SHODH SAGAR®
Universal Research Reports
ISSN: 2348-5612 | Vol. 11 | Issue 4 | Jul – Sep 2024 | Peer Reviewed & Refereed

An Analysis of crop rotation practice by the farmers of North-western Haryana: Using geospatial technology

Dr. Parveen
Email ID - parveenbisla77@gmail.com

DOI: http://doi.org/10.36676/urr.v11.i4.1310
Accepted: 22/07/2024 Published: 25/07/2024
* Corresponding author

1. Abstract

Crop rotation studies that include comprehensive temporal and spatial data are essential for sustainable agricultural management, crop monitoring, and addressing food security concerns. Insufficient agricultural information is a significant barrier to effective policy-making and research aimed at ensuring food security. A study was carried out in northwestern Haryana to map crop rotation using satellite-based remote sensing data, combined with other spatial and non-spatial collateral data. The main data sources utilized were Landsat-5 and Sentinel-2, which were analyzed using digital image processing techniques in ERDAS Imagine and ArcGIS software. An interactive supervised classification method was applied to evaluate the data. Crop rotation maps were created for the periods 1990-1991 and 2021-2022. The findings indicated that the cotton-mustard cropping area comprised 19.85% of the total geographical area in 1990-1991, while the rice-wheat cropping area accounted for 31.46% in 2021-2022. This indicates that cotton-mustard was the predominant crop rotation in 1990-1991, whereas rice-wheat became the primary crop rotation by 2021-2022, as adopted by farmers in northwestern Haryana.

Keywords: supervised classification, crop rotation transpose, Remote sensing, GIS, Spatio-temporal analysis

2. Introduction

Agricultural resources are crucial renewable and dynamic natural assets. Agriculture forms the backbone of the Indian economy, making comprehensive, reliable, and timely information on these resources essential for a country like India, where agriculture is a primary economic activity (Balaselva kumar S.,1997). Remote sensing significantly contributes to agriculture by offering essential data on crop distribution and conditions across various spatial levels. Its high compatibility with GIS environments facilitates effective analysis. Additionally, integrating information about other vital natural resources supports sustainable agricultural practices (Chatterji, B.N. 1979).

The cropping pattern of a region is influenced by climate, soil, available resources like irrigation and fertilizers, mechanization, and socio-economic conditions. Changes in these patterns typically result from alterations in one or more of these factors. Socio-economic conditions often have a significant impact, sometimes leading to the adoption of new cropping systems at the expense of agro-ecological balance (Panigrahy et al., 1995). To gain a clearer understanding of cropping patterns, it's important to examine the land area dedicated to each crop and the rotation practices used by farmers. This study utilized satellite-based remote sensing data along with additional spatial and non-spatial information to map the crop rotation methods employed by farmers in north-western Haryana. Crop rotation aims to increase agricultural productivity and preserve soil fertility, thus promoting sustainable farming practices

3. Study Area

The north-western region of Haryana comprises Sirsa, Fatehabad, and Hisar districts, covering about 24.42% of the state's total land area, approximately 10,798 square kilometers. Geographically, it spans from longitude 74°28'E to 76°19'E and latitude 28°54'N to 29°59'N. Major crops grown here include cotton, paddy, wheat, sugarcane, bajra, gram, and mustard, cultivated during both Rabi and Kharif seasons. This study utilizes geospatial technology to analyze crop rotation practices among the local agricultural communities, aiming to enhance food grain production sustainably. Introduction of new agricultural technologies has notably shifted traditional cropping patterns, replacing the cotton-mustard rotation with a wheat-rice rotation in north-western Haryana.

4. Objective of the study

- To investigate the crop rotation practices adopted by farmers in north-western Haryana from 1990-1991 to 2021-2022

5. Satellite image acquisition

Landsat-5, characterized by a 30-meter spatial resolution and a 16-day revisit cycle, captures data across three spectral bands: green (0.52–0.60 µm), red (0.63–0.69 µm), and near-infrared (NIR: 0.76–0.90 µm). It covers a swath width of 185 kilometers. Sentinel-2, in contrast, offers finer details with a 10-meter spatial resolution and a 10-day revisit cycle. Its spectral bands include green (0.543–0.578 µm), red (0.650–0.680 µm), and near-infrared (NIR: 0.785–0.900 µm), spanning a swath width of 290 kilometers.

For the analysis of crop rotation in north-western Haryana from 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). These images were processed using the World Geodetic System 1984 (geographic coordinate system) and Universal Transverse Mercator zone 43 N (projected coordinate system) for accurate georeferencing and overlaying with the region's boundary.

Table:1

The detail of input remote sensing data for analysis is given in table

Satellite	Band	Spatial resolution	Temporal resolution	Description	Swath
landsat-5	B2	30m	16 days	Green	185km
	B3	30m		Red	
	B4	30m		Near infrared	
sentinel-2	B3	10m	10 days	Green	290 km
	B4	10m		Red	
	B8	10m		Near infrared	

6. Software Used

ArcGIS and ERDAS IMAGINE, both commercial software tools, were used for tasks such as radiometric corrections, georeferencing, classification, and spatial modeling of crop rotation in north-western Haryana.

7. Research Methodology

Data from Landsat-5 (bands 2, 3, and 4) and Sentinel-2 (bands 3, 4, and 8) were used to analyze information from the Rabi and Kharif seasons. The data underwent layer stacking and subsetting for

the specific area of interest. To enhance accuracy, non-agricultural areas like built-up zones, roads etc were excluded from the maps.

The method of supervised digital classification was applied to geo-coded digital images. Multiples training samples for each desired class were selected from the specified area of the image that indicates a class type and then each class's samples was integrated. An interactive supervised classification method was employed to analyze the data from cropping pattern during kharif season 1990, rabi season 1991, kharif season 2021 and rabi season 2022 were segregated.

Thus, the maps for the Kharif season and rabi season of to decades;- 1990-91 to 2021-22 were created using classified images and logical arrangement. Crop rotation represents the sequence of crops cultivated on a particular piece of land over time. For example, growing rice during the Kharif season and then wheat during the Rabi season is known as a rice-wheat rotation. After creating cropping pattern maps for the Kharif and Rabi seasons of 1990-1991, these seasonal maps were combined to generate crop rotation maps.

8. Results and Discussion

The areal extent and spatial distributions of crop rotation in north-western Haryana were mapped and analyzed are presented in (Table 2 & Figure 1 and figure 2). There are total 25 categories (excluded other) of crop rotation has been identify in north-western Haryana. The analysis of crop reveals that cotton-mustard is the first dominant crop rotation in 1990-91 and rice-wheat in 2021-22 grown in the strata, accounting for 19.85% and 31.46% of the total geographical area as shown in table 2.

Cotton-wheat is the second dominant crop in 1990-91 and 2021-22 grown in the north-western Haryana 16.46% and 21.80% to the total geographical area as shown in figure 1 and figure 2. The analysis revealed that the primary cropping sequences in north-western Haryana in 1990-91 were cotton-mustard and cotton-wheat. By 2021-22, the main sequences had shifted to rice-wheat and cotton-wheat. The soil and climate of the north-western Haryana are most suited for the cultivation of this crop and has responded well to canal irrigation.

The distribution of cropping patterns reveals that most areas practiced double cropping, with some areas also engaged in single cropping. Single crops such as cotton-fallow, bajra-fallow, sugarcane-fallow, and rice-fallow occupied a smaller area, totaling 183,588.74 hectares (16.77%) in 1990-91 and 148,347.93 hectares (13.64%) in 2021-2022 relative to the total geographical area of north-western Haryana, as indicated in Table 2. This study concluded that the shift from cotton-mustard in 1990-91 to rice-wheat in 2021-22 was influenced significantly by improved irrigation infrastructure.. Therefore, dynamics of crop rotation has been studied for North-Western Haryana districts of Sirsa, Hisar and Fatehabad. These districts have some agro-climatic similarities too in terms of rainfall, soil quality, temperature, etc. In the areas where five or six crops are grown in rotation the agricultural practice is highly traditional and very little surplus is available in 1990s but there is a dramatically shift towards modern agricultural practice using modern inputs, hybrids seeds, improved irrigation facilities leads to increase in moderate to high surplus in present time.

Table: 2

Crop rotation from 1990 To 2022 in North-Western Haryana

Crop rotation	Area in hectares 1990-91	Percentage in 1990-91 (TGA)	Area in hectares 2021-22	Percentage in 2021-22 (TGA)

ISSN: 2348-5612 | Vol. 11 | Issue 4 | Jul – Sep 2024 | Peer Reviewed & Refereed

Bajra-Fallow	30949.00	2.85	2061.74	0.19
Bajra-Gram	7068.21	0.65	91.31010088	0.01
Bajra-mustard	52969.40	4.87	1836.56	0.17
Bajra-Sugarcane	11.96	0.00	-	-
Bajra-Wheat	4969.46	0.46	303.57	0.03
Cotton-Fallow	78714.63	7.24	106281.53	9.78
Cotton-Gram	13201.84	1.21	4061.837531	0.37
Cotton-mustard	215775.41	19.85	211802.32	19.48
Cotton-Sugarcane	47.41	0.00	12.71	0.00
Cotton-Wheat	178945.41	16.46	237079.74	21.81
Fallow-Fallow	122828.64	11.30	20497.79	1.89
Fallow-Gram	22900.71	2.11	287.5724793	0.03
Fallow-mustard	76658.64	7.05	12626.66	1.16
Fallow-Sugarcane	107.90	0.01	0.0925	0.00
Fallow-Wheat	12936.40	1.19	4045.79	0.37
Other-mustard	37943.56	3.49	30.47077558	0.00
Rice-Fallow	25457.61	2.34	23033.55	2.12
Rice-Gram	143.58	0.01	27.07390378	0.00
Rice-mustard	43174.93	3.97	39751.73	3.66
Rice-Sugarcane	18.92	0.00	21.31	0.00
Rice-Wheat	103055.69	9.48	342010.2	31.46
Sugarcane-Fallow	1.29	0.00	5.54375	0.00
Sugarcane-mustard	0.67	0.00	1.52	0.00
Sugarcane-Sugarcane	5.48	0.00	47.68375	0.00
Sugarcane-Wheat	17.39	0.00	12.41375	0.00
Other-Other	-	-	128.67	0.01
Total	**1027904.12**	**94.56**	**1006059.39**	**92.55**
non-agricultural	59169.78	5.44	81013.74	7.45
Grand Total	**1087073.89**	**100.00**	**1087073.13**	**100.00**

ISSN: 2348-5612 | Vol. 11 | Issue 4 | Jul – Sep 2024 | Peer Reviewed & Refereed

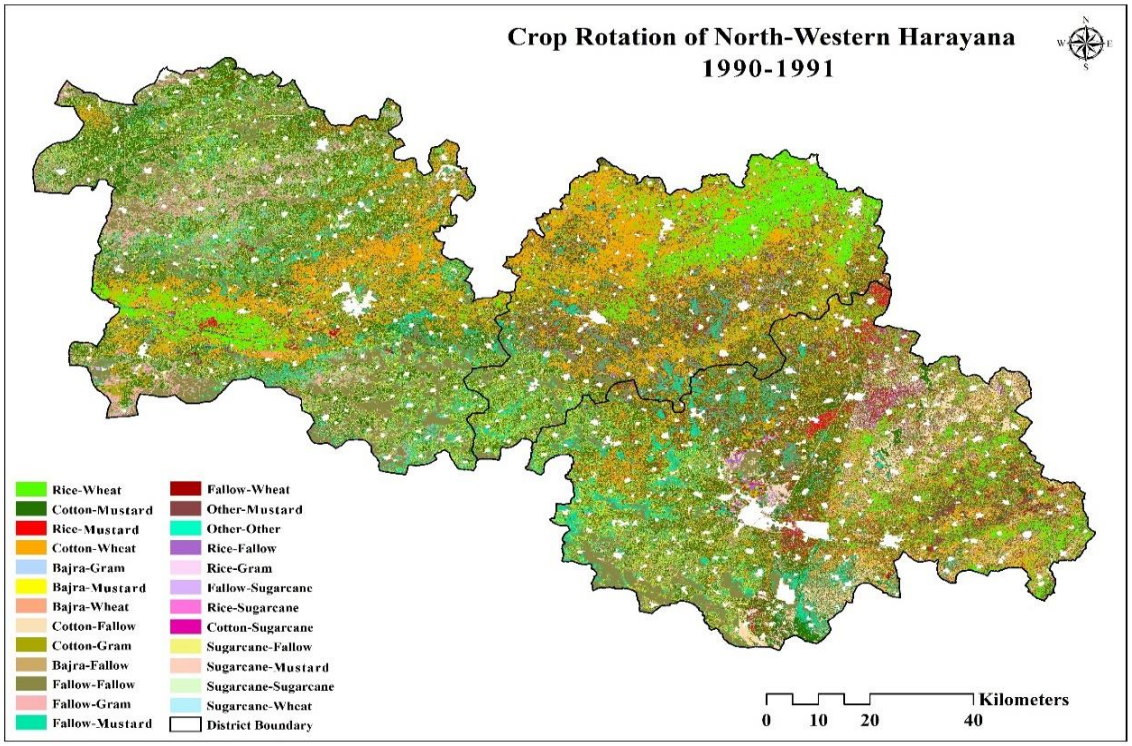

Figure 1: Crops rotation and other classes in north-western Haryana (1990-91).

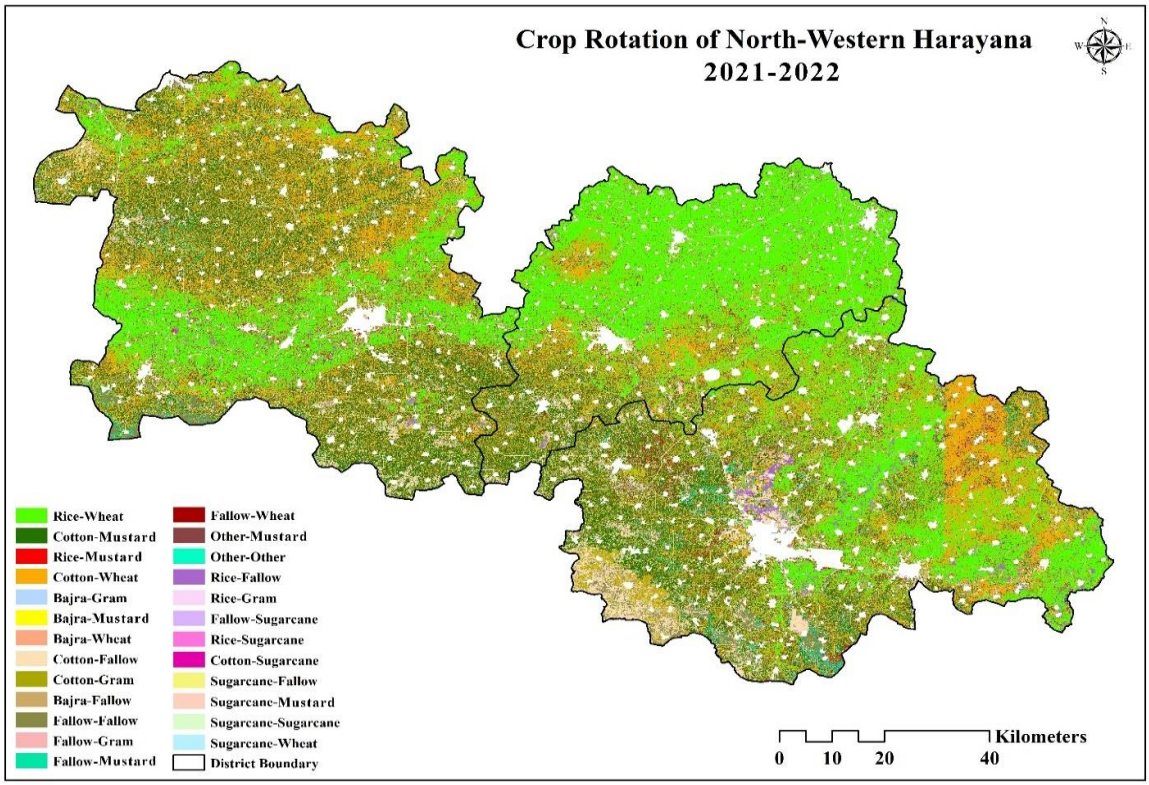

Figure 2: Crops rotation and other classes in north-western Haryana (2021-22).

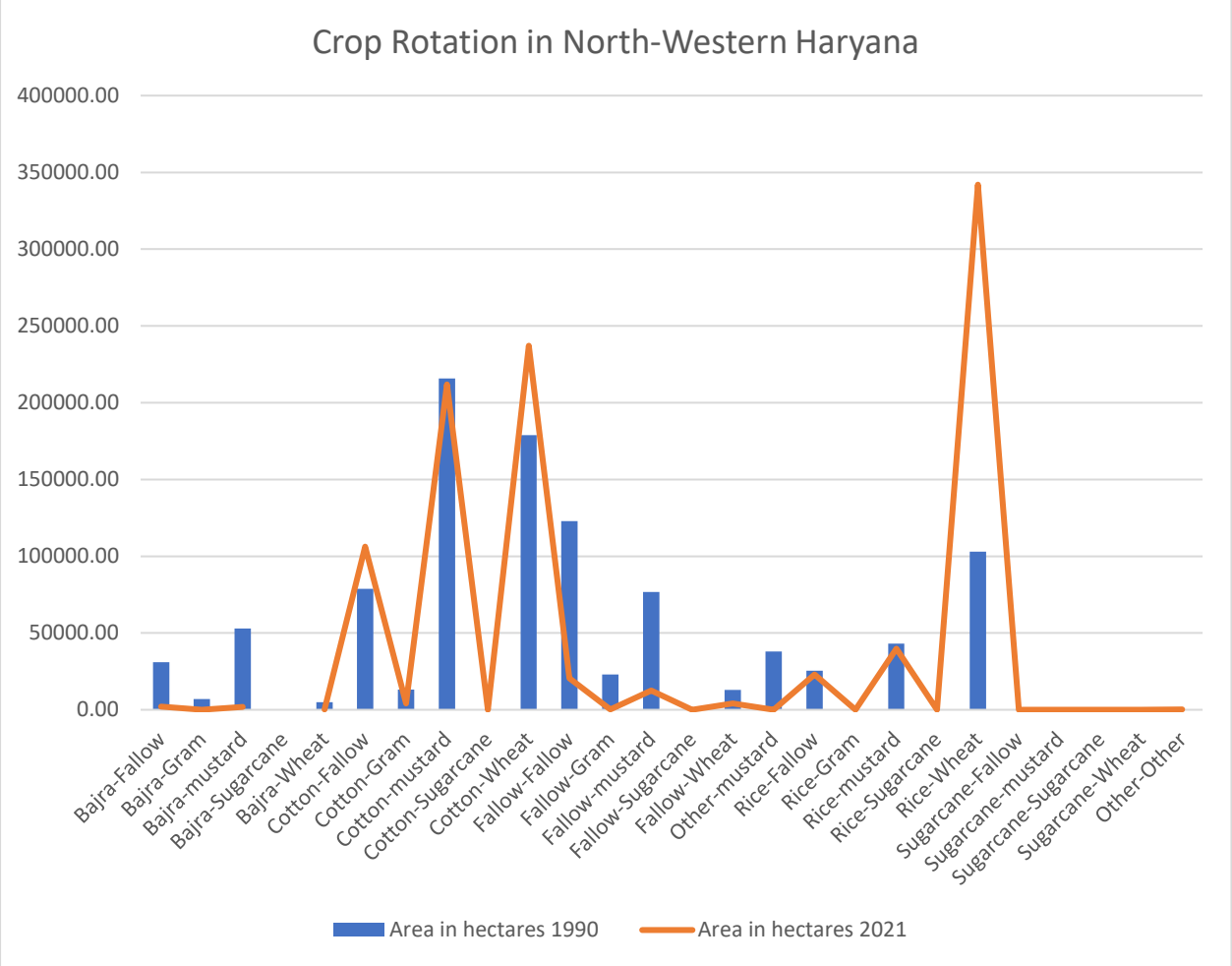

Figure 3 : Areal extent of various crops rotation followed in north-western Haryana (1990-91 and 2021-22).

9. Conclusion:

This study examined the crop rotation practiced in North-western Haryana in reference period of 1990-1991 to 2021-2022 using landsat-5 and sentinel-2A satellite based remote sensing data. Thus, the study proved that geospatial technology is a effective tool to analyse the crop rotation. Total 25 crop rotation (excluded others) categories were observed in the north-western Haryana (including fallow).

It was evident from the findings that the primary cropping sequences in north-western Haryana were cotton-mustard and cotton-wheat in 1990-91, transitioning to rice-wheat and cotton-wheat by 2021-22 and the soil, climate of the north-western Haryana are most suited for the cultivation of these crops and has responded well to canal irrigation.

10. References:

1. Panigrahy. S., Singh, R.P., Sharma, S.A. and Chakraborty, M. (1995). Results of potential use of simulated IRS-1C WiFS data for crop monitoring. J. Indian Soc. Remote Sensing, 23:175-183.
2. SUSHMA PANIGRAHY*, S.S. RAY*, ANIL SOOD**, L.B. PATEL**, P.K. SHARMA** AND J.S. PARIH R* (2004). ANALYSIS OF CROPPING PATTERN CHANGES IN

BATHINDA DISTRICT, PUNJAB. Journal of the Indian Society of Remote Sensing, Vol. 32, No.2.

3. Balaselva kumar S., (1997) Saravanan S., "Remote sensing techniques for agriculture survey" Department of Geography, Bharathidasan university, Tiruchirapalli. Publi. No. 169.104-123 pp.
4. B.N Chatterji., S Mati. B.K mandal., (1979). Cropping system Theory & Practice.
5. Savitpal, Vinod Kumar., M.P, Sharma., Vikas Sihag., Mohit., Dr. Ashok Beniwal., (2015). " Geospatial Technology Based Cropping System Analysis & Management of Sampla Block, Rohtak, Haryana" Department of Geography, FGM Govt College, Adampur. ISSN:2349-2163, Issue 10, volume 2.