiation of Cereal Crops (2000-01 to 2014-15)

Cereals are the most dominant crop in the region. It covered an area of 1,75,066 hectares in 2000-01 which declined to 1,56,309 hectares in 2014-15, accounting 73.26 per cent and 62.86 per cent of the total cropped area respectively. The productivity region of cereals for the period 2000-01 and 2014-15 has been presented in Figures 1 and 2 respectively. In 2000-01, three blocks namely Sasni, Sadabad and Hasayan have been recorded as a highly productive region with an index value of more than 102.08. The index value ranges between 98.23 and 102.08 falls under the category of medium productivity region which is found in Sikandra Rao block only. The lower productivity region lies in the blocks of Mursan, Hathras and Sahapao which accounted for 42.86 per cent of the total blocks. On the other hand, in 2014-15, two blocks Mursan and Sahapao have been recorded as highly productive whose value lies above 103.40. The medium productivity regions of cereals are found in the block of Sasni and Sadabad. The low productivity extended over the three blocks namely, Sahapao, Hathras and Hasayan having indices value less than 99.63. The study unveils that though the number of blocks under high productive region has been decreased but the index value is remaining high during the period of study.

Figure 01: Productivity Regions of Cereals (2000-01) in Hathras District

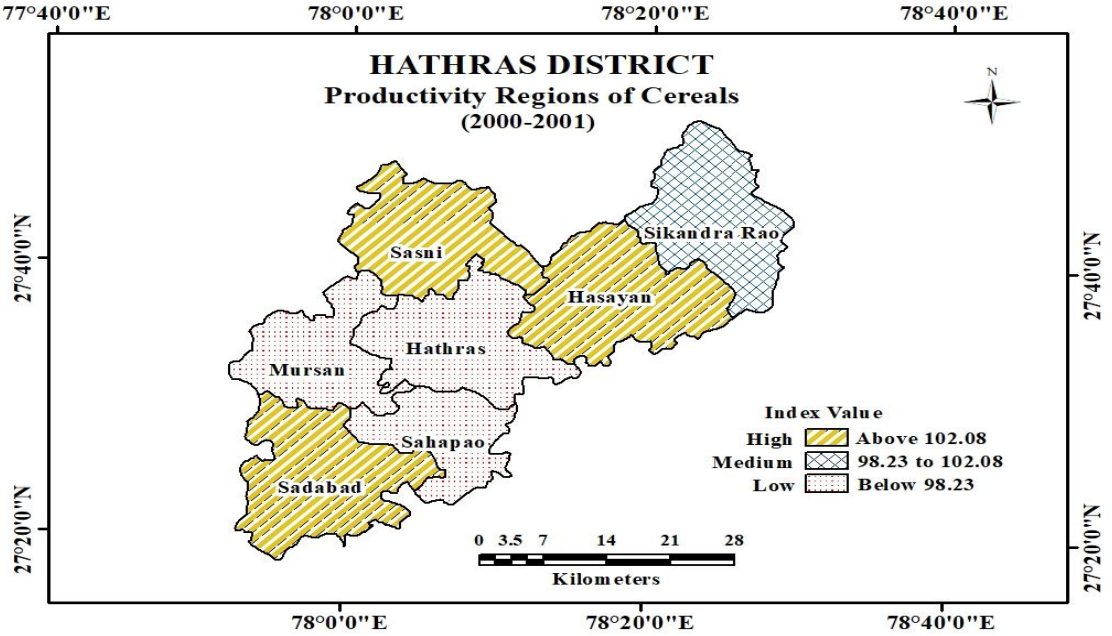
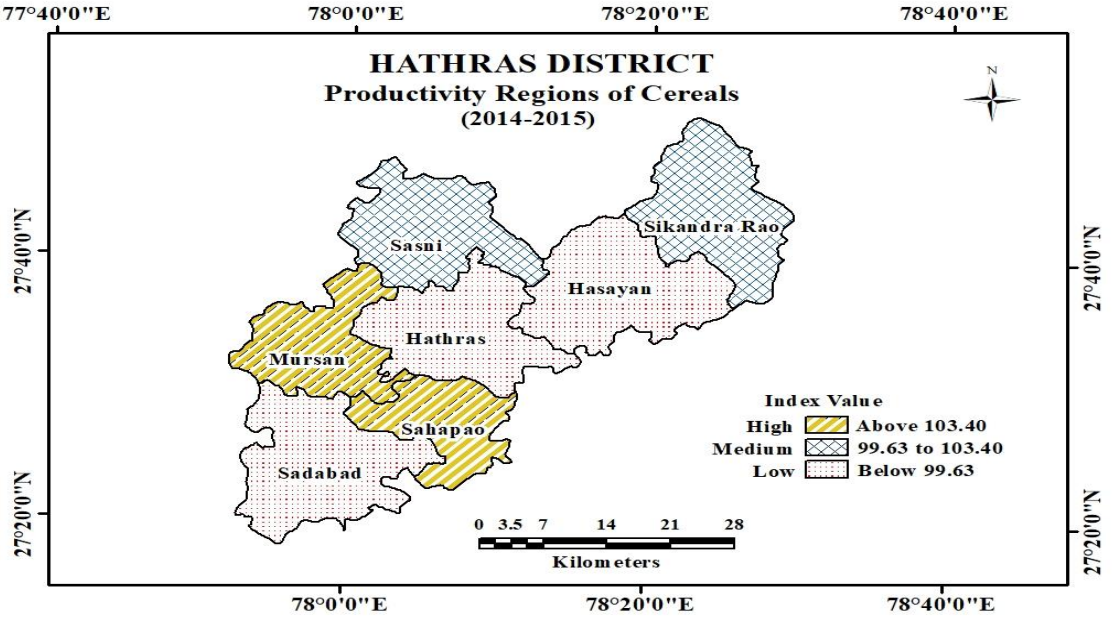


Figure 02: Productivity Regions of Cereals (2014-15) in Hathras District



Productivity Differentiation of Pulses Crops (2000-01 to 2014-15)

Pulses include masur, gram, pea, arhar, urad and moong in the district. The area under these crops was 12,665 hectares with 5.30 percent of the total cropped area during the year of 2000-01. It can be seen from Figure 3 that during 2000-01, two blocks namely, Mursan and Sahapao have recorded an indices value of more than 101.44 falls in the category of higher productive region, whereas the low productive regions include three blocks namely, Hasayan, Hathras and Sikandra Rao. The remaining two blocks i.e. Sasni and Sadabad have reported medium productivity in the district. The area under pulses was reached up to 5,845 hectares in 2014-15, which accounted for 2.35 per cent of the total cropped area in the region. It is observed from Figure 04 that Sadabad is the only block that comes under the higher productive region of pulses. The indices value ranges from 98.62 to 105.62 lies in the medium productive region. It includes Mursan, Hasayan and Sikandra Rao blocks. The remaining three blocks namely, Sasni, Hathras and Sahapao have been found under the low productive region with an indices

value of less than 98.62. It discovers that the area under pulses has been declined by 6,820 hectares during the period from 2000-01 to 2014-15. All crops under this group have found negative growth where the area of gram decreased by 99.47 per cent followed by pea 94.42 per cent, masur 56.52 per cent, moong 51.54 per cent, arhar 46.21 per cent and urad 28.24 per cent over the year of 2000-01. The productivity regions of pulses show that there are three blocks which recorded a decrease in productivity i.e. highest decreased in Sahapao block by 12.9 points followed by Sasni block 6.57 points and Mursan block 3.43 points, whereas the remaining four blocks namely Hathras, Sadabad, Sikandra Rao and Hasayan have accelerated their productivity throughout the analysis.

Figure 03: Productivity Regions of pulses (2000-01) in Hathras District

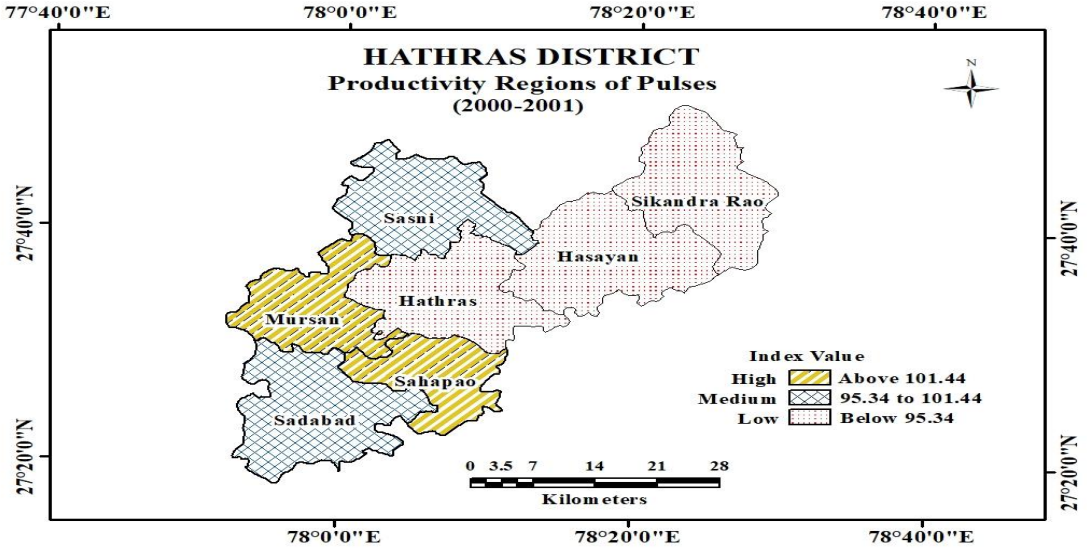
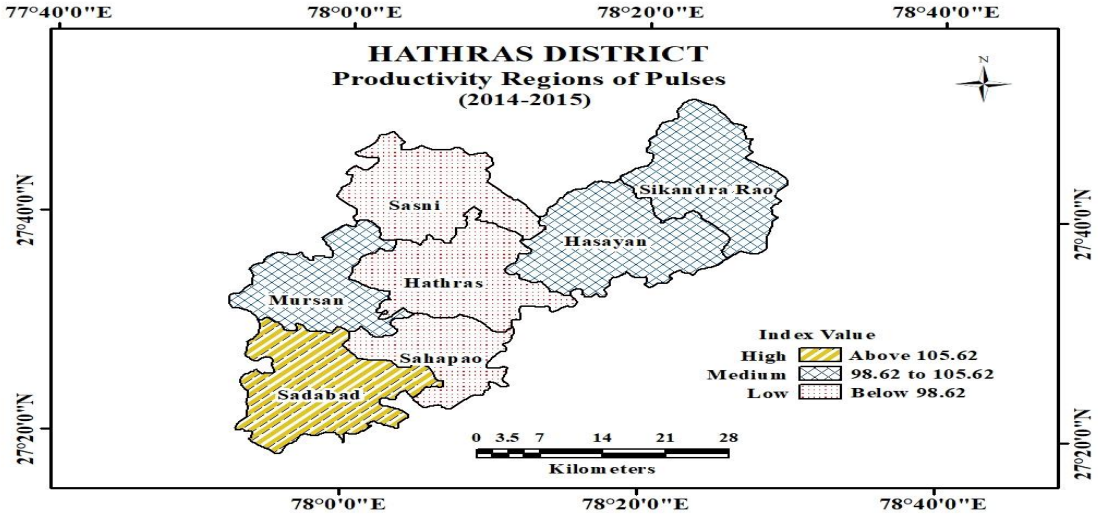


Figure 4: Productivity Regions of Pulses (2014-15) in Hathras District



Productivity Differentiation of Oilseeds Crops (2000-01 to 2014-15)

Oilseeds occupy an area of 11,049 hectares which is 4.62 per cent of the total cropped area in the region. Productivity regions of oilseeds for the period 2000-01 have been presented in Figure 5. It ascertains that there are four blocks namely, Hathras, Mursan, Sahapao, Sadabad and Sikandra Rao emerged in the higher productive region with an indices value of more than 94.77. The medium productivity region of oilseeds has been found in the block of Hasayan, whereas the low productive region with indices value of less than 84.87 appears in Sasni block. In 2014-15, oilseeds covered a total of 6,448 hectares area which represents 2.59 per cent of

the total cropped area in the district. It is observed from Figure 6 that a large proportion of the district falls under the category of medium productive regions which includes Mursan, Hathras, Sahapao and Sikandra Rao blocks with an indices value varying from 97.06 to 103.36. The high productive region of oilseeds has been recorded in the block of Sadabad. The remaining two blocks Sasni and Hasayan lie below 97.06 come under the cluster of the low productive region. The area under oilseeds has been reduced by 4,601 hectares during the period from 2000-01 to 2014-15. But til is the only oilseed which makes remarkable enhancement in terms of both areas as well as production in the region. It added 71 hectares of area under its cultivation, whereas sarson decreased by 4,619 hectares and sunflower by 53 hectares over the year 2000-01. Similarly, Tables 3 and 4 depict that there are three blocks namely, Sasni, Sadabad, Mursan and Sikandra Rao have raised their productivity by 15.79 points, 11.24 points, 2.15 points and 0.79 points respectively. But the highest decline is observed in the Hathras block 3.18 points followed by Hasayan block 2.88 points and Sahapao block 2.58 points during the period from 2000-01 to 2014-15.

Figure 05: Productivity Regions of Oilseeds (2000-01) in Hathras District

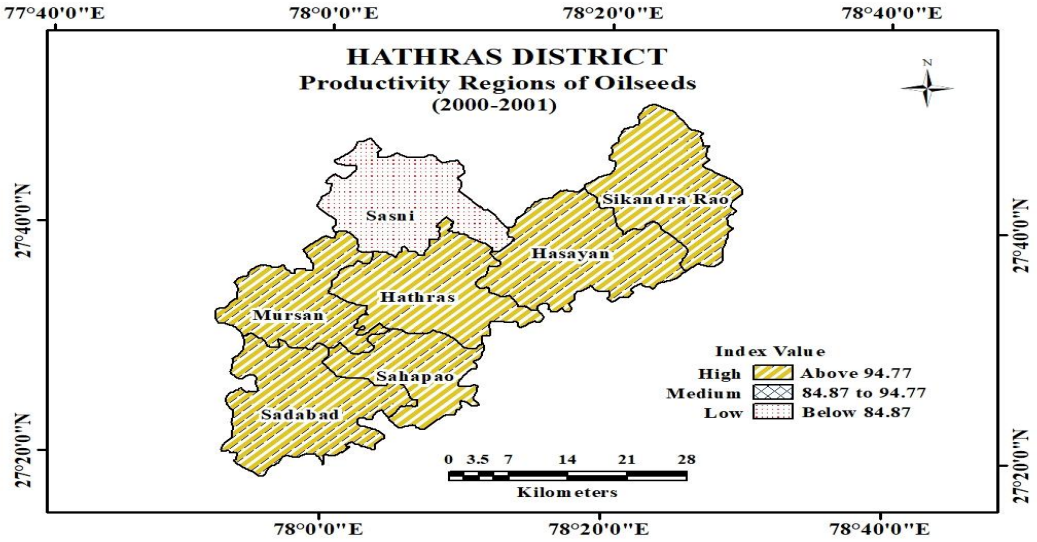
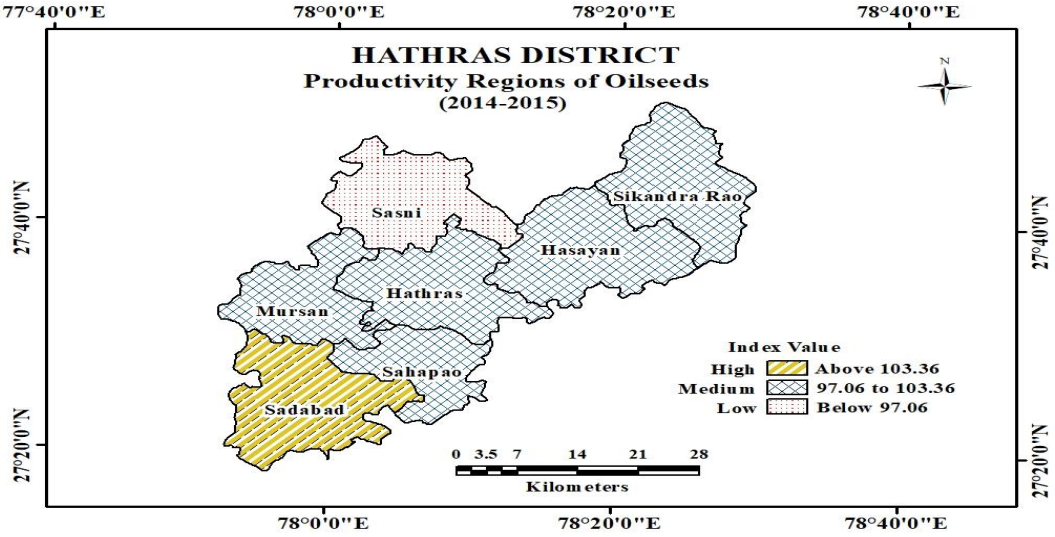


Figure 06: Productivity Regions of Oilseeds (2014-15) in Hathras District



Productivity Differentiation of Cash Crops (2000-01 to 2014-15)

Cash crops covered an area of 14,531 hectares accounted for 6.08 per cent of the total cropped area of the region in the year 2000-01. It is found from Figure 7 that the highest productivity of

cash crops has been recorded in the blocks of Sadabad, Hathras and Sikandra Rao having an indices value of more than 101.08, whereas Mursan, Sahapao and Hasayan blocks whose value ranges between 98.36 and 101.08 seen as a medium productive region. The remaining Sasni block falls under the low productive region in the district. Cash crops include sugarcane, potato and cotton extended over 50,666 hectares of land which becomes the second-largest crop after cereals, covering 20.13 per cent of the total cropped area of the region in 2014-15. It is obvious from Figure 8 that the Sahapao block has been reported higher productivity, but a large number of blocks namely, Mursan, Sahapao, Sikandra Rao and Sasni have been found under the category of low productivity region with an indices value lying below 102.87. The medium productivity records in the block of Hathras and Hasayan in the study area. The temporal variation of cash crops productivity regions reveals that it has made considerable progress in both areas as well as production during the period from 2000-01 to 2014-15. It is found that Sahapao block has increased the productivity of cash crops from an indices value of 99.50 in 2000-01 to 114.62 in 2014-15, Hasayan block claimed from 98.67 to 106.02, Hathras block from 101.32 to 106.10, Sasni block from 95.64 to 97.01 and Sadabad block grown from 101.85 to 102.49. The remaining two blocks Mursan and Sikandra Rao record a sharp decrease in their indices during the period of research.

Figure 07: Productivity Regions of Cash Crops (2000-01) in Hathras District

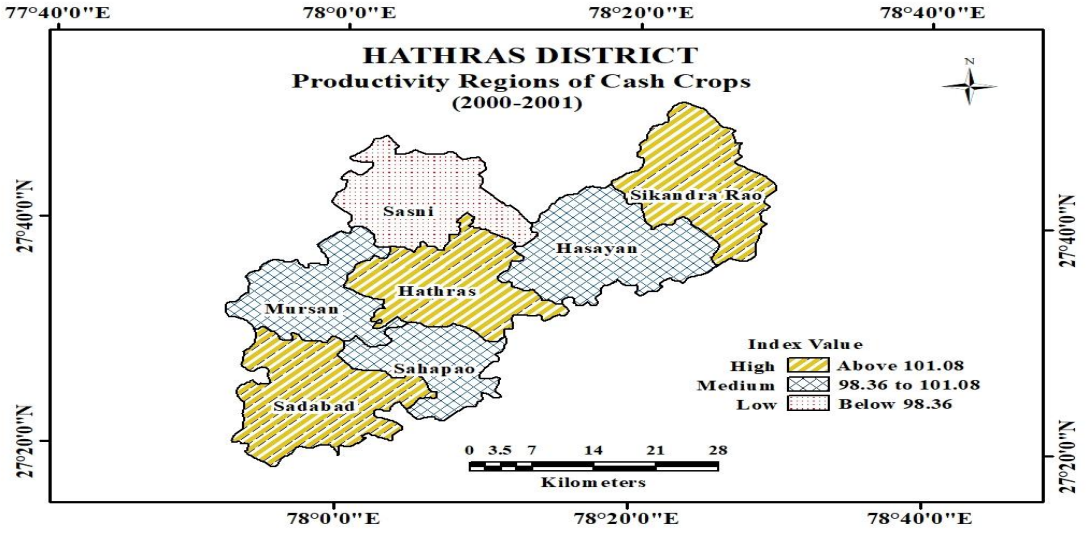
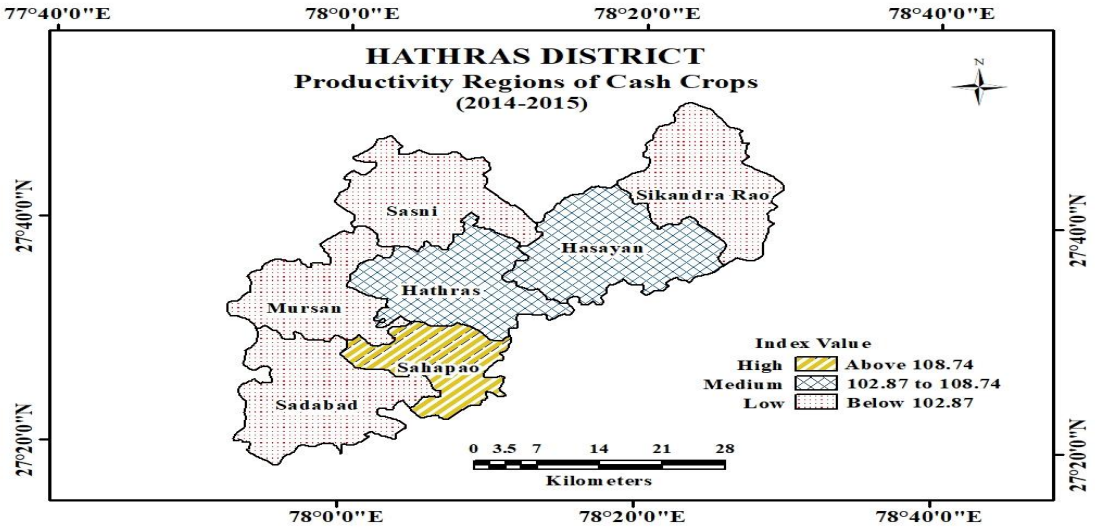


Figure 08: Productivity Regions of Cash Crops (2014-15) in Hathras District



Overall Agricultural Productivity Differentiation (2000-01 to 2014-15) and Future Trends (2030-31)

The composite Yang's crop yield index has been calculated by considering all four indices of agriculture i.e. cereals, pulses, oilseeds and cash crops for the year 2000-01 and 2014-15 which are represented in Figures 9 and 10 respectively. However, all the major crops come under these major crops category in the study area, but due to the dearth of disaggregated data on vegetables, horticulture, spices and others are not included exclusively in the study. It is evident from Table 3 and Figure 9 that in 2000-01, the higher productive region includes Mursan, Sahapao, Sadabad and Hasayan blocks with the indices value of more than 99.02. There are two blocks namely, Hathras and Sikandra Rao appear as medium productive regions. The low productive region is found in the Sasni blocks with an indices value of less than 95.97. During 2014-15, the composite index of productivity regions affirms that a small proportion of area comes under the category of the high productivity region which includes Sadabad and Sahapao blocks with an indices value above 101.88. A large number of blocks i.e. Mursan, Hathras, Hasayan and Sikandra Rao have recorded medium productivity, whereas the Sasni block with an indices value below 98.37 is found under the low productivity region. The temporal variation of the composite index of productivity denotes that all seven blocks namely, Sasni, Hathras, Mursan, Sadabad, Sahapao, Hasayan and Sikandra Rao have made reasonable improvement in their indices values during the period from 2000-01 to 2014-15.

Figure 09: Yang's Productivity Regions (2000-01) in Hathras District

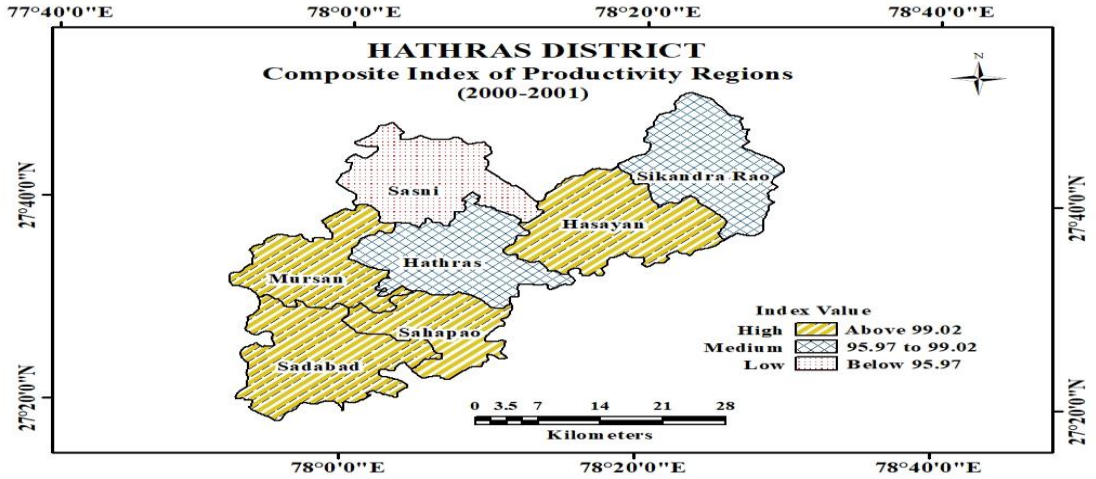


Figure 10: Yang's Productivity Regions (2014-15) in Hathras District

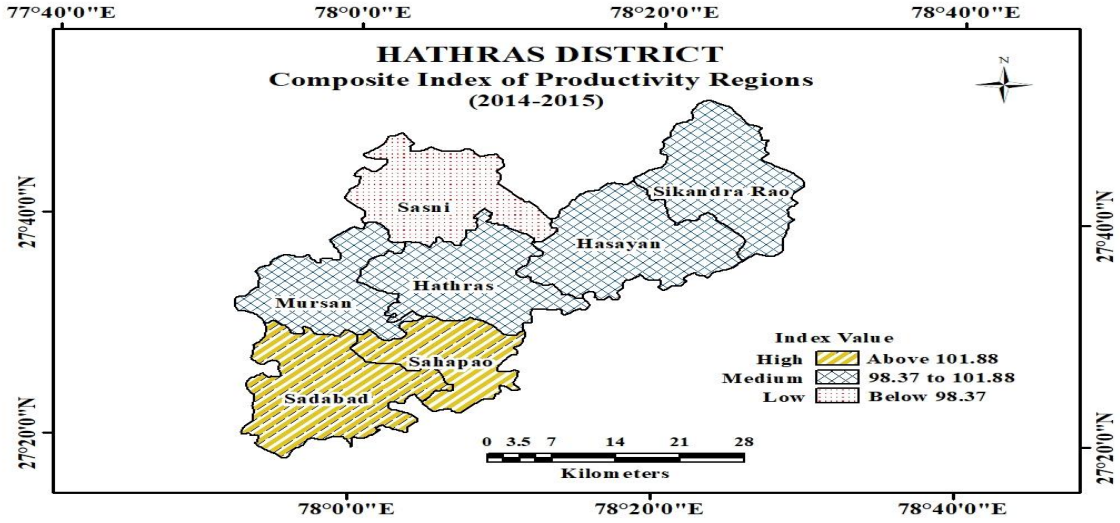


Table 03: Yang's Productivity Regions in Hathras District (2000-01)

Blocks	Cereals	Pulses	Oilseeds	Cash Crops	Composite Index
Sasni	102.88	98.19	74.97	95.64	92.92
Hathras	94.39	90.54	103.02	101.32	97.32
Mursan	94.5	102.38	100.84	100.03	99.44
Sadabad	105.78	98.48	98.43	101.85	101.13
Sahapao	96.57	107.54	104.68	99.5	102.07
Sikandra Rao	98.96	89.24	100.57	103.81	98.14
Hasayan	105.93	93.04	103.85	98.67	100.37

Source: Yang's Crop Yield Index Based on District Statistical Bulletin, Hathras

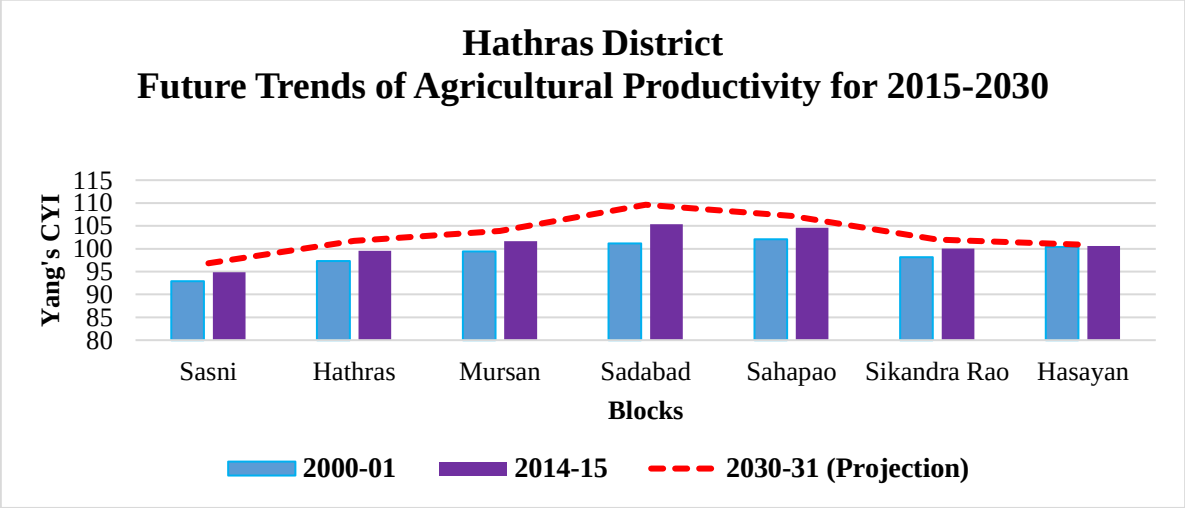
Table 04: Yang's Productivity Regions in Hathras District (2014-15)

Blocks	Cereals	Pulses	Oilseeds	Cash Crops	Composite Index
Sasni	100.11	91.62	90.76	97.01	94.87
Hathras	96.45	95.7	99.84	106.1	99.52
Mursan	106.1	98.95	102.99	98.67	101.68
Sadabad	96.75	112.62	109.67	102.49	105.38
Sahapao	107.17	94.64	102.1	114.62	104.63
Sikandra Rao	100.22	98.67	101.36	100.04	100.07
Hasayan	95.87	99.61	100.97	106.02	100.62

Source: Yang's Crop Yield Index Based on District Statistical Bulletin, Hathras

The future trends of agricultural productivity for the year 2030-31 are depicted in Figure 11. It has been discussed earlier that the study area has continuously boosted its productivity since 2000-01. Similarly, it is observed that all seven blocks of the district namely, Sasni, Hathras, Mursan, Sadabad, Sahapao, Hasayan and Sikandra Rao will make considerable enhancement in their agricultural productivity in 2030-31 too. This positive proliferation in agricultural productivity is due to agricultural development-induced outcomes in the study area (Islam, 2020; Islam, Ahmad and Bano, 2020).

Figure 11: Future Trends of Agricultural Productivity for 2030-31



Conclusion

The aforesaid study of spatio-temporal differentiation of agricultural productivity denotes that all seven blocks namely, Sasni, Hathras, Mursan, Sadabad, Sahapao, Hasayan and Sikandra Rao have made reasonable improvement in their overall indices values during the period from 2000-01 to 2014-15. Though the number of blocks under high productive regions of cereal crops has been decreased but the index value is remaining high. The productivity regions of pulses show that four blocks namely Hathras, Sadabad, Sikandra Rao and Hasayan have accelerated their

productivity throughout the analysis. The cash crops productivity regions reveal that it has made considerable progress in both areas as well as production during the period from 2000-01 to 2014-15. It is found that Sahapao block has increased the productivity of cash crops from an indices value of 99.50 in 2000-01 to 114.62 in 2014-15, Hasayan block claimed from 98.67 to 106.02, Hathras block from 101.32 to 106.10, Sasni block from 95.64 to 97.01 and Sadabad block grown from 101.85 to 102.49. The cultivable land is quite fixed in the study area, still, it has marked a significant positive agricultural productivity during the period from 2000-01 to 2014-15. Similarly, the future trends of agricultural productivity for the year 2030-31 indicate that the study area has continuously boosted its productivity since 2000-01. This positive agricultural performance perhaps is due to agricultural development-induced outcomes in the study area. Moreover, the study area has a lacking of accessibility, invention and equal delivery mechanism of government-sponsored schemes, programs, policies and projects like irrigation, capacity building programs, farmer sensitization issues and others (Islam, 2020). However, farmers must be properly educated and trained through extension services that taught them how to use modern agricultural inputs for increasing productivity.

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References

1. Agriculture Census (2015) Department of Agriculture & Farmers Welfare. Available at: https://agcensus.nic.in/ (Accessed: 27 September 2022).
2. Ahmad, M. (2002) Agricultural Development in Uttarakhand. Aligarh Muslim University.
3. Ahmad, M. and Islam, P. (2017) 'Agricultural Modernization and Rural Development: A Case Study of Mahamaya Nagar District, Uttar Pradesh', National Geographical Journal of India, 63(2), pp. 17–28.
4. Aktar, N. (2016) 'Agricultural productivity and productivity regions in West Bengal', The NEHU Journal, XII(2), pp. 49–61.
5. Anríquez, G. and Stamoulis, K. (2007) 'Rural Development and Poverty Reduction: is Agriculture still the key?', ESA Working Paper/ Agricultural and Development Economics Division, FAO, 7, pp. 1–38.
6. Chandramouli, C. and General, R. (2011) Census of India, censusindia.gov.in. New Delhi.
7. District Census Handbook (2011) Directorate of Census Operations UP, Lucknow.
8. District Economics and Statistics Officer and Development Block Level Offices, Department of Planning, Government of Uttar Pradesh (2001) 'District Statistical Bulletin, Hathras'.
9. District Economics and Statistics Officer and Development Block Level Offices, Department of Planning, Government of Uttar Pradesh (2015) 'District Statistical Bulletin, Hathras'.
10. FAO (2017) 'The future of food and agriculture--Trends and Challenges', Annual Report.
11. FAO (2020) ' World Food and Agriculture—Statistical Year Book 2020', World Food and Agriculture-Statistical Yearbook.
12. Fischer, G. (2009) 'World food and agriculture to 2030/50', in Technical paper from the Expert Meeting on How to Feed the World, pp. 24–26.
13. Islam, P. (2020) Spatio temporal analysis of Agricultural modernization and regional development in Hathras District of Uttar Pradesh. Aligarh Muslim University. Available at: https://shodhganga.inflibnet.ac.in/handle/10603/355828 (Accessed: 25 April 2022).
14. Islam, P., Ahmad, M. and Bano, E. (2020) 'Exploring the Adoption Behaviour and Determinants of Agricultural Modernization using Path Analysis in Hathras district, Uttar Pradesh', Annals of Rajasthan Geographical Association, XXXVI, pp. 1–12.
15. Kumar, A. and Sharma, P. (2022) 'Impact of climate variation on agricultural productivity and food security in rural India'. Available at:

https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4144089 (Accessed: 3 October 2022).
16. Liu, J. et al. (2020) 'Agricultural productivity growth and its determinants in south and southeast Asian countries', Sustainability, 12(12), p. 4981. Available at: https://doi.org/10.3390/su12124981.
17. Munir, A. (1992) Agricultural Productivity and Regional Development. New Delhi, India: Manak Publications Pvt Ltd.
18. Nattagh, N. (1986) Agriculture and Regional Development in Iran. Outwell, UK: Middle East and North African Studies press.
19. Nossal, K. and Gooday, P. (2009) 'Raising Productivity Growth in Australian Agriculture', Australian Bureau of Agricultural Resource Economics [Preprint].
20. OECD (2008) Organisation for Economic Co-Operation and Development (OECD) Annual Report 2008. Available at: https://www.oecd.org/newsroom/40556222.pdf (Accessed: 2 October 2022).
21. Pandit, S.N. (1983) Critical Study of Agricultural Productivity in Uttar Pradesh, 1951-1975. New Delhi: Concept Publishing Company.
22. Rahaman, H. (2020) Diversified Cropping Pattern and Agricultural Development: A Case Study from Malda District, India. Springer Nature.
23. Rehman, H. (2003) 'Spatial Distribution of Agricultural Productivity and Its Correlates in North Bihar Plain', The Geographer, 50(1), pp. 73–84.
24. Saxon, E. (1965) ' Concept of Productivity', Agricultural Productivity, 6, pp. 112–120.
25. Shafi, M. (1984) Agricultural Productivity and Regional Imbalances, Annals of the Association of American Geographers. New Delhi: Concept Publishing Company. Available at: https://doi.org/10.1111/J.1467-8306.1984.TB01437.X.
26. Sharma, D. (2022) Indian Innovation, Not Jugaad-100 Ideas that Transformed India. Roli Books Private Limited.
27. Sharma, S. and Sharma, M.L. (1993) 'Planning optimum Agricultural Infrastructure for Regional Development- A Case Study of Tarabfanj Tahsil', pp. 33–46.
28. Siddiqui, S., Rehman, H. and Siddiqui, M. (1984) 'Regional Analysis of Agricultural Productivity in Bihar', The Geographer, 31(1), pp. 77–85.
29. Socio-Economic Survey 2021-22 (no date). New Delhi.
30. Stamp, L.D. (1958) 'The Measurement of Land Resources', Geographical Review, 48(1), p. 1. Available at: https://doi.org/10.2307/211698.
31. Usmani, T.M. (1994) Impact of Agricultural Productivity on the level of Regional Development in Bihar. Aligarh Muslim University.
32. Yang, W. (1965) 'Methods of farm management investigations for improving farm productivity, ', FAO Agriculture Series.