IOSR Journal of Applied Geology and Geophysics (IOSR-JAGG)
e-ISSN: 2321–0990, p-ISSN: 2321–0982.Volume 13, Issue 6 Ser. I (Nov. – Dec. 2025), 01-09
www.iosrjournals.org

Analysis Of Cropping Pattern Dynamic Changes Using Geospatial Technology in Ellenabad Block of District Sirsa

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Abstract
Cropping pattern and crop rotation show the spatial and temporal arrangements of crops in the same area across different seasons. Agriculture is influenced by several factors such as soil type, climate change, socio-economic conditions of farmers and irrigation facilities. Studying cropping patterns helps in understanding land use efficiency, sustainability of the agriculture system and crop diversification. Over time, cropping pattern change due to technological advancements, changing environmental condition, and market demand. Geospatial technology is emerging as a vital tool in agriculture practices, enhancing efficiency by saving time and resources, and providing accurate and actionable information. Therefore, with the help of geospatial technology, it is possible to easily monitor agriculture changes over a large area for the development and management of an agriculture ecosystem. The study has been conducted for the ***Ellenabad block*** *of Sirsa district of Haryana state (India) based on multi-dated* ***sentinel 2*** *data for the year* ***2024-25****. The study of this cropping pattern has been conducted using Geospatial technology's software,* ***Erdas Imagine 2014*** *and* ***ArcGIS 10.8*** *software. An unsupervised digital image classification method has been used, and the* ***Isodata*** *technique was applied to derive the cropping pattern. The major crops in crop rotation like; Wheat-Rice= 46.3% / Wheat-Cotton= 13.0% / Mustard-Cotton= 7.8% of the total geographical area of the Ellenabad block.*
Key Words: *Cropping Pattern, Crop Rotation, Unsupervised Classification, Spatial-Temporal Analysis*

I. Introduction

At international level agriculture plays a very important role. It also helps in improving our food security, reduces poverty. Total population of India is 12.10 Crore. Out of which, the urban population is 31.16% and the rural population is 68.84% (Census of India 2011) **[1].**Approximately 21.9% of India's population was living Below the Poverty. According to (10th Agriculture census report 2015-16) **[2]** total operational land is 146.45 million.

Due to the increasing population, the demand for food is rising in every country, whether it is a developed, developing or underdeveloped nation. In particular, in Southeast Asia; India, the growing population is causing a significant increase in food demand.

Sirsa is the largest district of Haryana, and Ellenabad block constitutes one of its administrative divisions. The region is primarily characterized by the cultivation of two major cropping seasons, Rabi and Kharif. In the Ellenabad belt, the northern part is influenced by the presence of the Ghaggar River, which ensure adequate water availability. Consequently, the areas adjacent to the Ghaggar belt exhibit intensive cultivation of rice and wheat. The rate of cropping intensity is very high in Ellenabad block because the agro-climatic conditions and irrigation facilities are both favorable. Therefore, the agriculture land degradation is quite serve here due to waterlogging and alkalinity, over exploitation of water and monocropping practices. Here, most farmers cultivated two crops-Rabi or Kharif- but in some areas, triple cropping is also practiced (with fodder crops or short duration crops).

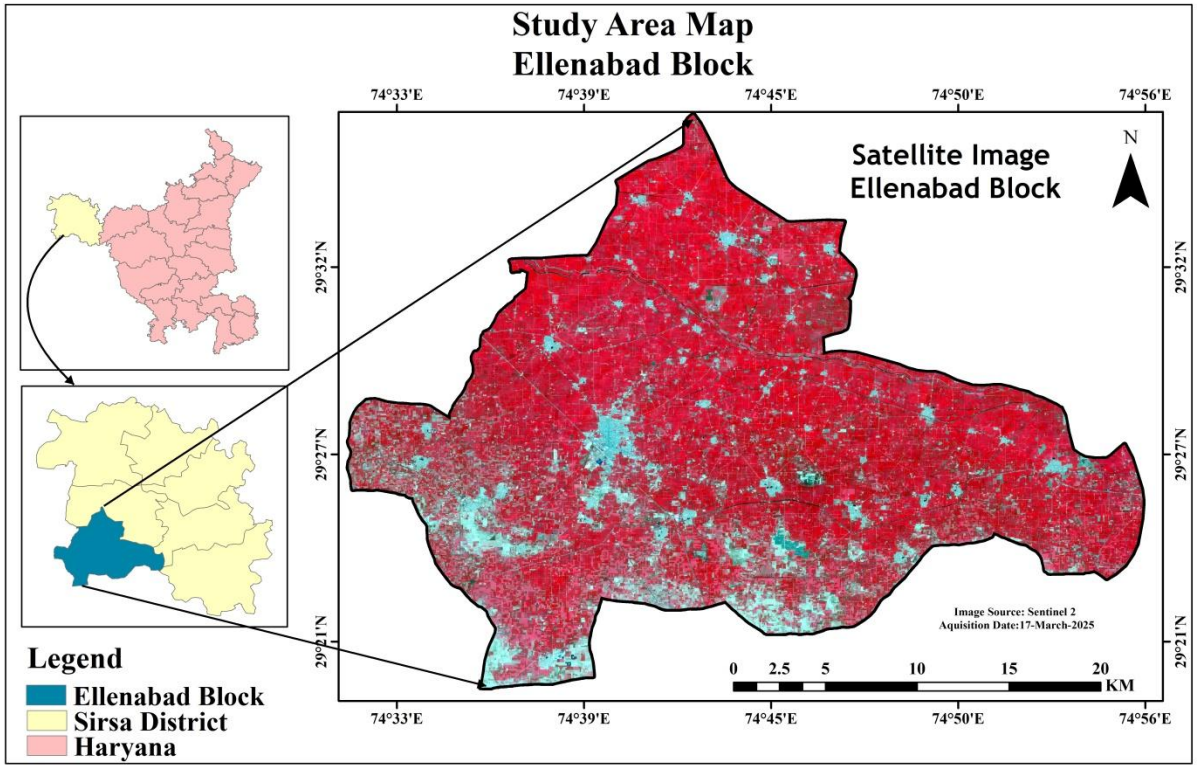
Many researchers have conducted studies in this field. (*Kumar and Kumar, 2020)* **[3]** tried to assess the Analysis of Cropping System Using Geospatial Technology with Remote sensing geo-coded digital data of multi-dated and multi-season of (2018-19) Sentinal-2A/B in Nathusari Chopta Block of Sirsa District (Haryana).They have used unsupervised classification in this study. In this classification, they have applied the isodata clustering classifier method. (*Savitpal et Al., 2015)* **[4]** tried to assess the Geospatial Technology Based Cropping System Analysis & Management with IRS P6 LISS-3 data of 2000-08 of both seasons of Sampla Block, Rohtak, Haryana. (*Nathaniel Blessing, 2025)* **[5]** tried to assess the Temporal and spatial variability of Cropping Pattern in the Punjab region of Pakistan using time-series data from the Moderate Resolution Imaging Spectroradiometer (MODIS) Normalized Difference Vegetation Index (NDVI) spanning 2000 to 2023.

(Dr. Parveen, 2024) **[6]** tried to assess the analysis of crop rotation using Geospatial Technology with Remote sensing data of 1990-1991 to 2021-2022, Landsat-5 images acquired in February 1991 (Rabi season) and August 1989, September 1991 (Kharif season) were compared with Sentinel-2 images from February 2022

(Rabi season) and August 2021 (Kharif season) in North-western Haryana. They have used Supervised Classification in this study. Crop rotation represents the systematic sequence of cultivating different crops on the same parcel of land during different seasons. For instance, when rice is cultivated in the Kharif season and Wheat is grown on the same land in the subsequent Rabi season, it is referred to as a Rice-Wheat crop rotation system. *(Mubashir Jamil, 2016)* **[7]** tried to assess the cropping system efficiency pattern using remote sensing and GIS with Remote Sensing Satellite (IRS)-P6 LISS III data of 2014-15 of Bijnor District, India. They have used unsupervised classification in this study. A multi-phased unsupervised ISODATA classification was used in their study.

II. About Study Area

Haryana's Sirsa district is in its southwest region. As one of the primary agricultural districts in the state, Sirsa has geographical coordinates of 29°14' – 30°00' N latitudes and 74°29' – 75° 18' E longitudes. The district is approximately 4,277 square kilometers, and seven administrative blocks: Sirsa, Ellenabad, Rania, Odhan, Baragudha, Nathusari Chopta, and Dabwali. Our study area is the **Ellenabad Block**, Which is the main administrative block of Sirsa district. Geographically, it lies between **29°05' to 29°35'N** latitude and **74°30' to 74°55'E** longitude. This block covers an area of approximately 600 square kilometers and shares its boundary with Rajasthan to the southwest. The highest temperature here during the summer season ranges from **35°C** to **47°C** and the lowest temperature during the winter season ranges from **5°C** to **28°C**. This region is the part of the **semi-arid zone**, characterized by **hot summers, low rainfall and mild winters.** Here the **Ghaggar River** flows through the northern part, serving as a source of irrigation. Here the main occupation of the people is farming and the major crop for (Rabi season) Wheat and Mustard, and (Kharif season) Rice and Cotton.



Map: 1.1 Study Area Map of Ellenabad Block

III. Methodology Chart

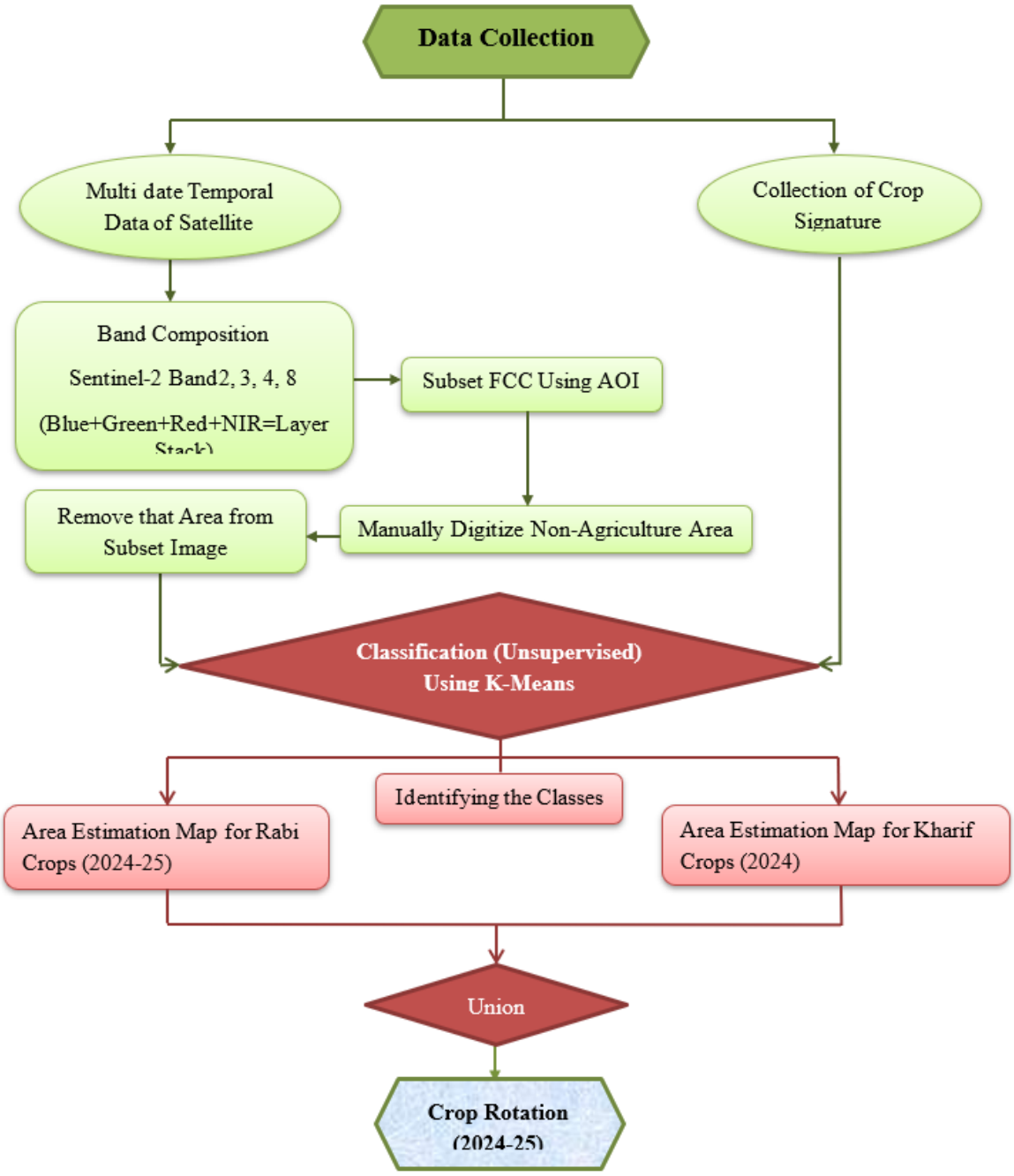


Figure: 2.1 Flow Chart

Firstly, select the area where you want to conduct your study, whether it is a district, block and village. Here, our study area is the Ellenabad block, which falls under the Sirsa district.

IV. Data Obtained

A. Secondary Data:- Firstly, download your image from the Copernicus earth observation programme specially designed for earth observation. Sentinel-2 provides a high resolution temporal data. Sentinel 2 Multi Spectral Instruments (MSI) captures images in 13 different bands which helps the study of different types of vegetation and land indices. Temporal data through a 5 day high revisit frequency from a constellation of two satellites—Sentinel 2A and Sentinel 2B—Designed for high resolution optical imaging of earth.

Image Date:

- **For Rabi Crop-**15 February 2025
- **For Kharif Crop-**13 September 2024

B. Primary Data:-The primary data source for studying cropping patterns can be obtained from ground surveys, farmer interviews and block level agriculture office interviews.

V. Methodology

Download the sentinel 2 image from Copernicus earth observation programme for estimation of cropping pattern of Rabi and Kharif crops and extracted from the zip format and subsequently opened in ArcMap 10.8 for further analysis. The resolution of Sentinel 2 image is 10 meter for its four visible and near-infrared bands, 20 meter for its six red edge and shortwave infrared bands and 60 metres for its three atmospheric bands.

1) Band Composition:- Band Composition in Remote sensing and GIS means that each satellite band provides data at different wavelength e.g. (Red, Green, Blue, NIR, SWIR etc.) By performing band Composition, We combine all these bands into a single composite image so that classification, Land Use/Land Cover mapping can be carried out afterwards. This is very useful for certain features like vegetation, soil, built-up area and water.

Examples:-

- **True colour Composite:-**It shows those features on earth which are visible to the human eye. R=B4 (Red), G=B3 (Green), B=B2 (Blue). In this earth look like a real vision.
- **False colour Composite:-**It is an image visualization technique in which different spectral bands are combined to create a image, making it easier to differentiate ground features such as vegetation, soil; and water bodies. NIR (Band 8), Red (Band4), Green (Band 3).

2) Subset:-In remote sensing and GIS, Subset means extracting a smaller area of a dataset (Raster or vector) from a larger area. For Example:-If you have sentinel 2 imagery of the entire Haryana, and your AOI is Sirsa district, then this method will be useful.

After composite bands the sentinel 2 imagery, we performed a clipping operation using the Ellenabad block boundary, resulting in a raster image restricted to the Ellenabad block area.

3) Digitization:- The meaning of digitization is that ground features like: built-up areas, roads and water bodies etc., are traced and stored in vector format (point, line, polygon). After this, only the agriculture area remains.

4) Remove Non-agriculture Area:-Exclude non-agriculture areas (such as roads, ponds, and urban regions) from the subset image to retain only the agricultural areas. So that cropping pattern classification can be performed on it.

5) Unsupervised Classification:-Unsupervised classification is a machine learning technique where the data is unlabelled. This classification groups together pixels that are similar, and then we assign a class to them according to their signatures. In this classification, we have used the K-Means method. This technique is helpful for identifying ground features.

6) Cropping Pattern of Rabi & Kharif Crops:- It shows the arrangement of India's two main agriculture seasons. It provides detailed information on the sowing and growing schedules of the two main cropping patterns.

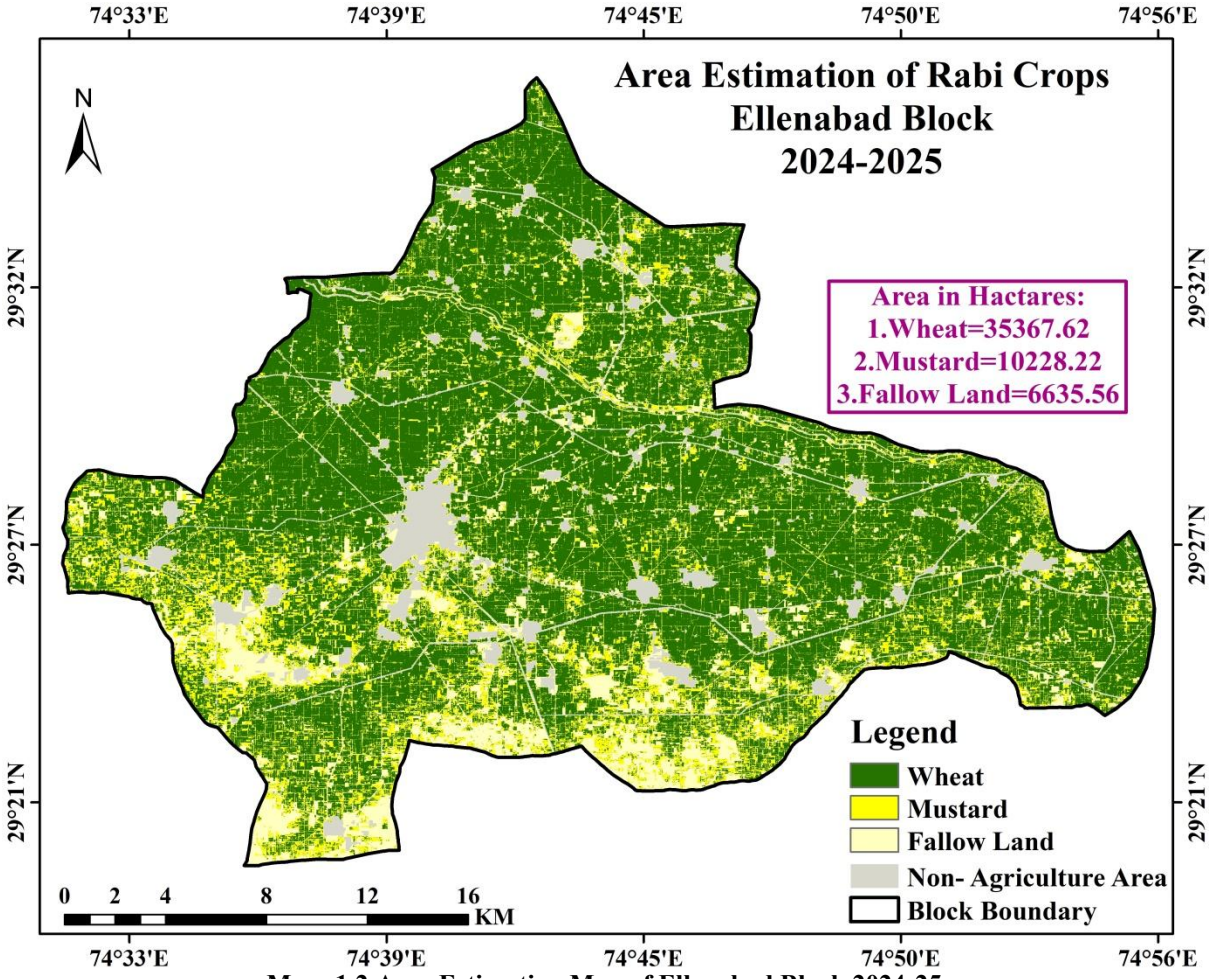
7) Two Crop Season:-

- **Rabi Crop:-** (November to April) Crops Grown in Winter Season. These Crops are sown around October to November and harvested around the March to April. Main Crops of Rabi season include Wheat, Mustard, Barley and Gram.
- **Kharif Crop:-** (June to October) Crops Grown in Summer & Monsoon Season. These Crops are sown during rainy season around June and harvested during the autumn season around September to October. Main crops of Kharif season include Rice, Cotton, Maize, Millets, Bajra and Jowar.

8) Union:-To observe the union of Rabi and Kharif crops, we first assess the area under Rabi crops, which major crops including wheat, mustard, barley, and gram. Similarly, the area under Kharif crops, which major crops such as rice, cotton, maize, millets like Bajra and Jowar, is examined. After evaluating both crop areas, a union operation is performed to determine the combined extent of the union. In this way, the union command is useful for the cropping pattern.

VI. Result and Discussion

Rabi is the major crops in India. Here, we have described the spatial distribution of the crops in our study area.



Map: 1.2 Area Estimation Map of Ellenabad Block 2024-25

In this Figure (1.2), we have described the Rabi season crops of the Ellenabad block. The dark green color represents wheat, the yellow color represents mustard, the light yellow color indicates fallow land and the light grey color shows the non-agriculture area.

TABLE: 1

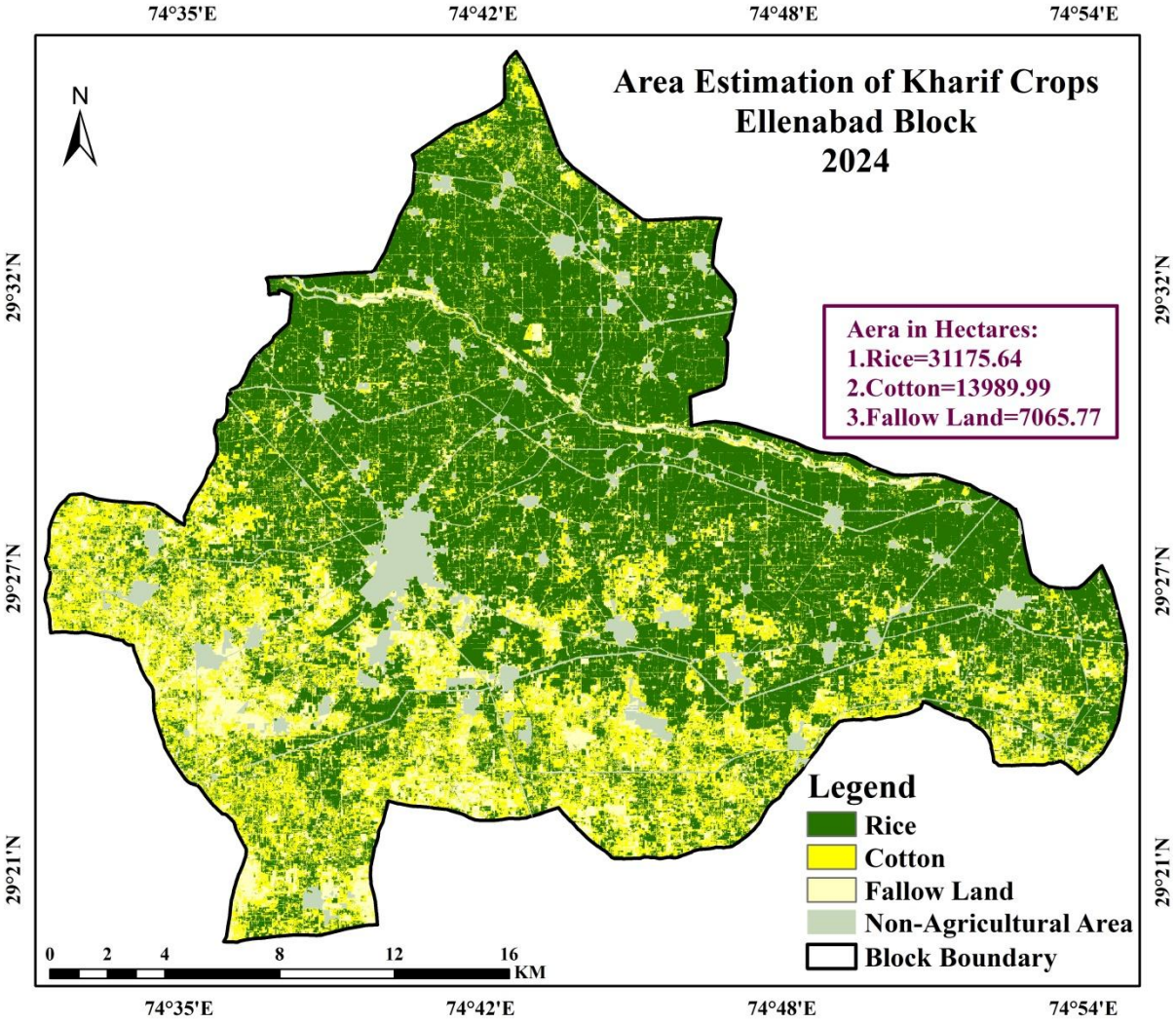
Sr. no.	Class	Area Estimation in (Hectares)	Area Estimation in %
1	Rice	31175.64	55.52
2	Cotton	13989.99	24.91
3	Fallow Land	7065.77	12.58
4	Non- agriculture	3918.57	6.97
	Total	**56146.97**	**100**

Table 1: Showing the total agriculture area of Rabi season in (ha) with percentage.

Analysis of **Rabi season** (February 2025) image showed that the Rice was the single major dominant crop, occupying an area of about 31175.64 ha, which accounts for 55.52% of the total geographical area of the study area (Table-1). Cotton was the 2nd major dominant crop, occupying an area of about 13989.99 ha, which

accounts for 24.91% of the total geographical area. The fallow land covers a total area 7065.77 ha, which accounts for 12.58% of the total geographical area. And the other part is non- agriculture area, which occupies the 6.97% of the total geographical area of the Ellenabad block. Rice is cultivated the most here because water availability is good due to the Ghaggar River.

Kharif are the major crops in India. Here, we have described the spatial distribution of the crops in our study area.



Map: 1.3 Area Estimation Map of Ellenabad Block 2024

In this Figure: 1.3, we have describe the Kharif season crops of the Ellenabad block. The dark green color represents Rice, the yellow color represents Cotton, the light yellow color indicates fallow land and the lightest green color shows the non-agriculture area.

TABLE: 2

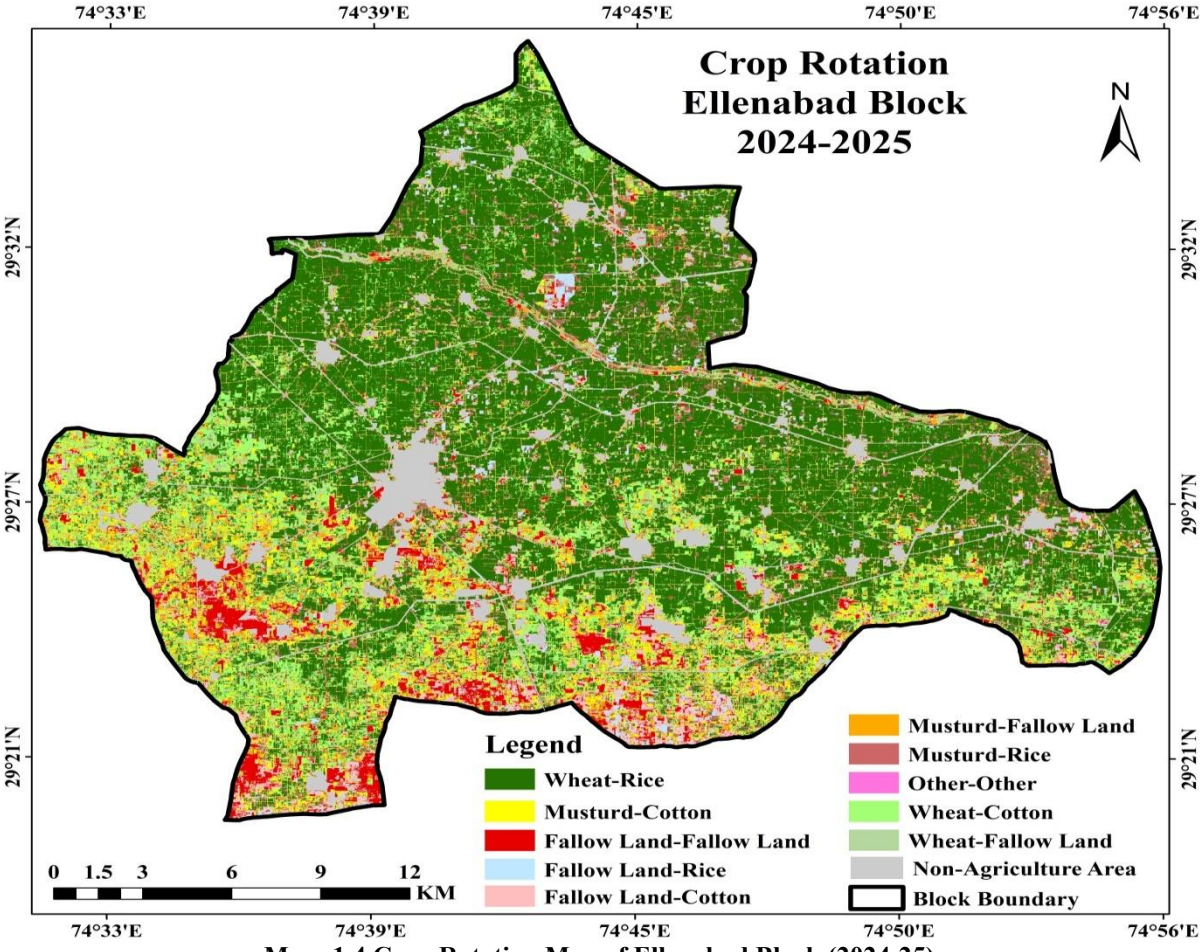
Sr. no.	Class	Area Estimation in (Hectares)	Area Estimation in %
1	Wheat	35367.62	62
2	Mustard	10228.22	18.21
3	Fallow Land	6635.56	11.81
4	Non- agriculture	3918.57	6.97
	Total	**56146.97**	**100**

Table 2: Showing the total agriculture area of Kharif Crops in (ha) with percentage.

Analysis of **Kharif season** (September 2024) image showed that the Wheat was the 1st major dominant crop, occupying an area of about 35367.62 ha, which accounts for 62% of the total geographically area of the study area (Table-2). Mustard was the 2nd major dominant crop, occupying an area of about 10228.22 ha, which accounts for 18.21% of the total geographically area of the study area. The fallow land covers a total area 6635.56 ha, which accounts for 11.81% of the total geographical area. And the other part is non- agriculture area, which occupies the 6.97% of the total geographical area of the Ellenabad block.

VII. Crop Rotation

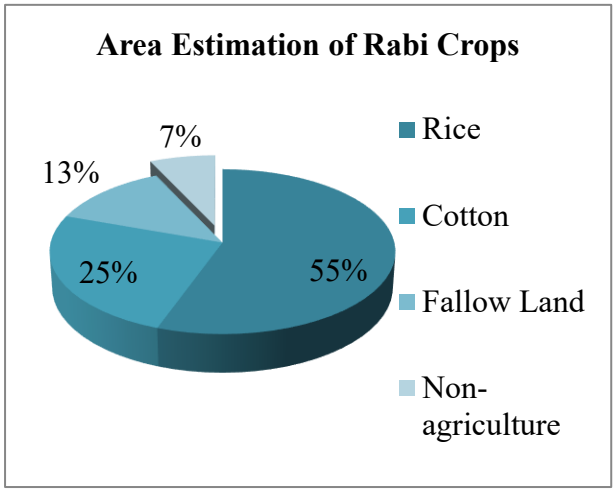
Crop rotation means the sequence of different crops grown on the same land in different season. For example, if wheat is grown on a particular field during the Rabi season, then rice is grown on the same field during the Kharif season. In this way, Crop rotation like: Wheat-Rice/ Wheat-Cotton/ Mustard-Cotton.



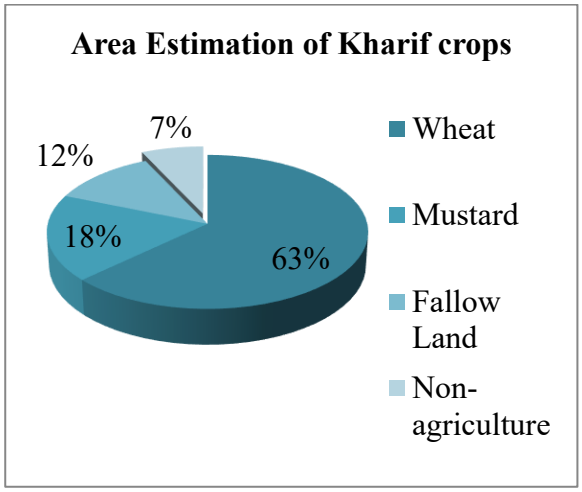
Map: 1.4 Crop Rotation Map of Ellenabad Block (2024-25)

This figure: 1.4, shows information about crop rotation. The major crop rotations include Wheat-Rice/ Mustard-Cotton/ Mustard-Rice.

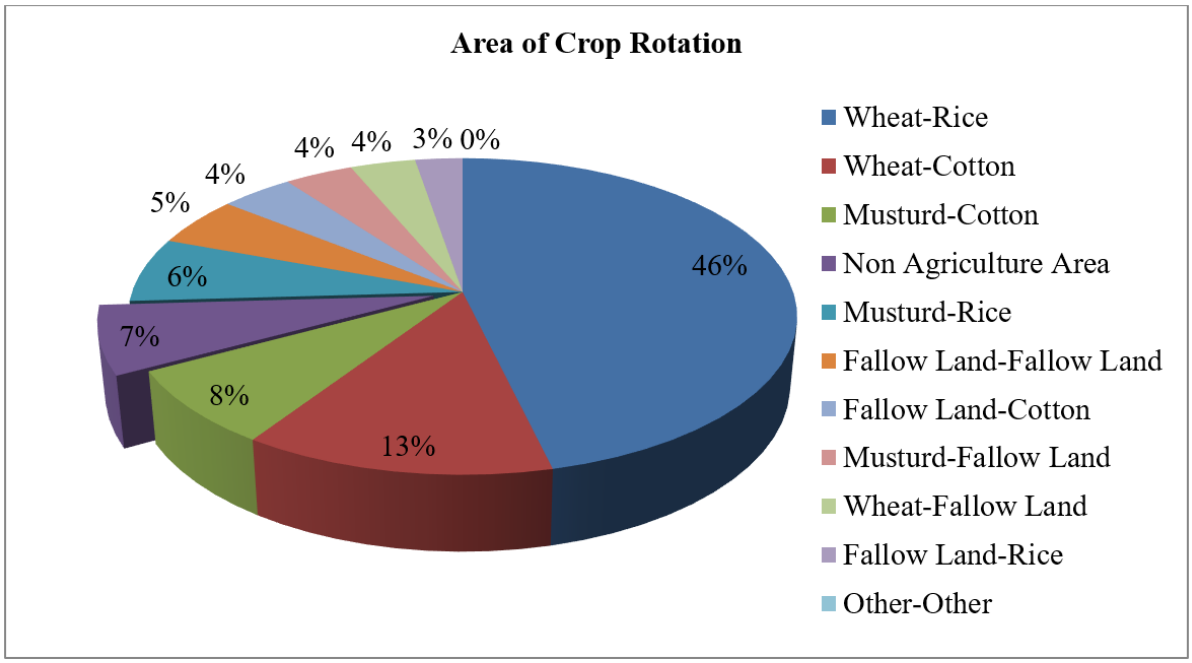
Pie Chart & Graph about Rabi crops, Kharif crops and the Crop Rotation:



(a)



(b)



(c)

In all these Charts, I have shown the distribution of Rabi, Kharif crops and crop rotation using pie chart **(a)**, **(b)** and **(c)**.

VIII. Conclusion

This study has proven that geospatial technology plays a vital role in the study of cropping pattern and crop rotation. It shows the spatial and temporal distribution of various crops. This study has been carried out using the K-Means method in unsupervised classification, through which the cropping pattern of the Ellenabad block has been analyzed in detail. After obtaining the data for Rabi and Kharif season, we also came to know about the cycle of crop rotation. This data belongs to the year 2024-2025, which can also be used for further agriculture and economic studies. In the northern part of the study area, crop rotation is higher because the Ghaggar River provides abundant water, leading to more Rice and Wheat cultivation. In Contrast, crop rotation is lower in the southern part due to presence of the sandy soil.

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