

Original Research Article

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## Mapping Area under Major Rabi Crops in Jhajjar District of Haryana using Geoinformatics

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### ABSTRACT

Accurate and timely information of crop area, production and crop condition etc. is essential for making policy designs regarding procurement, storage, transport, export and import of agricultural produce. The present study was conducted to estimate area and generate crop map of major rabi crops namely wheat and mustard for Jhajjar district using high resolution Sentinel-2A satellite data of rabi season 2015-2016. District boundary of study area was overlaid on the image and all the data elements (pixels) were extracted for analysis. The image was classified using complete enumeration approach and unsupervised Iso-data clustering classifier by applying logical combinations and defining conditions such as number of clusters, threshold, standard deviation etc. To improve the classification accuracy, Normalized Difference Vegetation Index (NDVI) and non-agricultural masks were generated and used during the analysis. Crops and other associated features were identified using ground truth data collected using hand held GPS. Mask of mixed classes was prepared and image under the mask was re-classified to segregate the crops and associated features. Remote sensing based estimates are compared with crop estimates of Department of Agriculture by computing Percent Relative Deviation (%RD) and found to be quite close. Multispectral high resolution data of Sentinel-2A satellite with 10 meter spatial resolution is found to be very useful for the crop acreage estimation and crop map generation for major crops i.e. Wheat and Mustard at district level. Crop map generated in spatial domain will be useful for the planning purposes.

#### Keywords

Rabi crops,  
Sentinel-2A, High  
resolution, Remote  
Sensing, NDVI,  
Ground Truth data

#### Article Info

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### Introduction

Remote sensing techniques have become very popular in area estimation over the past few decades, as the technology and methodologies have matured. An excellent document on the issues of area estimation in general as well as those from the earth observation (EO)

perspective was published by the Group on Earth Observations (GEO) following a June 2008 conference on the topic (Gallego, 2008). Geospatial technologies began to make a real impact in area estimation in the 1980's. Early versions of GIS's were mainly used to store final area sampling frames in a digital form, but as the technology increased, information

stored in digital form began to be readily accessible. Early digital data was usually in the form of scanned documents. Later, remotely sensed images would load directly into GIS's and related image processing programs. Being able to review and store boundaries derived from or overlain on different data sources greatly aided area frame construction. This technology is still advancing; increases in computer power make many processes much more manageable. New devices such as Global Positioning System (GPS) receivers and various types of handheld computer tablets, etc., allow data processing anywhere (Carfagna and Keita, 2009). Gallego, 2006 and Narciso, *et al.*, 2008 described two recent research efforts focused on avoiding or minimizing ground data collection that ultimately proved unsatisfactory.

Remote sensing has a long history of use in crop acreage estimation and assessment dating back to the 1970s. With technology improvements in sensor quality and availability and processing advances, it has become an even stronger player in countries' efforts to estimate crop area and production. However, issues especially with regard to timing, efficiency, and assurances of continuing availability remain with its use. According to Gallego (2008), the timing or schedule of crop area estimation or early estimation depends on various elements like 1) the number of days after sowing a crop can be detected by a remote sensor, 2) the spatial variability in sowing practices of the region, 3) the crop calendars of competing crops, 4) the characteristics of remote sensors (revisiting time), 5) the date in which the crop can be reliably recognized in the field, 6) the time needed for the ground survey, and 7) the time needed for ground data processing. Kussul *et al.*, (2012) described the crop area estimation and condition assessment work currently being done in the Ukraine, under the auspices

of the Joint Experiment for Crop Assessment and Monitoring (JECAM) project of the Global Earth Observation System of Systems (GEOSS). Jiao *et al.*, 2006 presented an interesting approach to paddy rice area estimation that was used operationally in China in 2005. This was a nearly pure remote sensing operation, although some ground data were collected to train the classification, which was based on MODIS imagery. Lochan (2006) described the survey approach used for crop production forecasting in India, as well as the initiatives that have been undertaken over the years to improve it, including the most current one called Forecasting Agricultural output using Space, Agro-meteorology, and Land based observations (FASAL). Hooda, *et al.*, 2006 provided additional information on the Indian experience at crop forecasting using remote sensing technology, in particular, focusing on wheat production in the state of Haryana. The authors presented a time series of how well remote sensing based estimates have compared over the years for both crop area and production since their inception in 1986.

Most of the studies described above provide statistical data on area and likely production of crops using rabi season satellite data. The statistics is compared with Department of Agriculture estimates, which match with above 90% accuracy at district level due to omission and commission errors. However, there are limited efforts on generating crop maps on a good scale because of the fear of limitation of spatial accuracy. The present study attempts to map the area under major rabi crops in Jhajjar district of Haryana along with a crop map indicating the spatial distribution of various crops.

### **Study area**

Jhajjar district, as one of the 22 districts of Haryana state in northern India,

was selected for the study. The geographical area of Jhajjar district is 1,834 km<sup>2</sup>. It is situated between 28°25'N and 28°42'N latitudes and 76°38'E and 76°43'E longitude. It is bound on the north by Rohtak district, on the east by Gurugram district and on the west by Charkhi Dadri district. The district has a population of 9,56,907 (2011 census). Bahadurgarh is the major city of district. Jhajjar district has 5 tehsils, Bahadurgarh, Beri, Matenhail, Jhajjar and Badli (Statistical Abstract Haryana, 2015-2016). Location of the district is shown in Figure 1.

## Materials and Methods

### Data used

#### Satellite data

The satellite data used in the present study includes the Sentinel-2A image with 10 meter resolution in blue, Green, Red and NIR bands. The ground-truth data was used for interpretation and accuracy assessment.

Date of Acquisition	Major crop during acquisition of data
09/02/2017	Wheat and
21/03/2017	Mustard

#### Collateral data

Administrative boundary (district).

Crop statistics at district & blocks level from “Dept. of Agriculture” (DOA), Haryana.

Land use statistics

In season ground truth data was collected using GPS.

### Softwares used

#### Arc GIS 9.3

Arc GIS 9.3 was used for composition and generation of maps.

#### Microsoft office

Microsoft Office was used for database preparation.

#### Erdas Imagine 9.3

Erdas Imagine 9.3 was used in subsetting image.

#### Geomatica 10.3

Geomatica 10.3 was used for classification and crop identification.

The study describes the methodology and results of major rabi season crops like Wheat and Mustard crops analysis for Jhajjar district of Haryana. High resolution Sentinel-2A satellite data of rabi season 2015-2016 was used in the current study. District boundary of study area was overlaid on the image and all the data elements (pixels) were extracted for analysis. The image was classified using complete enumeration approach and unsupervised Iso-data clustering classifier by applying logical combinations and defining conditions such as number of clusters, threshold, standard deviation etc. To improve the accuracy Normalized Difference Vegetation Index (NDVI) and non-agricultural masks was generated and used during the classification. Crops and other associated features were identified using ground truth data collected using hand held GPS. Mask of mixed classes was prepared and the image under the mask was re-classified to segregate the crops and associated features.

**Results and Discussion**

Analysis of Remote Sensing data at district level indicates that in the Jhajjar district of Haryana Mustard and wheat are the major crops during Rabi season, which could be identified using single-date Sentinel-2A Remote Sensing data (Fig. 2). Wheat crop is evenly spread throughout the Jhajjar district except in eastern part of Jhajjar where the concentration of fallow land is more. Mustard crop is evenly spread through in the district but its presence is more in northern and north western part of the district. Mustard and wheat crops occupied 104.81 and 24.34 thousand

hectares area respectively (Table 1). Spatial distribution of crops and associated categories is depicted in Figure 3. Mustard and Wheat cropping pattern at block level is shown in Figure 4. Remote Sensing (RS) based estimates of crops are compared with Department of Agriculture (DOA) estimates by computing percent Relative Deviation (% RD). RS based estimates are found to be quite close with DOA estimates for the same year both at district as well as block level.

However, Mustard being the major crop of the district, less RD was observed for mustard compared to wheat at district level (Table 2).

**Table.1** Comparison of deviation of mustard and wheat area of Jhajjar district

S. No.	Crop	Area (000' ha.)		RD (%)
		RS	DOA	
1	Mustard	104.81	107.67	-2.72
2	Wheat	24.34	25.67	-5.46

**Table.2** Comparison of mustard and wheat area of various blocks of Jhajjar district

S. No.	Blocks	Crop	Area (000' ha.)		RD (%)
			RS	DOA	
1	Bahadurgarh	Mustard	3.45	3.18	7.82
		Wheat	28.41	30.13	-6.05
2	Jhajjar	Mustard	6.80	6.94	-2.05
		Wheat	28.32	26.12	7.76
3	Matenhail	Mustard	8.63	7.86	8.92
		Wheat	16.09	17.85	-10.93
4	Beri Khas	Mustard	2.35	2.53	-7.65
		Wheat	20.91	21.62	-3.39
5	Salhawas	Mustard	4.47	4.81	-7.60
		Wheat	11.34	11.55	-1.85

Fig.1 Location map of study area

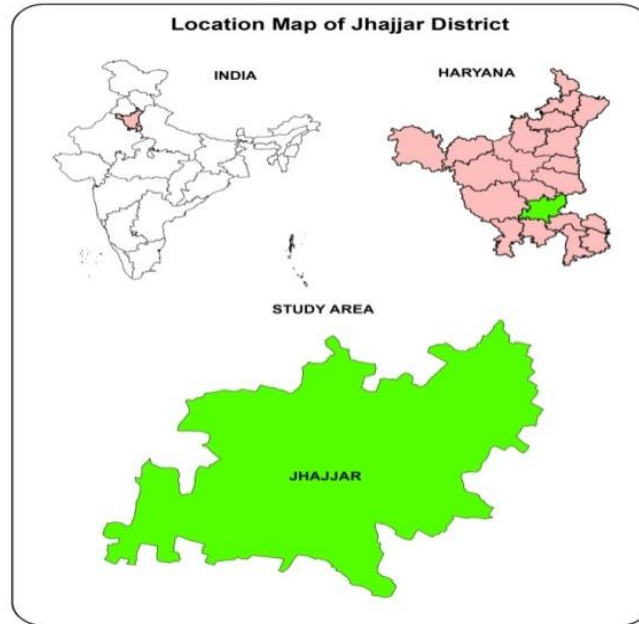
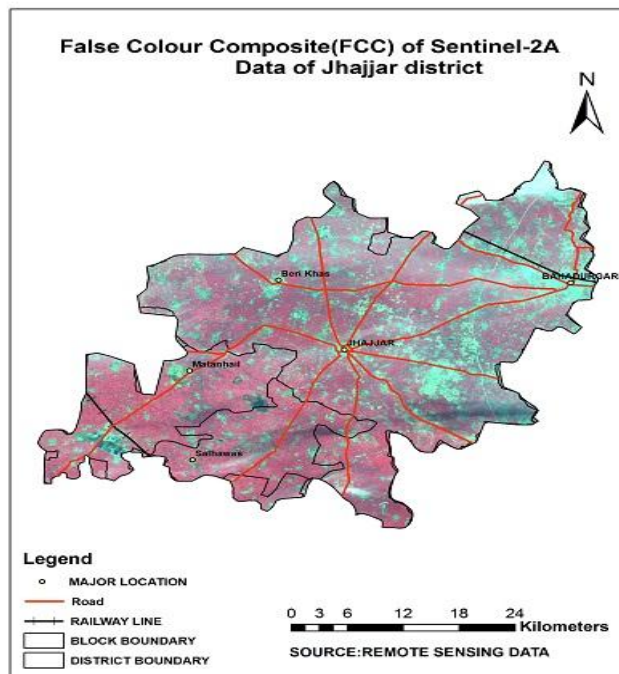
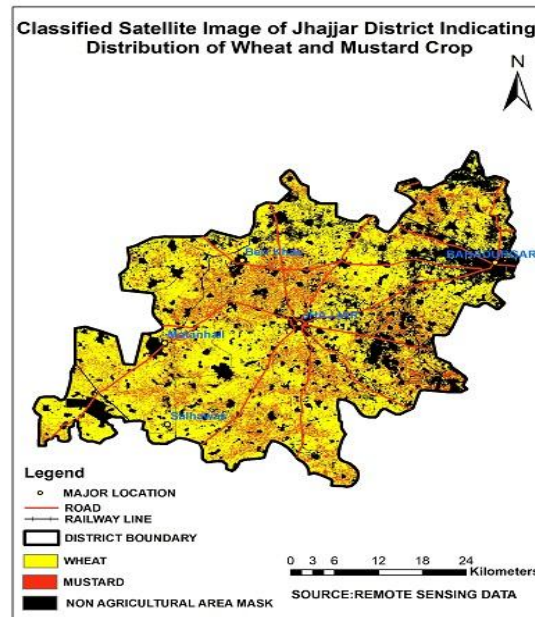


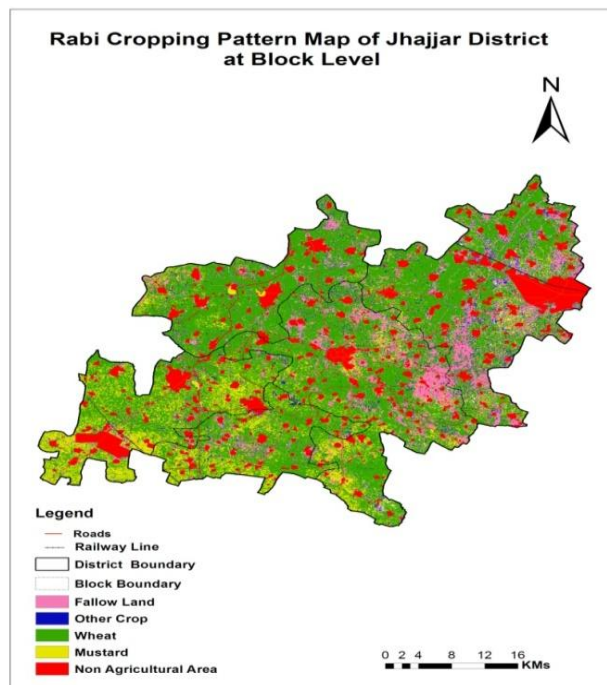
Fig.2 False Colour Composite (FCC) image of Sentinel-2A Data of Jhajjar District (2017)



**Fig.3** Classified satellite image of Jhajjar District indicating distribution of wheat and mustard crops (2017)



**Fig.4** Rabi cropping pattern map of Jhajjar district at block level (2017)



Single-season optical remote sensing data of Sentinel-2A Satellite having spatial resolution of 10 m was used to generate Mustard and Wheat cropping pattern map for Jhajjar district at block

level. RS data analysis showed that Mustard and Wheat are the major crops during Rabi Season. Single-season optical data with spatial resolution of 10 m from Sentinel-2A Satellite is found to

be useful for crop area estimation with fairly low RD and generation of crop maps at District and Block level in an intensively cultivated district Jhajjar of Haryana.

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### References

- Carfagna, E. and Keita, N., 2009: Use of modern geo-positioning devices in agricultural censuses and surveys. *Bulletin of the International Statistical Institute*, the 57th Session, Proceedings, Special Topics Contributed Paper Meetings (STCPM22) organised by Naman Keita (FAO), Durban, August 16-22, 2009.
- Gallego, F. J., 2006: Review of the Main Remote Sensing Methods for Crop Area Estimates Agriculture unit. *ISPRS Archives XXXVI-8/W48 Workshop proceedings: Remote sensing support to crop yield forecast and area estimates*, Commission VIII, WG VIII/10, pp 65-70.
- Gallego, J., Craig, M., Michaelsen, J., Bossyns, B., and Fritz, S., 2008: Workshop on Best Practices for Crop Area Estimation with Remote Sensing Data: Summary of Country Inputs. *Group on Earth Observations (GEO), GEOSS Community of Practice Ag Task 0703a, EC JRC*, Ispra, Italy.
- Hooda, R.S., Yadav, M., and Kalubarme, M.H., 2006: Wheat Production Estimation Using Remote Sensing Data: An Indian Experience. *ISPRS Archives XXXVI-8/W48 Workshop proceedings: Remote sensing support to crop yield forecast and area estimates*, Commission VIII, WG VIII/10, pp 85-90.
- Jiao, X., McNairn, H., Yang, B., Jiali Shang, J., and Zhiyuan PEI, Z., 2006: Operational crop acreage estimation at a national scale based on statistics and remote sensing. *Compilation of ISPRS WG VIII/10 Workshop 2006, Remote Sensing Support to Crop Yield Forecast and Area Estimates*, Stresa, Italy.
- Kussul, N., Shelestov, A., Skakun, S., Kravchenko, O., Moloshnii, B., 2012: Crop State and Area Estimation in Ukraine Based on Remote and Insitu Observations. *International Journal "Information Models and Analyses" Vol.1 / 2012*, pp 251-259.
- Lochan, R., 2006: System of Collection of Agricultural Statistics in India Including Land Use and Area Statistics. *Internal report*, Directorate of Economics and Statistics, New Delhi, India.
- Narciso, G., Baruth, B., Klisch, A., 2008: Crop Area Estimates with Radarsat: Feasibility Study in the Toscana Region – Italy. *JRC, IPSC – Agriculture Unit, 21020 Via Fermi 1*, Ispra, Varese, Italy, Commission VI, WG VI/4, pp 159-164.
- Statistical Abstract of Haryana, 2015-16: Department of Economic and Statistical Analysis Haryana.  
[https://en.wikipedia.org/wiki/Jhajjar\\_district](https://en.wikipedia.org/wiki/Jhajjar_district)

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