Cropping Pattern and Decadal change in Cropping Pattern of Charkhi Dadri District of Haryana using Remote Sensing & Geostatistical Technique.

Manju Kumari[1], Chander Shekhar*[2]

[1] M.sc. Geography, Govt. P.G. College, Hisar
*[*2] M.sc. Geoinformatics.*

Abstract: *Crop patterns are very important to understand when deciding how to use agricultural land. A variety of crops can be grown on arable land as cropping patterns change. The degree of variety increases with the level of competition. The fundamental benefit of studying crop zones is that it helps us comprehend how physio-socio-economic factors affect the agricultural environment. The study identified the crucial elements affecting Charkhi Dadri's agricultural output and suggested certain policy adjustments to increase output there. The methodology combines Geostatistical methods with optical remote sensing data from Landsat-8 (September 2022 and February 2022) and Landsat-5 (September 2011 and March 2011). It also uses an unsupervised classification system. It was discovered when it was easiest to tell agriculture from other types of land cover. The largest Mustard output is at Charkhi Dadri, followed by Bhiwani and Mahendergarh in Rabi Season. Charkhi Dadri is the highest recorded Cotton production in Kharif Season. The areas with the lowest rice output include all Blocks of the District. To increase the accuracy of the mapping, this map is validated by using GPS receivers to collect ground truth data in the study area. Using GIS and RS, a number of Supervised Classifications will be computed in order to assess the cropping system's effectiveness.*

Keyword: *Cropping pattern, Remote Sensing, Geographical Information System (GIS), Geostatistical Technique and Decade Change.*

I. Introduction:

Cropping patterns have received much study in the remote sensing literature, but historically, the majority of attention has been placed on mapping agricultural land and crop types. Over time, greater options for agricultural research emerged as a result of the expansion of satellite data availability and the quick development of remote sensing technologies, such as machine learning techniques.

Analysis of cropping patterns is crucial for examining agriculture's sustainability. The management of dynamic agricultural resources can now be done very effectively with the help of remote sensing and geographic information systems (GIS). Croplands may now be mapped and crop types can be determined at the local, regional, and international levels thanks to satellite imaging. In recent years, satellite data has proven to be a useful resource for gathering accurate, timely, and cost-effective information.

The green revolution in India started in the 1967s and increased food production by introducing high-yield crop types and using modern farming methods. Haryana's agriculture is significantly impacted by the Green Revolution. Recent years have seen a growth in the area and production of some crops, particularly rice and wheat, as a result of the commercialization of state agriculture's relationship with a few particular crops. This has an impact on the area and production of other crops as well.
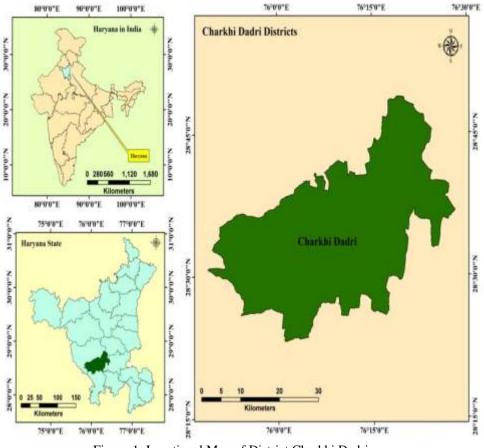
One of the crop management strategies that can accelerate sustainable intensification is the use of certain cropping patterns. The sequencing and spatial arrangement of yearly crops on a plot of land are referred to as cropping patterns. Agricultural policies, socioeconomic and environmental conditions, the availability of water, and crop management techniques all play a role in the selection of crop patterns. These causes make cropping patterns dynamic; they shift across time and space. As a result, it is crucial for policymakers, farmers, and agronomists to report such changes in crop-ping patterns on a regular basis because this information is needed for evaluations of food security and land management.

Study Area:

Charkhi Dadri district is one of the 22 districts of Haryana state in northern India. The Government of Haryana notified Charkhi Dadri as the 22nd district on 01 December 2016. District Charkhi Dadri consists of two sub-divisions (Charkhi Dadri and Badhra). and consists of two tehsils (Charkhi Dadri and Badhra) and one sub-tehsil (Boundkalan). District Charkhi Dadri is situated between 28.5921°" north latitude and 76.2653°" east

longitude respectively. District Charkhi Dadri is situated 112.6 KM from India's capital New Delhi and 295 KM from Haryana's capital Chandigarh.

The Charkhi Dadri District experiences temperature ranges of 2 to 45 degrees Celsius. minerals such as gypsum and building stone, or flexible stones (Kaliyana Village). Crops include a small amount of Paddy & Major crop is Cotton in Kharif & Wheat & Mustard in Rabi. Only 483 mm of rain falls annually, mostly in the months of July and August. Neem, Sheesham, Peepal, and other thorny trees are also present in the vegetation, along with Babool, Jandi, and Kair.

Figure-1: Locational Map of District Charkhi Dadri

Methodology:

In this case, cropping patterns in the study region were mapped using several remotely sensed variables that were extracted from Landsat-8 and Landsat-5 imageries.

Sources of Data: Some satellite data products are accessible for free, and you can download them from a variety of websites that the data provider has created. There are several different remote sensing systems, and the specifications for each are available on a number of websites from data suppliers, satellite operators, and manufacturers. A remote sensing data user must be familiar with the various products and their uses in order to select the best data product for a certain project.The Lansat-8 image features a 14-day return cycle, a 30-meter spatial resolution, a large coverage area, and excellent spatial and temporal resolution. For the crucial Coton, Mustard, and wheat growth seasons in 2022 and 2011, we selected Landsat-8 and Landsat-5 (Band 2, 3, 4 and 5) broad field view (with a less than 10% cloud cover).
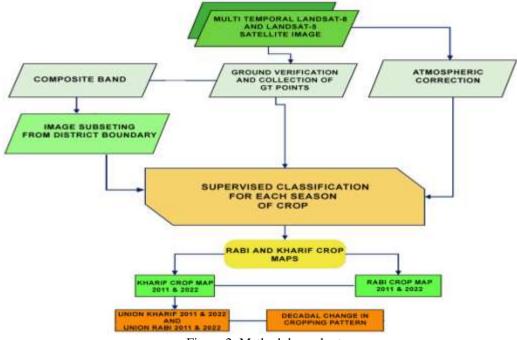
Figure-2: Methodology chart

Ground Verification (Data Sample from the Field):
We used field samples to validate the accuracy of our proposed classification methodology. Taking photos, manually identifying the crop type, and using a portable global positioning system (GPS) to record latitude and longitude were all part of the sample of land features. For supervised classification systems to evaluate classification accuracy, the same verification samples as for supervised classification are required.

Supervised Classification:
For each land cover class in supervised classification, analysts choose representative samples. These "training areas" are subsequently utilized by the software, which then applies them to the full image. The spectral signature identified in the training set is used in supervised classification. In supervised classification, a variety of techniques are utilized, including maximum likelihood and minimum-distance classification. The concept behind supervised classification is that a user can choose a sample set of pixels from an image that best represents a given class, and then instruct the image processing software to utilise these training sites as references when classifying all other pixels in the picture.

Union:
Union is a geostatistical strategy in GIS software. We use this information to identify the Charkhi Dadri district's cropping pattern. The decadal change in crop patterns is produced by combining crop data from the years 2011 and 2022.

II.   Result and Discussion:
Cotton and a small amount of rice were found to be the two main crops in the Kharif season, according to an analysis of data from the Multi-date Landsat Satellite. Except for the eastern section of the district, cotton is primarily concentrated there. The two main crops grown during the Rabi season are wheat and mustard, then other crops. Additionally, there are other fallow and non-agricultural areas in both seasons.Built-up areas, water bodies, scrub land, roads, etc. are considered non-agricultural land (Figure-3) and are mask off from satellite image processing for increased accuracy.
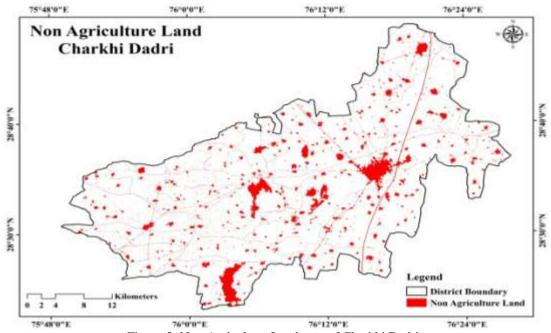
Figure-3: Non Agriculture Land map of Charkhi Dadri.

Crop Pattern depicts the planting of crops in time order. It shows that the largest Kharif crops in the Pattern are grown in Charkhi Dadri District. The main crops in the Rabi season, which is based on the two seasons Kharif and Rabi, are rice-cotton and mustrad-wheat crops. We primarily observed the cultivation of rice during the kharif season in the centre of Charki Dadri, with cotton predominating elsewhere(Figure-4). Similar to 2011, we see that the northern and central portions of Charkhi Dadri is Grown Rice crop rest area dominated by cotton in 2022 (Figure-5).

This might be because Cotton and Mustard, the two main crops grown during the Kharif and Rabi seasons, are gradually moving from the north to the south of Charkhi Dadri District. Therefore, the Charkhi Dadri district's agricultural land is primarily used for two crops, with less land being used for more than two. Other crops are gradually disappearing, especially during the Rabi Season.
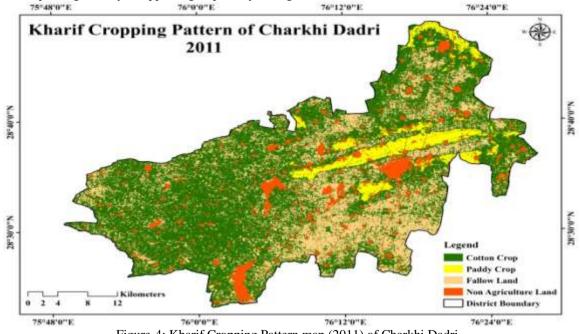

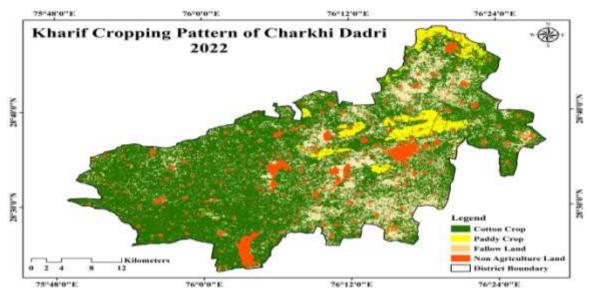Figure-4: Kharif Cropping Pattern map (2011) of Charkhi Dadri.

Figure-5: Kharif Cropping Pattern map (2022) of Charkhi Dadri.

Kharif Cropping Pattern 2011-2022		
Class Name	2011 (Area in Hectare)	2022 (Area in Hectare)
Cotton	78744.6	89180.8
Rice	8814.6	7006.5
Fallow	37145.9	29613.5
Non AG	12616.8	11521.0
Total	137321.9	137321.9

Table-1: Area Table of Kharif Cropping Patten 2011 and 2022.

Cotton and rice are the two main crop patterns for the Kharif seasons in 2011 and 2022. As shown in Table 1 and Figure 4 and 5, the cotton crop area in 2011 was 78744.6 hectares and the rice crop area was 8814.5 hectares. In 2022, the cotton crop area is expected to increase slightly to 89180.8 hectares and the rice crop area will decrease to 7006.5 hectares.
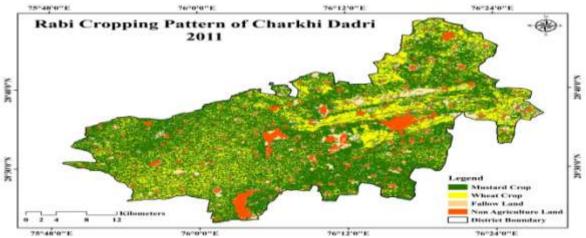

Figure-6: Rabi Cropping Pattern map (2011) of Charkhi Dadri.

Rabi Cropping Pattern 2011-2022		
Class Name	2011 (Area in Hectare)	2022 (Area in Hectare)
Mustrad	82620.2	83712.8
Wheat	28248.8	32735.1

Fallow	15146.8	9725.4
Non AG	11306.1	11148.6
Total	**137321.9**	**137321.9**

Table-2: Area Table of Rabi Cropping Patten 2011 and 2022.

Mustrad and wheat are the two main crop patterns for the Rabi seasons in 2011 and 2022. As shown in Table 2 and Figure 6 and 7, the Mustrad crop area in 2011 was 82620.2hectares and the wheat crop area was 28248.8hectares. In 2022, the Mustrad crop area is expected to increase slightly to 83712.8hectares and the wheat crop area also increase to 32735.1 hectares.
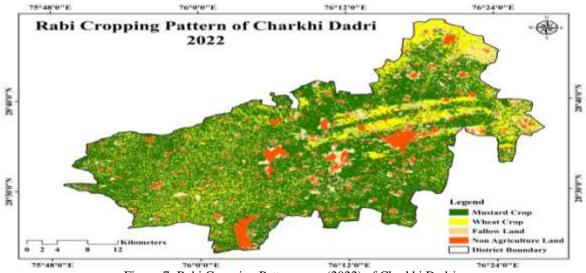

Figure-7: Rabi Cropping Pattern map (2022) of Charkhi Dadri.

Change in Cropping Pattern Analysis:
The change in cropping pattern is shown in terms of the area under various land use categories as well as the expansion in the area, output, and productivity of the main crops farmed in Charkhi Dadri from 2011 to 2022.

The (tables -3 and Figure-8) make it obvious that the proportion of Rabi crops to the overall change in Mustard to wheat area was only 14693.1 hectare and for wheat to mustard a maximum of 18944.1 hectare. There are not many other modifications. Still, from 2011 to 2022, mustard is cover 60783.7 hectares and wheat is cover 11942.6 hectares.
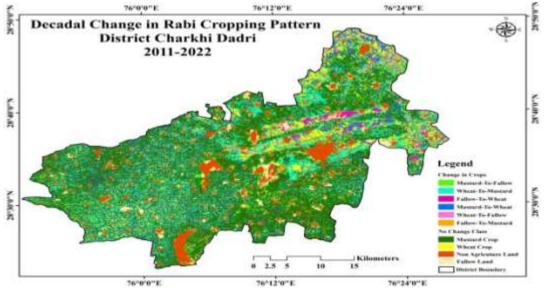

Figure-8: Decadal Change in Rabi Cropping Pattern map (2011-2022) of Charkhi Dadri.

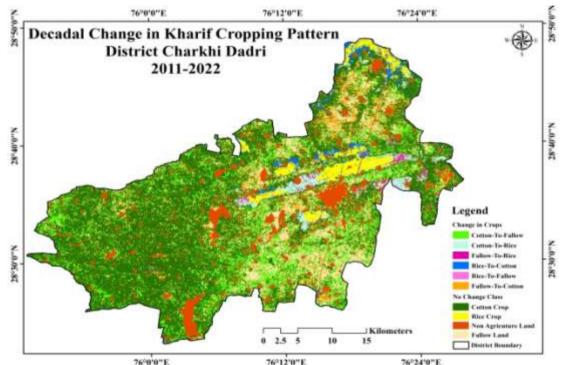| Rabi Cropping Pattern Change 2011-2022	
No Change Crop	**Area in Hectare**
Mustard-To- Mustard	60783.7
Wheat-To-Wheat	11942.6
Fallow-To-Fallow	5404.2
Non Agriculture-To-Non Agriculture	11167.2
Change in Crop	**Area in Hectare**
Fallow-To- Mustard	2854.4
Fallow-To-Wheat	1574.1
Mustard -To-Wheat	14693.1
Mustard -To-Fallow	8130.1
Wheat-To- Mustard	18944.1
Wheat-To-Fallow	1828.4
Grand Total	**137321.9**

Table-3: Area Table of Rabi Cropping Patten Change 2011 and 2022.

Figure-9: Decadal Change in Kharif Cropping Pattern map (2011-2022) of Charkhi Dadri.

Kharif Cropping Pattern Change 2011-2022	
No Change Crop	**Area in Hectare**
Cotton-To-Cotton	63579.6
Rice-To-Rice	4896.5
Fallow-To-Fallow	15025.4
Non Agriculture-To-Non Agriculture	11764.2
Change in Crop	**Area in Hectare**
Cotton-To-Rice	3492.8

Cotton-To-Fallow	22067.3
Rice-To-Cotton	1999.4
Rice-To-Fallow	106.2
Fallow-To-Cotton	13780.5
Fallow-To-Rice	610.0
Grand Total	**137321.9**

Table-4: Area Table of Kharif Cropping Patten Change 2011 and 2022.

The (tables -4 and Figure-9) make it obvious that the proportion of Kharif crops to the overall change in Rice to Cotton area was only 1999.4hectare and for Cotton to Fallow a maximum of 22067.3hectare. There are not many other modifications. Still, from 2011 to 2022, cotton is cover 63579.6hectares and Rice is cover 4896.5hectares.

III. Conclusion:

The current study describes a technique for analysing the cropping patterns for major crops, minor crops, and fallow land in the Charkhi Dadri district in 2011 and 2022. Cropping pattern and Decadal change maps are produced using supervised classification of multi-date Landsat-8 and Landsat-5 satellite images.

Using this method, you may see the major crops for the Kharif and Rabi seasons in the study area. The spatial linkages between the main crops and other crops at a certain place can be traced during the research period, even though it only reveals decadal variation in crop patterns as such. The possibility of showing some spatial relationships between crops, which could reveal specific locations of some rotations, is a benefit of the suggested approach. For instance, the spatial link between cotton and wheat, two seasonal crops grown in the months of Kharif and Rabi, in the study area of Charkhi Dadri district, reveals the precise position of typical distribution areas. and the ten-year change in the Dadri district's charkhi pattern. The use of a multi-year cropping pattern map in predicting future spatial crop distribution is another possibility given that it contains implicit probabilities of change and expert knowledge about the spatial relationships between the crops in the study area.

References:

[1]. See M. Pal and G.F. Foody, Feature selection for classification of hyperspectral data for SVM, IEEE Transactions on Geoscience and Remote Sensing, vol. 48, no. 5, May 2010, pp. 2297–2307 for a demonstration of the Hughes phenomenon with the support vector machine of Sect. 8.14.

[2]. Based on results presented in K.S. Fu, D.A. Landgrebe and T.L. Phillips, Information processing of remotely sensed agricultural data, Proc. IEEE, vol. 57, no. 4, April 1969, pp. 639–653.

[3]. Predominant cropping systems of India: Technologies and strategies by Yadav, A.K., Prasad Kamta and Singh, A.K. (1998).

[4]. Bégué, A.; Arvor, D.; Bellon, B.; Betbeder, J.; de Abelleyra, D.; Ferraz, R.P.D.; Lebourgeois, V.; Lelong, C.; Simões, M.; Verón, S.R. Remote sensing and cropping practices: A review. Remote Sens. 2018, 10, 99.

[5]. Chaves, M.E.D.; Picoli, M.C.A.; Sanches, I.D. Recent applications of Landsat 8/OLI and Sentinel-2/MSI for land use and landcover mapping: A systematic review. Remote Sens. 2020,12, 3062.

[6]. Chauhan, S.; Darvishzadeh, R.; Boschetti, M.; Nelson, A. Estimation of crop angle of inclination for lodged wheat usingmulti-sensor SAR data. Remote Sens. Environ. 2020,236, 111488.

[7]. Boschetti, M.; Stroppiana, D.; Brivio, P.A.; Bocchi, S. Multi-year monitoring of rice crop phenology through time series analysis ofMODIS images. Int. J. Remote Sens. 2009,30, 4643–4662.

[8]. Abubakar, G.A.; Wang, K.; Shahtahamssebi, A.; Xue, X.; Belete, M.; Gudo, A.J.A.; Shuka, K.A.M.; Gan, M. Mapping maize fieldsby using multi-temporal Sentinel-1A and Sentinel-2A images in Makarfi, Northern Nigeria, Africa. Sustainability2020,12, 2539.

[9]. Wardlow, B.D.; Egbert, S.L. Large-area crop mapping using time-series MODIS 250 m NDVI data: An assessment for the U.S.Central Great Plains. Remote Sens. Environ. 2008,112, 1096–1116.

[10]. Panigrahy, K. R. Manjunath& S. S. Ray (2005) Deriving cropping system performance indices using remote sensing data and GIS, International Journal of Remote Sensing, 26:12, 2595-2606.

[11]. S.S. RAY (2005) use of gis and remote sensing for crop diversification - a case study for punjab state, Journal of the Indian Society of Remote Sensing, Vol. 33.

[12]. Joshi, P.K., A. Gulati, P.S. Birthal and L. Tewari (2004), "Agricultural Diversification in South Asia: Patterns, Determinants and Policy Implications", Economic and Political Weekly, Vol.39, No.24, June 12-18.

[13]. Wharton S. W. 1982. A contextual classification method for recognizing land use patterns in high resolution remotely sensed data. Pattern Recognition. 1(4): 317-324.