# Spatio-Temporal Analysis of Cropping Pattern Changes Using Remote Sensing and GIS: A Case Study of Bhiwani District, Haryana

Kapil[1], Deepa[2]

[1]Department of Geography, Chaudhary Bansilal University, Bhiwani

[2]Department of Geography, Chaudhary Bansilal Govt. College for Women, Tosham

Received : 24-02-2026 Accepted : 15-03-2026

## Abstract

The current study aims to examine the patterns and variations in the area under significant crops in the Kharif and Rabi seasons using Landsat satellite data in the Bhiwani district of Haryana through unsupervised classification in the ERDAS IMAGINE 2014 software. Three time periods—2000, 2010, and 2020—were covered by the study. The study finds common crops, including cotton, rice, wheat, and mustard, using the main spectral bands (Bands 3, 4, and 8) used for vegetation analysis. The gram area has decreased, while rice, cotton, and mustard crops have taken over the study area, according to an analysis of cropping trends. Fertilizers, groundwater, and canal irrigation have led to an increase in rice and cotton production. In some locations, mustard has taken the place of the formerly planted gram. This study also shows how geospatial technologies, which provide informed agricultural planning, improve food security, maximize crop productivity, and increase climatic resilience. The findings provide a foundation for sustainable agricultural management techniques, enabling efficient land use and long-term agricultural output in Bhiwani District.

**Keywords**: Digital image processing (DIP), GIS, Landsat, Cropping patterns, Bhiwani, Haryana.

## Introduction:

A cropping pattern refers to the proportionate area under different crops during anagricultural year (Panwar K., 2024). Sustainable farming systems depend heavily on agricultural cropping patterns, which are impacted by a number of environmental, socioeconomic, and physical factors. Contemporary research has utilized sophisticated remote sensing technology and geospatial tools to examine and chart these trends, providing significant perspectives for enhancing agricultural output and resource administration. There have been many changes that have taken place in the croppingpattern of Haryana since the green revolution during the 1960s to the dates (Kumar,V., 2014). One of the most significant factors influencing the economic benefits of agricultural changes

in a region is the type of cropping pattern changes. Stated differently, the cropping pattern of a region indicates that a farmer's crop selections priorities one crop over a rival crop.

An important application of remote sensing is in agriculture. GIS technologies help determine the potential yield, soil conditions with NDVI, the degree of infestation or stress damage, and the health of crops. Agricultural practice monitoring, crop health and viability evaluations, and crop classification are all carried out using satellite and aerial imagery as mapping tools.

Several researchers at the local, state, national, and international levels have carried out several studies on shifting crop patterns. Crop diversification and cropping system sustainability were the primary subjects of the earlier research.

Lata, A., (2015) studied "Agricultural change during the post-reform period in Haryana".This outcome demonstrates how land usage, productivity, intensity, cropping patterns, and human activity changed in Haryana's agricultural fields after the reform.

Rawat, S.D., and Bala, S., (2021) shared "Changing Cropping Pattern in Haryana: A Spatio-temporal Analysis of Major Food Crops". As a result, throughout the 2001–2018 reference periods, there is geographical variance in the net sown area of wheat and rice production.

Gautam. R. and Sangwan. B., (2021) Compared to the area under pluses, sugarcane, bajra, maize, barley, and jowar, the shaded result shows an increase in rice and wheat.

Panwar K, Airon A, Kaswan R, Bishnoi KB.,(2024)studied "Changing crop pattern in western agroclimatic zone (South Western Parts) of Haryana using geospatial techniques". An examination of the study area's cropping patterns showed that the gram area had decreased while rice, cotton, and mustard crops had taken over.

**Objective of the Study:**

The specific objectives of our study are:

1. To identify the area and distribution of crops in study area.
2. To generate an information on cropping pattern of Bhiwani district for 2000, 2010 and 2020.
3. To make temporal analysis of changes in cropping pattern.

**Study Area:**

The study area of this research work Bhiwani is the district of the western Haryana state, with 3283 square kilometers area located from 28°19'Nto29°05'N latitudes and75°26'to76°28' E longitudes (fig.1).Geographically, it is located on the western part of Haryana and is surrounded by various neighboring districts like Hisar, Hansi to the north, and Rohtak to the east, Charkhi dadri and

Mahendergarh to the south and some area of Jhunjunu and Churu districts of Rajasthan on its west. The range of temperatures in the Bhiwani District is 2 to 45 degrees Celsius. The Bhiwani District is known for its construction stone, gypsum, and flexible stones in the villages of Dulheri, Khanak, and Dadam. In tehsil Tosham, as well as crops such as bajra and cotton during the kharif season and wheat and mustard during the Rabi season. There is little rainfall (483 mm annually), mostly in July and August. Vegetation, primarily prickly plants like janti and babool. The soils of the belt are grouped as Aridisols and Entisols. The soil is light-textured, sandy loam. Major crops are in this area: wheat, cotton, gram, bajra and rice (Singh et al.2010).

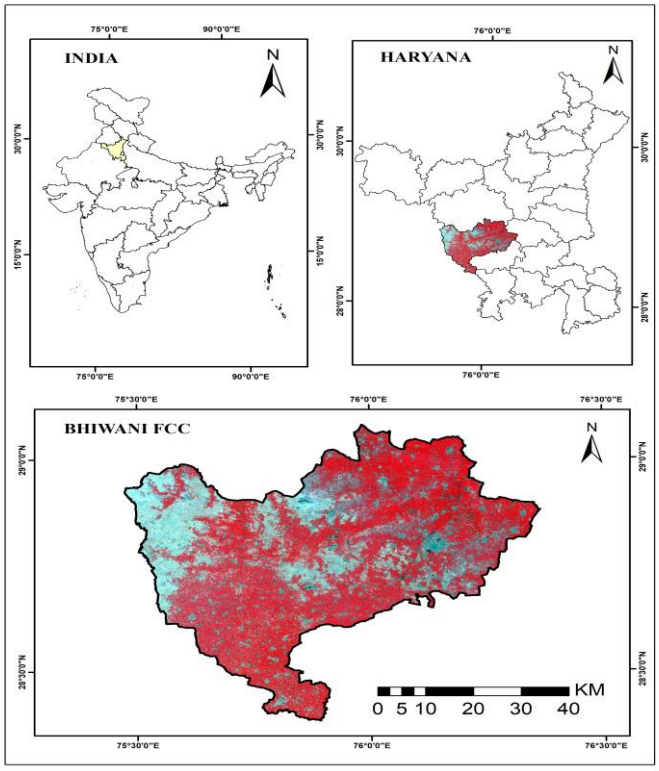


**Fig. 1 Location map of study area**

**Research Methodology and Data Base:**

The ERDAS IMAGINE 2014 software's window platform was used in this work to analyses digital images. A comprehensive enumeration approach was employed to examine the cropping pattern of the research area for the years 2000, 2010, and 2020. Satellite images from LANDSAT 4-5, 7, and 8 were unsupervised classification based on reflection and matching Google Earth photos, land use classes were determined. The satellite is a useful tool for environmental monitoring, disaster response, and sustainable resource management worldwide because of its high-resolution photography, frequent revisits, and open data policy.

(i) Primary Data:

The USGS website primarily provided satellite data with the best spatial and temporal resolution (LANDSAT series 4-5, 7 and 8). There were 5, 4, and 3 bands in the LANDSAT 4-5, 7 and 8 photos, but the bands in the photographs used were 4, 3, and 2.

(ii) Secondary Data:

The secondary data from the statistical abstract of Haryana for the years 2000, 2010, and 2020 were accessed.

**Table: 1 Details of satellite data used in the present study:**

| Sr. No. | Satellite/Sensor | Path | Row | Date of Scene |
|---|---|---|---|---|
| 1 | LANDSAT-4&5<br>Band 2 (0.52-0.60 µm)*<br>3 (0.63-0.69 µm)<br>4 (0.76-0.90µm) | 147 | 40 | 21/02/2010,3/09/2010 |
| 2 | LANDSAT-7<br>Band 2 (0.52-0.60 µm )<br>3 (0.63-0.69 µm )<br>4 (0.77-0.90 µm ) | 147 | 40 | 18/02/2000,13/10/2000 |
| 3 | LANDSAT-8<br>Band 3 (0.53-0.59 µm )<br>4 (0.64-0.67 µm )<br>5 (0.85-0.88 µm ) | 147 | 40 | 17/02/2020,28/09/2020 |

* Wavelength (micrometers)

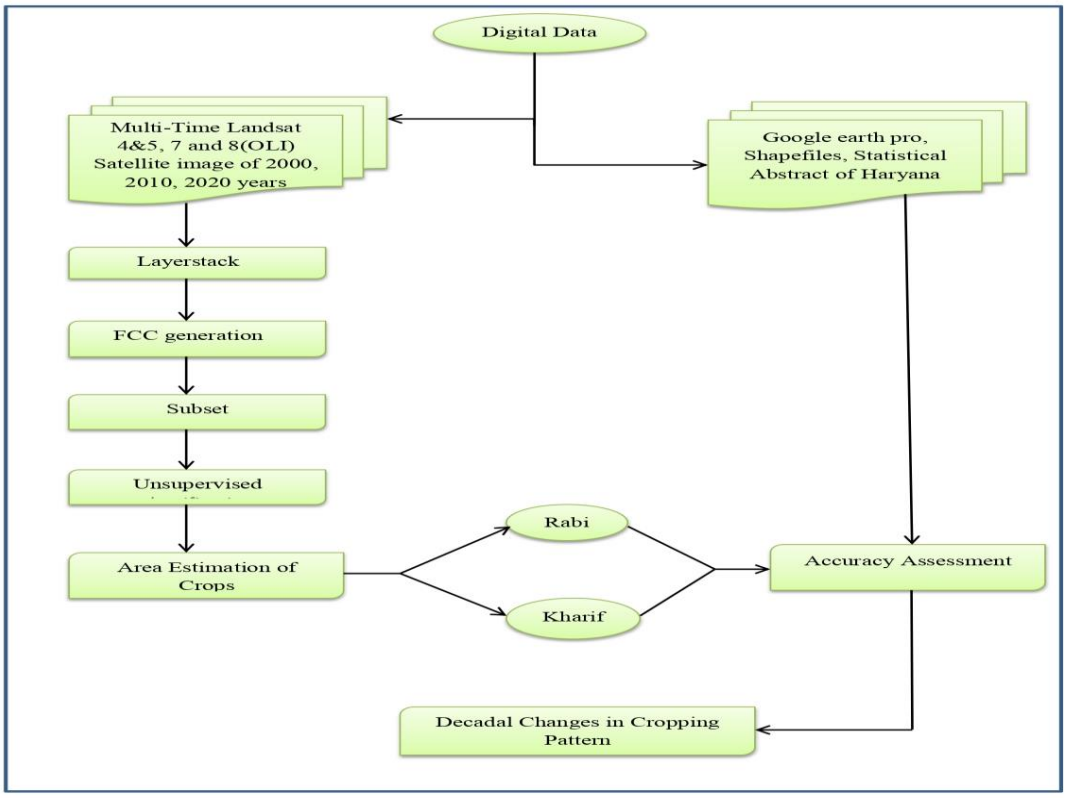


**Fig. 2 Methodology flow chart**

**Unsupervised Classification:**

Unsupervised classification is a method in which the computer searches for natural groupings of similar pixels called clusters(Jensen2015). ERDAS imagine software performs unsupervised classification using the Iterative Self-organizing Data Analysis Technique (ISODATA) method. Using this method, the analyst inputs the required number of clusters and a confidence level. Following the completion of the image's spectral improvements, an unsupervised classification using ISODATA was carried out with 36 classes and a 98% confidence level. A maximum of 36 iterations was established. The end product was a picture of 36 pixel groupings, each of which was coloured differently. To identify the classes, each class was highlighted one at a time. The original multispectral image was then interpreted to determine which land use each class belonged to. In order to detect vegetation, the image's NDVI was also created and compared with each class. Each class was then assigned a colour, such as rice and mustered in yellow, and wheat and cotton in green, along with a unique label and code in the attribute table.

**Result, Discussion and Findings:**

**Rabi Season**

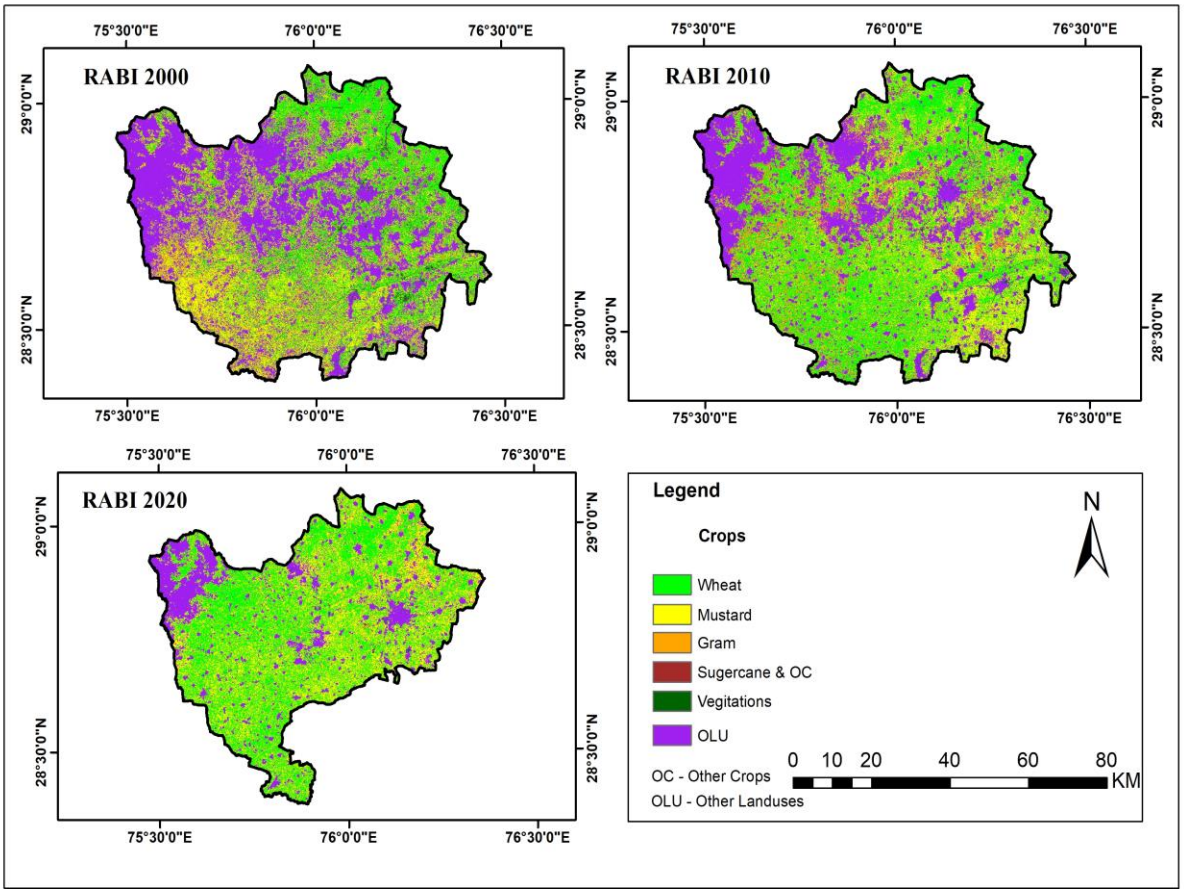


**Fig 3: Comparison of Rabi season crop area maps**

Rabi crops (October to March) of 2000 (2000–2001), 2010 (2010–2011), and 2020 (2020–2021), which include wheat, mustard, gram, and sugarcane, are representative of this study region. With 140.7 hectares, wheat was the most common crop, followed by mustard and gram, with 107.4 and 44.3 thousand hectares, respectively, on the maps from 2000 to 2001. Other land uses, such as highways, villages, water bodies, and fallow lands, are represented by the purple pixel. When this classified area was compared to the statistical abstract (2000–2001), minor differences were found in the area of various crops, such as wheat (0.7%), mustard (2.55%), and gram (3.36%).

The Rabi 2010–11 categorized images showed 155.9 thousand hectares of wheat, 135.8 thousand hectares of mustard, and 60.7 thousand hectares of gram. Between 2000 and 2011, or ten years, the mustard area grew. The crop area divergence between the 2010–11 data records was quite modest, with gram being 3.4%, mustard being 1.4%, and wheat being 0.8%. Additionally, it was discovered that the area of fallow land had shrunk in 2010.

From Bhiwani district, Charkhi Dadri created a new district in Haryana in 2020–21. The Rabi 2020–21 maps showed that the crop area was 18.7 thousand hectares for gram, 104 thousand

hectares for wheat, and 149 thousand hectares for mustard. This Rabi season (2020–21) has seen a 3.15% growth in wheat area compared to the 2010–11 Rabi season. Although the gram area had shrunk, it was not precise enough to be categorized as open land or pixels mixed with fallow. The primary cause of the decrease in grams was that in some areas, it had been replaced by the mustard crop, which had risen from Rabi in 2010–11.

**Table: District-wise crop areas at different times are shown in the table:**

**Area in ('000 ha.)**

| Remote sensing data | | | | | | Statistical Abstract data | | |
|---|---|---|---|---|---|---|---|---|
| **Districts** | **Crops** | **Years** | | | | **Years** | | |
| | | **2000** | **2010** | **2020** | | **2000** | **2010** | **2020** |
| **Bhiwani** | Wheat | 140.7 | 155.9 | 104 | | 140.0 | 156.6 | 107.4 |
| | Mustard | 107.4 | 135.8 | 149 | | 108.8 | 138.6 | 143.5 |
| | Gram | 44.3 | 60.7 | 18.7 | | 47.2 | 58.1 | 16.1 |
| | Rice | 8.1 | 18.6 | 26.6 | | 7.3 | 19.0 | 26.4 |
| | Cotton | 53.1 | 30.9 | 105.8 | | 50.5 | 32.8 | 101 |
| | Bajra | 194.6 | 180.9 | 87.7 | | 196.4 | 172.1 | 80.8 |

■ **Rabi crops** ■ **Kharif crops**

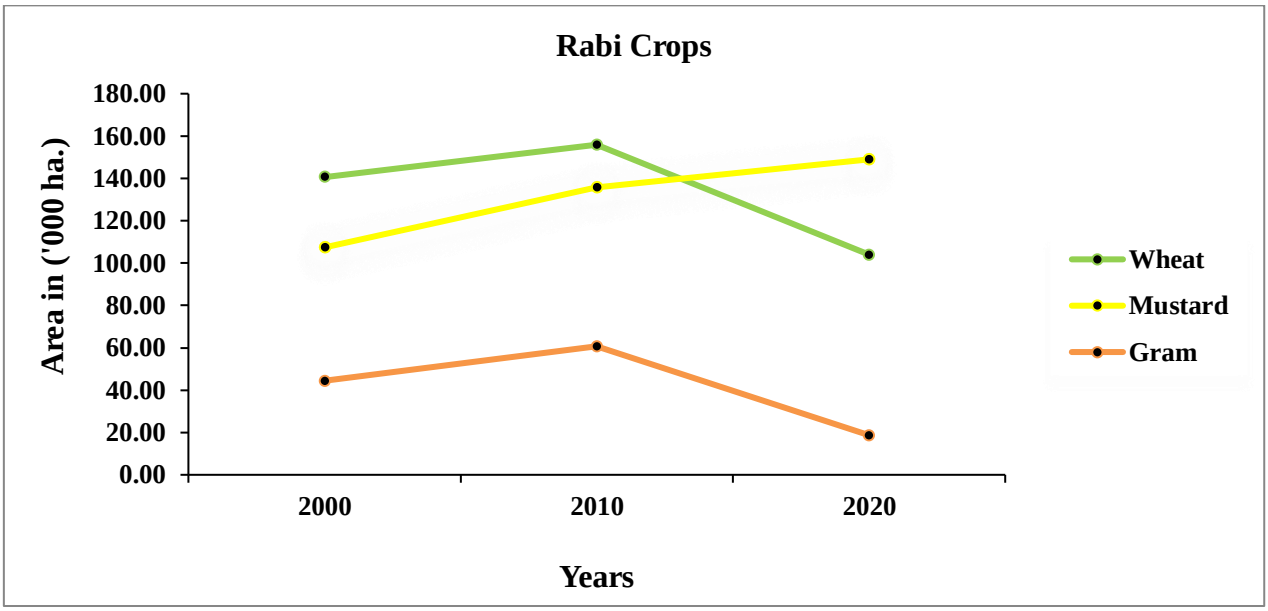


**Fig. 4 Comparison of crop area over three decades**

This research of Rabi cropping patterns shows that whereas the mustard area rose and the gram area drastically reduced between 2000 and 2020, wheat and sugarcane crop areas did not see any significant changes. Due to the usage of fertilizers and tube-well irrigation, a significant portion of

the gram was reduced in the district Bhiwani. In recent decades, mustard has emerged as a significant crop in the western region of Haryana.

**Kharif Season**

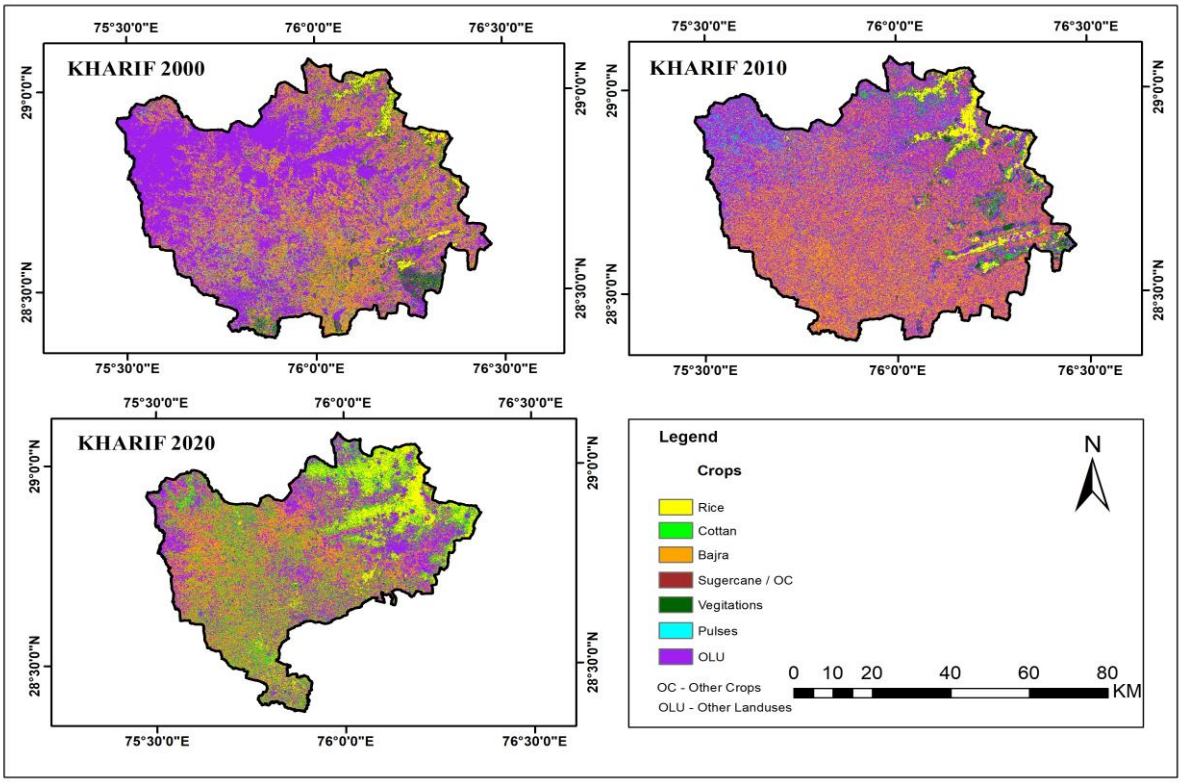


**Fig. 5 Comparison of Kharif season crop area maps**

In 2000, cotton, rice, bajra, and pulses were the kharif crops harvested. Bajra accounted for 194.6 hectares, cotton for 53.1, and rice for 8.1 thousand of the unsupervised classified area. The 2010 map indicates that the crops occupying 18.6 thousand hectares are rice, 30.9 thousand hectares are cotton, and 180.9 thousand hectares are bajra. When data were compared to the kharif of 2000, rice grew by 43.54% while cotton fell. In areas of Bhiwani, the rice acreage unexpectedly expanded as a result of irrigation facilities. In the district's western region, the cotton acreage shrank. For example, rice (19.0), cotton (32.8), and bajra (172.1) have statistical abstract records from 2010 that show minimal deviation from remote sensing image categorized data.

In the map 2020, the classification showed a rice area of 26.6 thousand hectares, cotton at 105.8 thousand hectares, and bajra at 87.7 thousand hectares. The area very highly increased in rice,cotton and Bajra decreased. Cotton areas are increasing on a large scale in Bhiwani district due to high-quality seeds, canal and tube well irrigation. Errors in classification with gazetted data were rice (0.3%), cotton (2.5%), and bajra (2.4%).

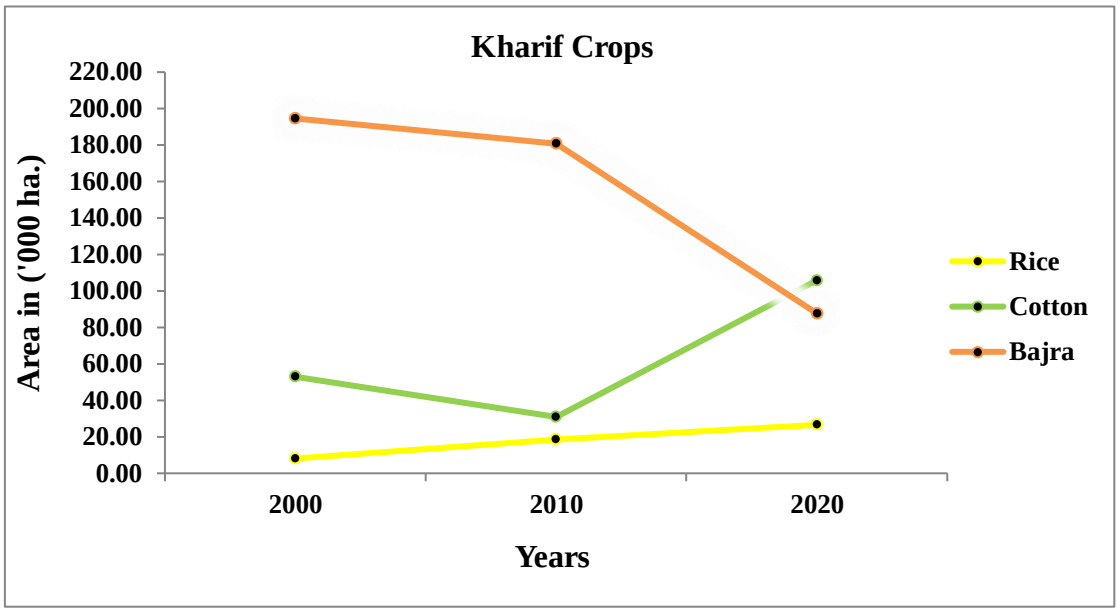


**Fig. 6 Comparison of crop area over three decades**

This kharif crop chart shows that the area planted to rice has significantly expanded between 2000 and 2020. The area planted to rice increased from 8.1 thousand hectares in 2000 to 26.6 thousand hectares in 2020. Bajra fall, but cotton area grew in highly amount. Hybrid seeds and modern irrigation technologies were the primary causes of the expanded crop area. The districts Bhiwani saw increases in rice and cotton acreage.

**Conclusion**:

The current study found that, whereas the area under Gram has significantly dropped (103%), primarily in western Bhiwani, the mustard crop (Rabi season) has increased significantly in the district from 2000 to 2020. In this region, wheat and mustard took the place of gram due to the greater availability of irrigation. The hybrid nature of seeds and chemicals was another potential cause. From 2000 to 2020, rice and cotton harvests were the most popular crops during the kharif season. The amount of land planted to cotton and rice had grown by 60%. Along with enhanced seed quality, more and better irrigation facilities, such as lift-canal irrigation and sprinklers, could enable the expansion of rice and cotton regions. The changing cropping patterns in this arid to semi-arid region also raise environmental concerns about sustainable development.

**References:**

1. Gautam, R., & Sangwan, B. (2021). A geographical analysis of changing cropping pattern in Haryana. *Turkish Online Journal of Qualitative Inquiry*, *12*(9), 3301–3332.
2. Jensen, J. R. (2015). *Introductory digital image processing: A remote sensing perspective* (4th

ed.). Pearson Education.

3. Kumar, V. (2014). Economic benefits and ecological cost of green revolution: A case study of Haryana, India. *International Journal of Enhanced Research in Education Development, 2*(6), 21–31.
4. Lata, A. (2015). Agricultural change during post reform period in Haryana (Doctoral dissertation, Maharshi Dayanand University, Rohtak, India).
5. Panwar, K., et al. (2024). Changing crop pattern in western agroclimatic zone (south western parts) of Haryana using geospatial techniques. *Research Journal of Agricultural Sciences, 15*(2), 352–356.
6. Rawat, S. D., & Bala, S. (2021). Changing crop pattern in Haryana: A spatio-temporal analysis of major food crop. *International Journal of All Research Education and Scientific Methods, 9*(3), 212–225.
7. Singh, A., et al. (2010). *Agroclimatic atlas of Haryana*. AICRP on Agrometeorology,CCS Haryana Agricultural University Hisar.
8. Economic and Statistical Adviser, Planning Department, Government of Haryana. (2000). *Statistical abstract of Haryana*. Government of Haryana.
9. Economic and Statistical Adviser, Planning Department, Government of Haryana. (2010). *Statistical abstract of Haryana*. Government of Haryana.
10. Economic and Statistical Adviser, Planning Department, Government of Haryana. (2020). *Statistical abstract of Haryana*. Government of Haryana..
11. U.S. Geological Survey. (n.d.). *Earth Explorer*. Retrieved December 2025, from https://earthexplorer.usgs.gov/.
12. Google LLC. (n.d.). *Google Earth Pro* (Version 7.3.1) [Computer software]. Retrieved December 24, 2025, from https://www.google.com/earth/versions/.