

PERFORMANCE OF NON-FOODGRAIN CROPS IN UTTAR PRADESH: AN ANALYSIS AT AGRO-CLIMATIC ZONE LEVEL

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Abstract: The present study examines the performance of non-foodgrain crops across the agro-climatic zones of Uttar Pradesh from 2004–05 to 2022–23. Focusing on five specific crops, the study evaluates regional variations in agricultural yield outcomes. The findings indicate considerable regional and agro-ecological disparities in productivity across the state's agro-climatic zones. These variations highlight the critical importance of adopting region-specific and agro-ecology-based policy interventions to promote balanced agricultural growth.

Key Words: Agro-Climatic Zone, Productivity, Non-Foodgrain etc.

1. INTRODUCTION

Agriculture sector persists as the economic bedrock and primary sustenance provider for large part of Indian population. Playing its role as major employment and livelihood provider in India over the years. In tandem, agriculture sector functions as the crucial economic engine for economy of Uttar Pradesh. Uttar Pradesh is top producer of various crops in India, however usually lags behind in productivity of many crops in comparison to better agriculturally developed states (Ahuja et al., 2007). Non-foodgrain crops play an important role in agricultural production of Uttar Pradesh, beyond traditional grains, these crops serve as catalyzing financial diversification for farms, enhancing rotational cropping patterns, and underpinning nutritional and food security. Crop rotation has become of crucial importance in contemporary agricultural patterns to maintain the soil fertility (Nayak et al., 2022). Characterized by an extensive geographical area, Uttar Pradesh remains highly susceptible to shifting meteorological and ecological forces highlighting the diverse agro-climatic conditions.

2. LITERATURE REVIEW

A systematic examination of regional agricultural dynamics in Uttar Pradesh underscores persistent spatial disparities and shifting structural trends. Historical assessments by Raman and Kumari (2012) establish that the Western region consistently leads in agricultural development, whereas the Bundelkhand region continuously lags as the least developed zone. Sant and Mohapatra (2019) highlights the crucial fact that even with the semi-arid conditions, several zones are shifting towards water intensive cropping patterns of wheat and rice production duo to ensured price support under minimum support prices. More recent macro-analyses by Kumar and Simran (2024) reveal that while the Western region's dominant share in state agriculture has marginally contracted, the livestock sector has emerged as a rapid growth driver across most regions, with the notable exception of Bundelkhand.

To counter these disparities, empirical literature heavily advocates for crop diversification and comprehensive infrastructural interventions. Kumar et al. (2019) document a progressive transition toward high-value horticulture specifically fruit and vegetable production and demonstrate that enhancements in rural infrastructure and credit facilities directly elevate agrarian welfare. Because the state's massive geographical scale prevents a uniform solution, Kumar et al. (2020) emphasize optimizing existing land use through input intensification, technology adoption, and improved literacy rates. Overall, these studies suggests to fostering sustainable agricultural growth in the state requires a shift away from blanket strategies in favor of region-specific, agro-climatic policies coupled with robust investments in value chains and rural infrastructure (Kumar et al., 2019; Kumar et al., 2020; Kumar & Simran, 2024).

3. OBJECTIVE OF THE STUDY

The overriding objective of the present study is to evaluate the geographical and trend variations in the productivity dynamics of major non-foodgrain crops throughout different agro-climatic zones of Uttar Pradesh over nearly two decades period.

4. RESEARCH METHODOLOGY AND DATABASE

Uttar Pradesh, being a vast territorial area, needs an analysis of crops productivity at the agro-climatic zone level which may provide a better insights into regional disparities and growth potential of these crops. In this context, the present study embarked on productivity trends of major non-foodgrain crops, namely Arhar, Gram, Peas, Potato, and Sugarcane, respectively. Leveraging district-level secondary data from 2004–05 to 2022–23, this paper evaluates yield trajectories for non-foograin crops across all nine agro-climatic zones of Uttar Pradesh tracing secular trends across decades. Districts level data of productivity of non-foodgrain crops has been compiled from various published sources. Most of the quantitative data were collected from Statistical diary of Uttar Pradesh, Government of Uttar Pradesh and Directorate of Economics and statistics (UPDES) portal of Government of Uttar Pradesh.

Table1: code used for agro-climatic zones

Full Name of Zone	Name of Zone
Bhabhar and Tarai	Zone-1
Bundelkhand Zone	Zone -2
Central Plains Zone	Zone -3
Eastern Plains Zone	Zone-4
Mid Western Plains Zone	Zone-5
North Eastern Plains Zone	Zone-6
South-Western Semi-Arid Zone	Zone-7
Vindhyan Zone	Zone-8
Western Plains Zone	Zone-9

Source: By author based on *Agro-climatic zone classification from the Planning Department, Government of Uttar Pradesh.*

Crop productivity is measured as physical yield per unit area. The major variable considered in this study is productivity of foodgrains, measured in quintals per hectare (q/ha). Productivity was calculated using the standard formula:

$$Yield \left(\frac{t}{ha} \right) = \frac{total\ production(t)}{area(ha)}$$

For Agro-Climatic Zone-Wise Productivity, data from all constituent districts within a specific zone are summed annually before calculating the ratio.

ANALYSIS OF THE STUDY

Table 2 exhibits the agro-climatic zone-wise productivity of Arhar in Uttar Pradesh from year 2004-05 to 2022-23. The data reveals substantial variations in productivity levels of Arhar across the agro-climatic zones along with sizeable swings across different years. Central zone of the state emerged as one of the best performing zones for Arhar cultivation throughout the study period of nearly two decades. While, Zone 6 and Zone 9 has highlighted the weak productivity relative to most other agro-climatic zones.

Table:2 productivity of arhar in uttar pradesh-agro climatic zone wise (in quintals/hectare)

Year/ Zone	Zone-1	Zone -2	Zone -3	Zone-4	Zone 5	Zone-6	Zone-7	Zone-8	Zone-9
2004-05	8.6	11.0	11.3	11.0	9.0	6.0	9.0	7.3	7.9
2005-06	8.6	8.9	11.5	9.8	8.9	8.8	9.1	6.8	7.8
2006-07	7.1	6.7	7.8	7.3	7.2	6.0	8.4	7.1	8.0
2007-08	8.5	5.4	10.7	10.6	8.6	7.2	10.0	7.1	6.0
2008-09	7.9	9.2	13.0	7.4	8.2	7.0	7.6	7.9	6.5
2009-10	6.7	5.5	7.8	8.6	6.8	5.5	7.7	4.0	6.9
2010-11	7.7	8.1	10.4	11.0	7.8	6.1	7.6	8.3	6.1
2011-12	8.3	10.8	12.7	10.0	8.7	6.6	8.4	10.4	6.5
2012-13	9.1	8.8	12.0	10.4	9.3	7.0	11.4	11.5	8.2
2013-14	6.0	8.7	9.9	8.4	9.2	6.3	13.0	10.0	5.6

2014-15	6.6	3.0	5.3	8.7	6.6	4.8	9.6	9.0	6.1
2015-16	6.6	2.7	7.2	8.9	6.6	6.8	8.4	10.0	5.3
2016-17	9.9	9.1	13.9	10.1	8.8	7.9	9.3	13.4	7.1
2017-18	5.5	10.2	15.0	10.8	8.4	6.9	10.3	11.1	9.0
2018-19	12.8	10.3	13.2	10.9	7.5	6.8	10.1	10.2	5.7
2019-20	2.5	8.8	11.9	10.1	9.1	4.0	10.2	8.2	6.4
2020-21	5.8	14.0	12.5	12.2	9.4	6.4	14.6	10.4	5.5
2021-22	6.7	15.4	10.4	12.3	10.5	6.6	12.6	10.6	6.3
2022-23	8.3	13.0	12.0	11.6	11.6	8.3	12.5	10.4	8.2

Data Source: Statistical Diary of Uttar Pradesh, Different Years

Overall, the analysis suggests that the Central, SWSA, Bundelkhand and Vindhyan Zone are comparatively more favorable for Arhar cultivation in Uttar Pradesh because of their higher productivity levels and better crop adaptability.

As demonstrated in Table 3, the yield pattern for gram in Uttar Pradesh of nearly two-decade period (2004-05 to 2022-23), showcased marked differences from one agro-climatic zone to another. Additionally, the data underscores a pattern of differences in productivity across agro-climatic zones of Uttar Pradesh, as well as show notable year on year fluctuations within zones. Throughout the majority of the timeframe analyzed, S-WS-A Zone can be seen as the top-performing zone in terms of gram yields. Later years of the study indicate better gram crop performance across all zones of the state, relatively.

Table:3 productivity of gram in uttar pradesh-agro climatic zone wise (in quintals/hectare)									
Year/ Zone	Zone-1	Zone -2	Zone -3	Zone-4	Zone-5	Zone-6	Zone-7	Zone-8	Zone-9
2004-05	9.2	9.2	10.2	8.2	9.2	9.0	12.4	8.5	8.0
2005-06	8.9	8.1	12.0	9.5	8.9	9.1	12.8	7.6	7.5
2006-07	7.3	6.4	9.8	8.2	7.4	7.3	7.9	9.5	6.5
2007-08	4.7	5.8	10.5	9.9	7.3	7.3	13.5	9.2	6.3
2008-09	10.4	9.7	12.5	10.8	8.1	9.9	9.9	9.1	8.6
2009-10	8.3	8.2	9.8	9.6	8.3	8.1	8.3	9.4	7.2
2010-11	8.8	8.5	10.6	11.0	7.1	8.8	14.2	10.1	7.6
2011-12	11.7	11.5	13.3	13.2	9.4	11.3	13.7	10.5	10.1
2012-13	11.1	11.4	12.4	11.8	11.0	10.8	15.0	11.2	9.6
2013-14	4.1	4.0	5.8	7.1	4.1	4.3	12.5	10.4	4.7
2014-15	1.0	3.1	4.4	7.5	3.0	3.0	8.5	10.0	1.9
2015-16	1.4	4.5	7.1	9.7	4.5	6.7	6.6	7.8	4.7
2016-17	7.2	10.5	10.9	17.2	7.6	10.4	12.2	11.5	5.4
2017-18	11.6	10.5	13.6	12.0	7.2	9.6	15.8	12.9	5.5
2018-19	8.4	13.1	12.9	14.1	8.8	9.7	14.1	11.5	7.6
2019-20	9.0	14.3	11.4	12.4	6.9	11.6	11.6	9.7	4.7
2020-21	12.0	12.0	12.7	14.5	10.9	9.9	15.1	13.4	8.7
2021-22	7.5	13.3	12.0	16.3	9.3	12.7	19.7	12.0	7.8
2022-23	13.5	13.6	11.8	14.0	9.7	13.2	15.5	14.0	7.9

Data Source: Statistical Diary of Uttar Pradesh, Different Years

Agro- climatic zone wise Pea’s productivity has been shown by Table 4 from 2004-05 to 2022-23. Data suggests differences in Pea’s productivity across agro-climatic zones as well as across years of the study. Consistently higher productivity has been shown by Zone-7 over the years as well as across agro-climatic zones. Zone-8 and Zone-9 indicated relatively low productivity in comparison to other agro-climatic zones over the study period.

Table:4 productivity of peas in uttar pradesh-agro climatic zone wise (in quintals/hectare)									
Year/ Zone	Zone-1	Zone -2	Zone -3	Zone-4	Zone-5	Zone-6	Zone-7	Zone-8	Zone-9
2004-05	15.0	12.8	11.8	9.8	16.2	12.3	15.9	9.7	11.7
2005-06	11.7	10.7	12.7	13.6	11.7	11.7	20.9	8.6	10.2
2006-07	9.8	7.9	12.1	10.3	9.8	9.8	11.2	10.0	7.4
2007-08	10.7	7.2	13.3	13.8	10.7	10.7	10.7	9.9	9.3
2008-09	12.0	11.5	12.9	12.2	12.0	12.0	11.9	9.9	10.7

2009-10	13.0	11.5	12.4	12.2	13.0	13.0	13.1	11.2	11.7
2010-11	14.0	8.3	13.6	13.4	15.9	12.0	17.8	10.4	9.9
2011-12	14.0	12.8	13.6	13.2	15.0	12.2	16.0	10.8	12.6
2012-13	15.6	13.5	12.5	12.4	17.8	13.1	18.4	11.2	13.5
2013-14	13.9	8.6	12.7	5.6	16.9	8.2	17.6	9.9	8.2
2014-15	9.3	+6.0	7.3	9.2	9.5	6.7	8.2	9.2	6.5
2015-16	9.2	7.5	11.6	9.9	9.5	10.1	10.0	9.7	8.7
2016-17	10.9	12.3	13.6	11.6	11.9	12.5	23.7	11.2	9.9
2017-18	14.2	12.3	13.6	13.9	17.7	13.5	21.9	10.1	10.5
2018-19	16.0	14.7	13.3	15.1	20.0	13.7	18.2	10.4	11.4
2019-20	14.1	15.0	9.5	15.4	14.5	13.4	22.3	8.0	11.5
2020-21	17.4	14.4	12.0	14.6	21.6	13.8	24.9	10.3	11.0
2021-22	30.8	13.9	15.5	16.1	20.2	14.8	20.5	10.5	11.3
2022-23	13.5	14.9	14.1	13.9	10.0	14.2	15.6	14.1	10.9

Data Source: Statistical Diary of Uttar Pradesh, Different Years

Table 5 presents the agro-climatic zone wise potato productivity of Uttar Pradesh from 2004-05 to 2022-23. Nearly one third of total potato production in India is produced by Uttar Pradesh alone, however, it lacks behind in productivity from Punjab. As shown in the table, Potato productivity has increased in all agro-climatic zones over the study period. Bhabhar and Tarai, Central zone, South west semi-arid and Mid-western plain zones have performed better in Potato productivity over the years in study period. Vindhyan zone, North eastern, Bundelkhand and Western zones has shown relatively lower potato productivity.

Table:5 productivity of potato in uttar pradesh-agro climatic zone wise(in quintals/hectare)

Year/ Zone	Zone-1	Zone -2	Zone -3	Zone-4	Zone-5	Zone-6	Zone-7	Zone-8	Zone-9
2004-05	251.5	189.1	197.7	169.4	238.3	199.5	263.7	151.1	185.3
2005-06	241.5	224.6	206.2	227.6	243.6	221.0	243.1	224.6	166.3
2006-07	226.9	220.4	203.7	184.5	193.3	204.4	243.6	220.4	154.7
2007-08	228.3	222.2	201.7	179.2	213.7	220.5	243.0	222.2	159.5
2008-09	189.0	205.5	199.6	150.5	172.4	173.2	238.1	205.5	182.9
2009-10	237.5	247.9	237.1	208.1	232.6	247.6	273.7	247.9	205.3
2010-11	231.2	241.5	208.6	218.1	221.9	216.5	278.6	241.5	195.3
2011-12	244.7	223.0	206.1	223.4	235.6	207.2	252.4	188.7	164.0
2012-13	219.9	243.9	214.6	192.6	206.9	213.1	279.5	243.9	207.1
2013-14	204.7	214.4	179.5	152.1	238.9	198.4	258.1	214.4	146.4
2014-15	196.0	225.2	183.9	207.5	195.3	203.1	251.6	294.6	192.3
2015-16	243.0	249.5	181.4	217.3	226.5	235.7	256.5	290.9	196.5
2016-17	218.7	242.5	214.2	215.8	240.6	215.4	256.3	313.0	223.0
2017-18	270.3	200.9	239.5	215.8	248.8	217.1	261.8	261.8	231.5
2018-19	275.1	298.5	281.3	229.8	271.6	278.1	306.7	329.1	245.0
2019-20	263.6	269.2	236.0	216.7	228.2	254.7	282.5	247.7	243.5
2020-21	293.6	269.6	254.7	228.9	275.7	272.1	320.8	228.7	239.8
2021-22	242.0	293.4	247.8	248.2	263.8	266.0	288.0	299.4	249.6
2022-23	283.4	271.1	312.0	304.5	313.5	284.4	334.0	283.7	242.6

Data Source: Statistical Diary of Uttar Pradesh, Different Years

Table 6 indicates the agro-climatic zone wise sugarcane productivity in UP from 2004-05 to 2022-23. On the sugarcane productivity side Uttar Pradesh lagged far behind then other states of the country and holds seventh position in the country. In 2022-23, Tamil Nadu has recorded the best sugarcane productivity in country with 104.48 tonnes per hectare, while Uttar Pradesh recorded only 82.31 (behind the national average productivity 84 tonnes per hectare) tonnes per hectare indicating the gap and need for sugarcane productivity improvement in Uttar Pradesh (Directorate of Sugarcane Development, 2023).

Table:6 productivity of sugarcane in uttar pradesh-agro climatic zone wise(quintals/hectare)

Year/ Zone	Zone-1	Zone -2	Zone -3	Zone-4	Zone-5	Zone-6	Zone-7	Zone-8	Zone-9
2004-05	639.0	479.4	544.2	447.7	621.7	536.8	495.9	430.4	573.8
2005-06	586.4	274.7	444.9	486.0	602.7	550.2	502.6	353.5	543.5
2006-07	621.0	413.6	500.9	466.2	604.0	537.3	528.5	433.0	573.5
2007-08	576.9	232.6	492.1	480.4	556.7	514.9	525.2	572.2	572.1
2008-09	522.3	330.6	480.4	440.4	545.9	457.0	475.3	527.1	516.6
2009-10	601.4	372.3	486.8	470.7	593.5	505.4	481.6	510.4	561.1
2010-11	561.6	439.0	539.2	459.6	566.1	525.1	522.7	535.0	536.3
2011-12	600.8	444.3	571.5	513.1	591.9	568.3	522.0	556.5	548.5
2012-13	609.8	371.5	609.0	551.6	618.2	585.3	516.7	542.4	583.1
2013-14	605.2	427.4	621.1	570.4	633.6	586.6	537.6	637.8	608.8
2014-15	658.4	404.4	615.4	583.7	648.3	593.7	487.2	658.2	621.3
2015-16	653.3	357.2	620.9	589.7	662.7	591.5	529.7	670.3	640.5
2016-17	727.2	408.5	662.9	634.8	697.7	635.3	582.0	726.7	661.7
2017-18	798.6	388.1	611.5	657.9	763.1	686.8	624.3	792.5	712.3
2018-19	808.1	382.0	631.2	669.4	747.6	728.0	629.4	808.1	726.3
2019-20	814.9	384.8	737.3	631.9	743.4	716.0	697.3	813.1	723.7
2020-21	825.9	643.5	660.2	654.6	759.2	695.3	650.1	818.1	733.3
2021-22	564.5	561.9	646.1	665.7	764.9	696.3	662.0	823.0	738.1
2022-23	845.0	512.3	283.4	625.2	778.2	604.5	417.0	824.0	635.3

Data Source: Statistical Diary of Uttar Pradesh, Different Years

Bhabhar and Tarai zone, Western plains zone and Mid-Western plains zone has consistently recorded the better productivity relative to other agro-climatic zones of the state. On the other hand, zones receiving low rainfall and having arid agro-climatic conditions, like Bundelkhand, Vindhyan and South West Semi-Arid has historically shown relatively low sugarcane productivity.

Sugarcane is crucial crop for rural households as is the largest employment provider in rural Uttar Pradesh if considered in terms of farming activity (Singh, et. al., (2008). Climate resilient nature and ensured minimum prices has supported the growth of sugarcane in western region. Conversely, the high water demands of irrigation-intensive crops like sugarcane have triggered critical groundwater depletion, particularly in the Western region, necessitating immediate policy intervention (Mohan et al., 2018).

5.5 CONCLUSION

This study evaluated the productivity trends of major non-foodgrain crops—including Arhar, Gram, Peas, Potato, Turmeric, and Sugarcane across the diverse agro-climatic zones of Uttar Pradesh from 2004–05 to 2022–23. The analysis reveals shifting productivity patterns across the state, alongside significant temporal and intra-zonal variations.

While Uttar Pradesh leads national production volumes for several of these commodities, it consistently lags in yield per hectare for the majority of non-foodgrain crops, with the exceptions of peas, potato, where it maintains a competitive edge. Nonetheless, the state’s favorable agro-climatic profile offers substantial untapped potential. Strategically leveraging these natural conditions can facilitate crop diversification, optimize crop rotation cycles, and improve long-term soil health.

Furthermore, the semi-arid conditions characteristic of certain agro-climatic zones present a viable opportunity to promote drought-resistant crops. Ultimately, this study underscores the urgent need to focus on enhancing agricultural productivity, profitability, and regional diversification. Achieving long-term sustainability in Uttar Pradesh's agricultural sector will depend heavily on strengthening rural infrastructure and accelerating technology dissemination.

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