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Comparative Insights into the Changing Patterns of Cropping Intensity in Haryana

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Abstract— *"Cropping intensity" refers to the practice of producing many crops in one agricultural year in the same location. A greater percentage of the seeded area is cropped more than once when cropping intensity is increased. A number of factors, such as the availability of modern agricultural equipment, fertilizers, insecticides, herbicides, and better irrigation systems, can lead to a rise in cropping intensity. Nonetheless, the average cropping intensity increased from 167.42% in 1990–1992 to 183.17% in 2022–2023 over the preceding three decades. Furthermore, the primary goal of the study is to examine the temporal perspective and geographic variance of the changing pattern of cropping intensity in the state's different agroclimatic zones. The findings indicate that the cropping intensity scenario is suitable in every agroclimatic zone, with the exception of the central one. The improved use of arable land and the increase in yield per hectare, which showed the progress of agriculture, were the overall results of these advancements.*

Keywords— ***Technological Advancements, Green Revolution, Cropping Intensity.***

I. INTRODUCTION

The foundation of India's economy, agriculture is always changing due to a variety of variables like socioeconomic dynamics, technical improvements, and climatic unpredictability. Since the Green Revolution, Haryana, one of the nation's most important agricultural states, has served as a hub for agricultural innovation. The agrarian environment of the state has seen significant changes throughout time, which has led to a critical analysis of its patterns of cropping intensity. The small land holdings, the kind of soil, the unpredictable monsoon rains, and the combination of irrigation infrastructure have all had an impact on the aerial distribution of cropping intensity. Since the reform, the state has witnessed a number of changes in how agricultural land is used, such as the setting up of irrigation systems, improvements in agricultural technology, and the profitability of different agricultural enterprises. The "new agricultural strategy" has made intensifying farmland use a top priority in an effort to bridge the widening gap between global population growth and food security.

One important measure of agricultural production and land utilisation efficiency is cropping intensity, which is the ratio of the gross cropped area to the net sown area (Stefan Siebert, 2020). Deciphering the intricacies of agricultural practices and creating plans that support sustainable land use require an understanding of the differences in cropping intensity (Hayami et al., 1971). With the title "Variations in the Cropping Intensity Pattern in Haryana: A Comparative Analysis," this study delves deeply into the many factors that influence the cropping intensity landscape throughout Haryana's several zones.

Significance of the study: -

This research contributes to both academic knowledge and real-world applications in the fields of agricultural and regional development, which makes it extremely important for a number of reasons.

1. *Resource Management:* Understanding cropping intensity patterns helps in efficient management of essential resources like water, soil, and fertilizers, which are crucial in a water-stressed state like Haryana.

2. *Economic Impact:* Analyzing cropping intensity can reveal potential areas for enhancing agricultural productivity, impacting the livelihoods of farmers and contributing to the state's agricultural economy.
3. *Environmental Implications:* Intensive cropping often leads to soil degradation, reduced fertility, and other ecological impacts. Studying these variations helps in assessing the environmental sustainability of current practices.
4. *Regional Development:* Comparing cropping patterns across different regions can aid in identifying disparities, allowing for targeted interventions to uplift underperforming areas and promote balanced agricultural growth.
5. *Policy Formulation:* The findings from such an analysis provide valuable insights for policymakers to design region-specific agricultural policies and support programs that optimize cropping patterns.

Objectives of the Study: -

i. To analyze spatial and temporal variations in cropping intensity across different regions of Haryana.

ii. To identify factors influencing cropping intensity patterns and recommend region-specific strategies for optimizing agricultural practices.

II. RESEARCH METHODOLOGY

A mixed-methods technique is used in this study to examine cropping intensity in Haryana. The Department of Economics and Statistical Affairs, Panchkula, Haryana, provided the secondary agriculture data that served as its secondary source. The current study examined the differences in cropping intensity in Haryana throughout two time periods, using data collected at the district level from various government publications issued by the Department of Economics and Statistical Affairs. An average of the data for three consecutive years at each point in time has been used to avoid anomalies brought on by annual weather fluctuations. The collected data is processed and analyzed to create tables and maps. Making maps has been done with ArcGIS software.

A formula has been used to calculate the cropping intensity which is as follows: -

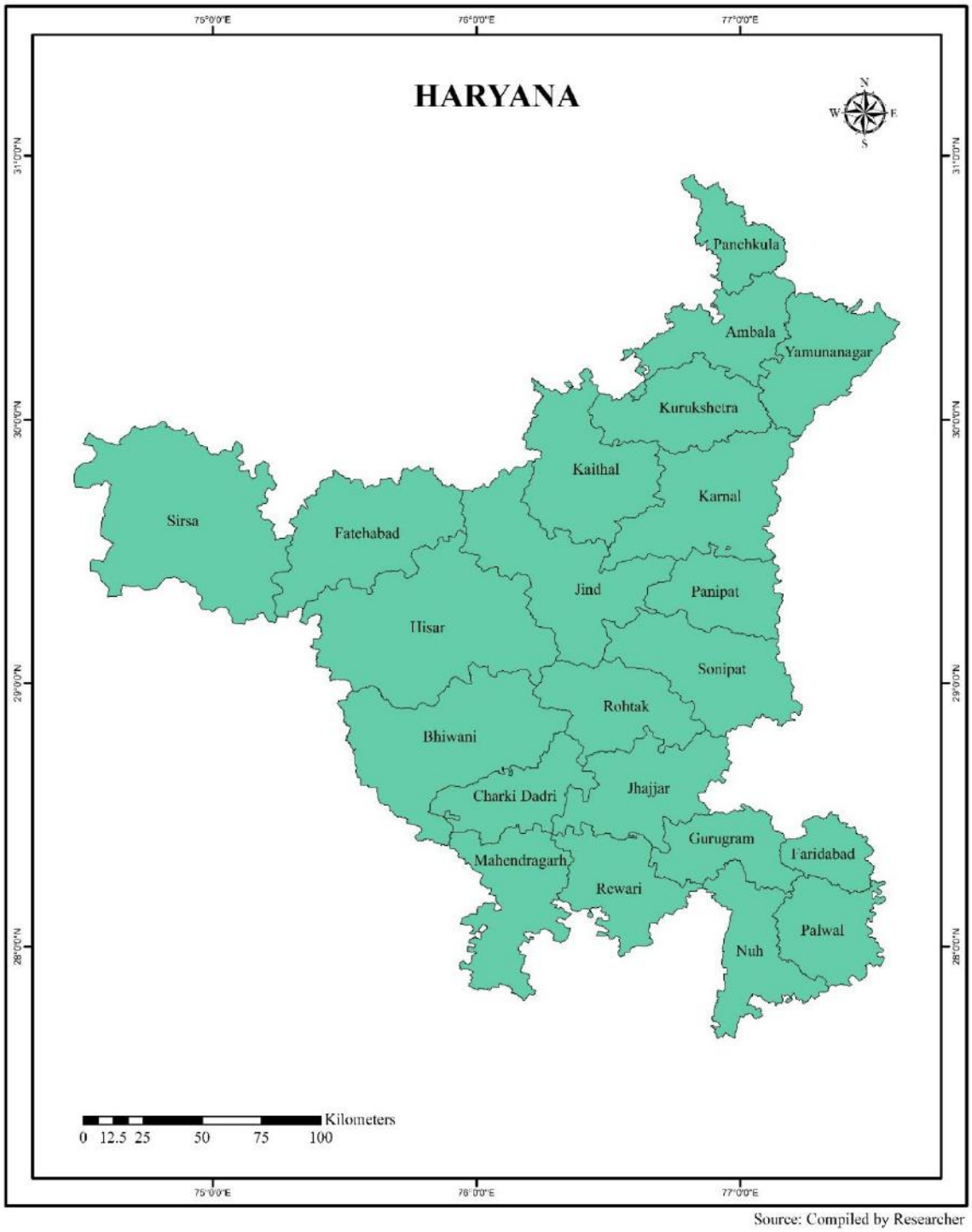
Cropping Intensity = **Total Cropped Area / Net Sown Area*100**

Study Area

Haryana, a northwestern state of India, is characterized by its rich agricultural heritage, geographical diversity, and historical significance. Established on November 1, 1966, following the reorganization of the erstwhile state of Punjab, Haryana has since evolved into a key agricultural hub, contributing significantly to the nation's food production. Geographically, the state is landlocked, bordered by Punjab to the north and west, Himachal Pradesh to the northwest, Uttarakhand to the northeast, Uttar Pradesh to the east, and Rajasthan to the south and southwest. Its proximity to the national capital, Delhi, enhances its economic and strategic importance. The current study is focused on the state of Haryana, which is situated between coordinates 27°39' and 30°55' N and longitudes 74°28' to 77°36' E. With a total size of 44212 sq. km, the State of Haryana occupies 1.4% area of the country. The soil richness and geography of the State are remarkably diversified. The administrative structure consists of 154 towns, 6841 villages, 143 Community Development Blocks, 22 districts, and 95 tehsils (Statistical Abstract of Haryana, 2022-23)..

III. RESULTS AND DISCUSSIONS

The collected data has been examined to provide insightful findings, which are presented in the results and discussion section. The findings, which give a summary of three decades of cropping intensity in the state of Haryana, are highlighted in the results. Following that, a critical discussion of these findings concerning the study's goals follows. A thorough grasp of the research's breadth is provided by the exploration of the results' ramifications as well as the acknowledgment of any study limitations. This volume's overall goal is to thoroughly analyze the study's findings and add to the current conversation in the pertinent academic or professional sector.



Source: Compiled by Researcher

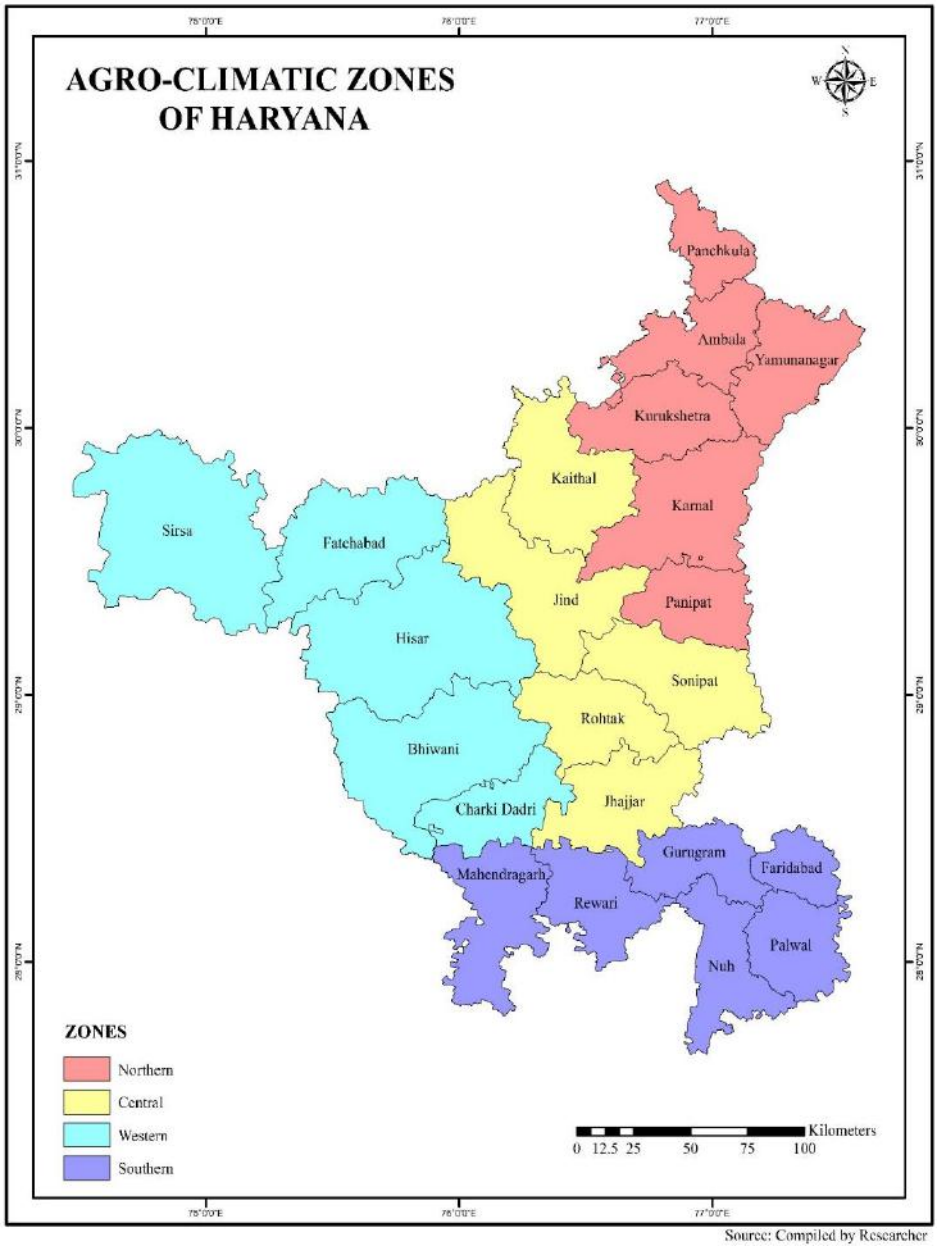
Agro-Climatic Zones of Haryana: -

The soil and climate in a specific area mostly dictate the cultivation pattern and crop output. Zoning is a tool used in land-use planning to separate areas with similar growth potential and boundaries. A particular geographic region can be classified into one of two zones. To facilitate data analysis and improve the study's applicability for planning and research on agricultural growth, Haryana has been divided into four uniform agro-climatic zones, which are as follows:

Table No. 1: Agro-Climatic Zones of Haryana

Sr. No.	Zones	Districts
1	Northern	Panchkula, Ambala, Yamunanagar, Kurukshetra, Karnal, Panipat
2	Central	Kaithal, Jind, Sonipat, Rohtak, Jhajjar
3	Western	Bhiwani, Hisar, Fatehabad, Sirsa, Charkhi Dadri
4	Southern	Faridabd, Gurugram, Rewari, Mahendragarh, Palwal, Nuh

Source: Economics of Farming in Haryana, 2020-21



Source: Compiled by Researcher

Characteristics of Agro-Climatic Zones: -

Haryana's division into four agro-climatic zones—Northern, Central, Western, and Southern—reflects its diverse agricultural landscape shaped by varying climate and soil conditions. The **Northern Zone**, including districts such as Panchkula, Ambala, and Karnal, has abundant rainfall and fertile soils, ideal for high-yield crops like wheat, rice, and sugarcane. The **Central Zone**—Kaithal,

Jind, and Rohtak—has moderate water resources and robust irrigation systems that support staple crops like wheat and pulses. The **Western Zone**, which includes Bhiwani, Hisar, and Sirsa, is drier, relying on irrigation for crops suited to semi-arid conditions, like cotton, wheat, and mustard. Lastly, the **Southern Zone** (Faridabad, Gurugram, and Rewari) experiences arid and semi-arid conditions, where water scarcity necessitates drought-resistant crops such as bajra (millet), mustard, and pulses. This zonal structure allows for tailored agricultural practices and efficient resource management across the diverse conditions of Haryana. Promoting the development of crops like pulses and pearl millet, although irrigation is still crucial. A semi-arid environment with moderate temperatures prevails in the central zone, which includes Rohtak, Sonipat, Jind, Kaithal, and Jhajjar. Thanks in great part to canal irrigation, crops including wheat, rice, and sugarcane flourish there. Reliance on irrigation, a variety of crop cultivation, and the use of intensive farming techniques are characteristics shared by all zones, demonstrating Haryana's resilience to a range of agroclimatic circumstances. The following are some traits of the sub-zones that make up the Trans-Gangetic Zone.

Table No. 2: Characteristics of Sub-Zones of Trans-Gangetic Zones

Sub Zone	Districts	Rainfall (in mm)	Climate	Soil	Crops
Plain	Kurukshetra, Karnal, Jind, Sonipat, Rohtak, Faridabad, Panipat, Kaithal Gurugram, Palwal, and Nuh	720	Semi-arid to Dry Sub-humid	Alluvial	Wheat, Rice, Maize, Sugarcane
Foothills of Shivalik & Himalayas	Panchkula, Ambala, Yamunanagar	1000	Semi-arid to Dry Sub-humid	Calcareous	Wheat, Rice, Maize, Sugarcane
Scarce Rainfall Arid Region	Hisar, Fatehabad Sirsa, Bhiwani, Charkhi Dadri, Rewari, Mahendragarh	360	Arid and extremely arid	Calcareous, Sierozemic, Alluvial, Desert	Wheat, Cotton, Gram, Bajra, Rice

Source: Planning Commission of India

Cropping Intensity in Haryana: -

Cropping intensity in Haryana, a critical measure of agricultural productivity, reflects the extent of land utilization and plays a significant role in food security, economic growth, and sustainable farming practices. Haryana's cropping intensity stands at an impressive 184%, well above the national average, with farmers generally cultivating more than one crop on the same plot annually. However, this intensity varies considerably across its four distinct agro-climatic zones—Northern, Central, Western, and Southern—each with unique environmental conditions affecting cropping patterns, resource availability, and agricultural practices.

The **Northern Zone**, comprising districts like Panchkula, Ambala, and Karnal, enjoys favorable climatic conditions with abundant rainfall and fertile soils, allowing for a cropping intensity above 200%. Here, irrigation from rivers like the Yamuna supports a double-cropping pattern dominated by wheat in the Rabi season and rice in the Kharif season.

In contrast, the **Central Zone**, covering Kaithal, Jind, and Rohtak, has moderately favorable conditions supported by strong irrigation infrastructure, resulting in a cropping intensity between 180% and 200%, with wheat, rice, and pulses as the primary crops. The **Western Zone**, including Bhiwani, Hisar, and Sirsa, has semi-arid conditions and lower rainfall, which require intensive irrigation, primarily from canals, to support crops like cotton, wheat, and mustard. This region's cropping intensity ranges from 150% to 170% and emphasizes water-efficient and resilient crops, although water scarcity remains a major challenge.

The **Southern Zone**, covering Faridabad, Gurugram, and Rewari, is the most arid region with the lowest cropping intensity, between 120% and 150%, as farmers mainly grow drought-resistant crops like bajra (millet), mustard, and pulses, suitable for the limited water availability and harsh climatic conditions. In addition to agro-climatic factors, the intensity in each region is influenced by soil health, irrigation infrastructure, and government policies promoting sustainable practices. However, intensive cultivation, particularly in the Northern Zone, has led to groundwater depletion and soil degradation, raising concerns about long-term sustainability.

Understanding and managing these variations is essential for Haryana's agricultural planning, allowing for tailored resource allocation, infrastructure development,

and policy implementation to balance productivity with environmental sustainability across the state's varied landscape. In summary, Haryana's cropping intensity reflects both opportunities for increased productivity and challenges in resource management, and it highlights the importance of sustainable agricultural practices that adapt to each zone's unique conditions for long-term resilience and growth.

Spatial Pattern of Cropping Intensity: -

The cropping intensity index showed a geographical variety during the fiscal year 2022–23, ranging from the lowest value of 129.41 percent in Gurgaon district to the maximum value of 200 percent in Panchkula district. All the districts have been categorized into the following groups to examine the state's geographical disparities in cropping intensity.

Table No. 3: Category-wise Cropping Intensity, 1990-91

Cropping Intensity (%)	Categories	Number of Districts	Districts Included
Above 190	High	3	Karnal, Sonipat, Jind
170-190	Medium	3	Kurukshetra, Kaithal, Hisar
Below 170	Low	10	Ambala, Yamunanagar, Panipat, Rohtak, Faridabad, Gurgaon, Rewari, Mahendragarh, Bhiwani, Sirsa

Source: Department of Economic and Statistical Analysis, 1990-91

Table No. 4: Category-wise Cropping Intensity, 2022-23

Cropping Intensity (%)	Categories	Number of Districts	Districts Included
Above 190	High	13	Panchkula, Yamunanagar, Kurukshetra, Karnal, Panipat, Kaithal, Jhajjar, Sonipat, Palwal, Jind, Hisar, Fatehabad, Sirsa
170-190	Medium	7	Charkhi Dadri, Faridabad, Gurugram, Nuh, Rewari, Rohtak, Bhiwani,
Below 170	Low	2	Ambala, Mahendragarh

Source: Computed by Researcher from Statistical Abstract, 2022-23

Between 1990-91 and 2022-23, Haryana's cropping intensity saw notable shifts across districts. In 1990-91, only 3 districts (Karnal, Sonipat, Jind) had a high cropping intensity (above 190%), whereas by 2022-23, this category expanded to 13 districts, including Panchkula, Yamunanagar, and Hisar. Medium-intensity districts (170-190%) increased from 3 to 7, with districts like Bhiwani and Rewari joining. Low-intensity areas (below 170%) decreased significantly from 10 to only 2 districts, now limited to Ambala and Mahendragarh. This change indicates overall improvements in agricultural practices, irrigation, and resource availability across Haryana, enhancing cropping intensity in many regions.

Table No. 5: District-wise Cropping Intensity, 1990-91, 2022-23

Sr. No.	Districts	Cropping Intensity	
		1990-91	2022-23
1.	**Ambala**	165.75	150.33
2.	**Panchkula**	-	218.18
3.	**Yamunanagar**	157.14	194.01
4.	**Kurukshetra**	189.21	202.75
5.	**Karnal**	217.42	193
6.	**Panipat**	135.48	197.91
7.	**Kaithal**	170.23	203.06

8.	**Rohtak**	123.73	174.45
9.	**Jhajjar**	-	192.50
10.	**Sonipat**	195.35	206.41
11.	**Jind**	200	203.57
12.	**Faridabad**	155.80	178.78
13.	**Palwal**	-	193.06
14.	**Gurugram**	154.78	170.33
15.	**Mewat/Nuh**	-	171.81
16.	**Rewari**	154.69	174.60
17.	**Mahendragarh**	167.95	151.89
18.	**Bhiwani**	153.40	174.82
19.	**Charkhi Dadri**	-	182.14
20.	**Hisar**	178.04	200.30
21.	**Fatehabad**	-	195.11
22.	**Sirsa**	159.52	192.36

Source: Department of Economic & Statistical Affairs, 1990-91, 2022-23

- **Data not available**

The map and table compare the cropping intensity across various districts in Haryana for the years 1990-91 and 2022-23, showing how agricultural practices and land use have evolved. The maps illustrate the spatial distribution of cropping intensity, categorized into three levels: low (0-170%), medium (170-190%), and high (190-217% in 1990-91, and 200-218% in 2022-23). The table further details the exact cropping intensity percentage for each district, showcasing shifts in productivity, which reflect advancements or declines in farming practices, irrigation, and resource management in different parts of Haryana.

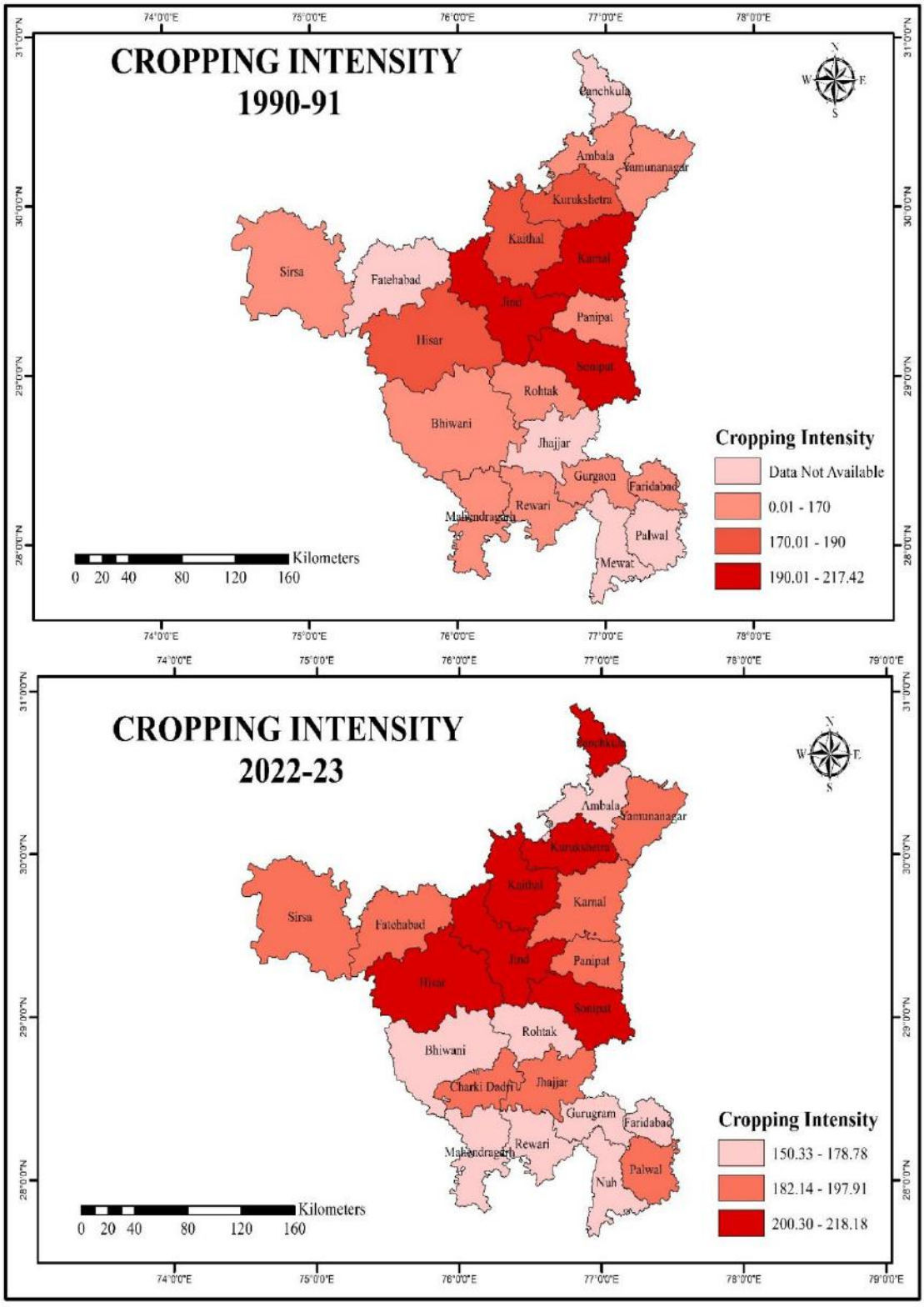
In 1990-91, the cropping intensity was generally lower across most districts, with only a few districts like Karnal, Sonipat, and Jind reaching high levels (above 190%). These districts, located in central and northern Haryana, benefitted from fertile soils and better access to water resources, which supported a higher cropping intensity. Meanwhile, districts such as Panipat, Rohtak, and Faridabad displayed relatively low cropping intensity (0-170%), suggesting limited water availability, lesser infrastructural support, or soil conditions that were less favorable for intensive cropping. Many districts, particularly in southern and western Haryana, faced challenges related to arid conditions and water scarcity, which contributed to their lower productivity.

By 2022-23, significant improvements in cropping intensity can be observed across several districts, reflecting advances in irrigation, agricultural practices, and policies that have bolstered productivity. For instance, Panchkula, which did not have data in 1990-91, registered the highest cropping intensity at 218.18% in 2022-23. Other districts like Yamunanagar, Kurukshetra, and Kaithal also saw substantial increases, reaching or surpassing 200% cropping intensity. These improvements suggest enhanced agricultural infrastructure and irrigation systems, especially in regions with previously moderate productivity. Meanwhile, districts like Ambala and Mahendragarh experienced a decline in cropping intensity, indicating potential challenges with resource depletion or limitations in agricultural expansion.

The southern and western districts, traditionally lower in cropping intensity, also witnessed moderate improvements. For instance, districts like Bhiwani and Rohtak increased their cropping intensity, moving from the low to medium category. Newer data for districts like Charkhi Dadri and Nuh also reflect moderate productivity levels, indicative of improvements in water management and adoption of crop varieties suited to local conditions. However, some areas, such as Mahendragarh, saw a decrease in cropping intensity, possibly due to declining groundwater levels or insufficient irrigation facilities. This variance across regions underscores the importance of localized agricultural policies to address specific challenges related to soil health, water availability, and climate.

Overall, the table and maps together highlight the dynamic changes in Haryana's agricultural landscape over

the past few decades. The increases in cropping intensity in many districts indicate successful interventions and advancements in agricultural practices, but areas with declining intensity or stagnation suggest the need for sustainable approaches. Policymakers and agricultural experts can leverage this data to focus on regions that need better infrastructure, sustainable water usage practices, and resilient crop varieties, ensuring balanced agricultural development across Haryana.



Source: Compiled by Researcher

IV. CONCLUSION

The analysis of cropping intensity in Haryana from 1990-91 to 2022-23 reveals notable shifts in agricultural productivity and resource management, influenced by advancements in irrigation, infrastructure, and policy support. Districts like Karnal, Sonipat, and Jind, which initially had high cropping intensities, have benefitted from fertile soil and water access, leading to sustained productivity. The significant improvement across districts such as Panchkula, Yamunanagar, Kurukshetra, and Kaithal suggests successful efforts to enhance agricultural infrastructure and irrigation systems, pushing their cropping intensities to or above 200%. These advances reflect effective policy and resource allocation that bolstered farming practices in previously moderate-intensity regions. However, the decline in districts like Ambala and Mahendragarh signals challenges, possibly from resource depletion or limited expansion options, highlighting the importance of sustainable practices and localized interventions.

Southern and western districts, traditionally limited by arid conditions, have shown moderate improvements, indicating successful water management and adaptation of crop varieties to local conditions. Still, certain areas continue to face challenges that need targeted solutions, such as groundwater depletion or insufficient irrigation infrastructure, as seen in Mahendragarh. The data overall underlines the evolving agricultural landscape in Haryana, where increased cropping intensity across many districts points to beneficial developments, yet the decline in some regions signals the need for careful resource planning and resilience-building measures. Policymakers and agricultural experts can use these insights to prioritize support for sustainable water use, resilient crop choices, and infrastructure enhancements tailored to regional needs, fostering balanced growth across Haryana's diverse agricultural zones.

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