International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 03 | Mar 2022 www.irjet.net p-ISSN: 2395-0072

Chilli Crop Acreage Estimation with Sentinel-2 Temporal Satellite Imagery in Nagpur District, Maharashtra

Poonam Jayhind Pardeshi[1], Dr. Indal Ramteke[2], Dr. Sudhakar Shukla[3]

[1]M.Tech Scholar, School of Geo-informatics, Remote Sensing Applications Centre, Uttar Pradesh, India
[2]Scientific Associate, Agriculture Resource Division, Maharashtra Remote Sensing Applications Centre, Maharashtra, India
[3]Scientist-SE and Head of School of Geo-informatics, Remote Sensing Applications Centre, Uttar Pradesh, India

---

Abstract - *Optical Remote Sensing technology made it easier to separate multiple crop types of the specific area. Study area with multiple crops and having the same sowing and harvesting time is difficult to classify using single date data. But multiple crops can be easily separable using time-series optical data. Hence, for the present study time-series, temporal satellite data is used for crop mapping and crop acreage estimation. Sentinel-2 B is the most used optical satellite data for vegetation mapping. It provides high-resolution free satellite data with spatial resolution of 10m and five days revisit time in various applications of agriculture study. This study aims to separate and acreage estimation of chilli crops in Nagpur district using multi-date Sentinel-2 imagery for Rabi season. Unsupervised classification method is adopted to separate chilli and verified with ground truth data.*

Key Words: **chilli; crop; classification; time-series; separation; k-means; sentinel-2; unsupervised**

1. INTRODUCTION

Agriculture is the largest sector available for livelihood in India. Most of the population of the country is based on agriculture and its allied sectors; the sector is occupied by both small and marginal farmers. Agriculture is an important sector of the Indian economy as it contributes about 17% to the total GDP and provides employment to around 58% of the population. Indian agriculture has registered impressive growth over the last few decades. India is the biggest exporter of Cotton in the world which is mostly grown in the Maharashtra region.

Multispectral Sentinel-2 satellite data with Blue, Green, Red and Near-Infrared bands having spatial resolution of 10m are used for accurate crop mapping. It also gives Coastal Aerosol, Water Vapour and SWIR-Cirrus band with 60m resolution, four Vegetation Red Edge bands with different wavelengths and having spatial resolution 20m and two different SWIR bands with spatial resolution of 20m. Optical remote sensing is used in various applications of agriculture such as biomass estimation, drought monitoring, crop condition monitoring, precision agriculture, crop yield mapping etc.

Here, Time series sentinel data of Rabi season is taken for analysis of the study area. To perform unsupervised classification with good accuracy, classification procedure is carried out with ground truth points.

2. STUDY AREA

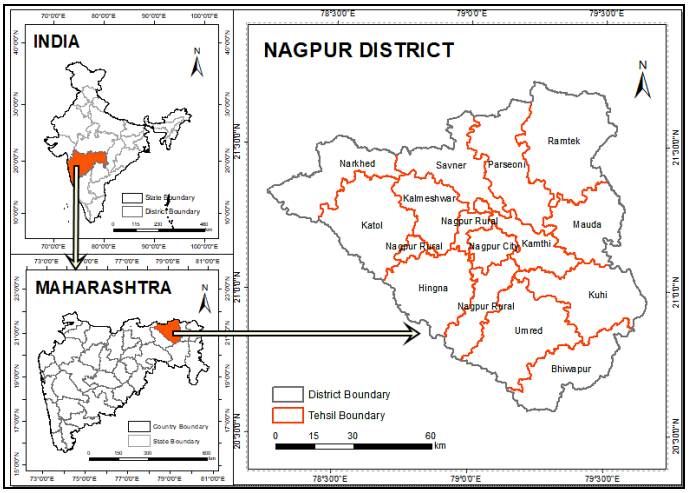

Fig-1 : Location Map of Nagpur District, Maharashtra

Maharashtra is the third largest state in area and the second-largest state in the population of India. Having an area of 307,713 sq. km with 35 districts, 358 blocks and 43711 villages and a population of 112,372,972 with 45% population of the state is urban. Nagpur is the winter capital city of Maharashtra state which is located in north eastern part of the state. The landscape in and around Nagpur consist of low flat-topped hills, black and fertile soils in the valleys of streams and rivers. The City is located at 20 35‟ to 21 45‟ North Latitude and 78 15‟ to 79 40‟ East Longitude. Altitude at 274m minimum and 652m maximum, location of the city is actually geographical center of the India. Kanhan River plays important role in the lives of the district. The Agriculture of Nagpur is primarily based on rain and canals which increases district production and productivity. In Nagpur district mainly Chilly and Oranges gives better returns as compared to other crops. In south eastern part of the district, Chilly crops are mainly taken. As the chilly is also famous by the name Bhiwapuri Mirchi. For crop separation

and acreage estimation of the district, data is acquired from the USGS Earth Explorer.

3. DATA AND SOFTWARE USED

Data used: Sentinel-2b, Shape files of Nagpur district, Ground truth data

Software: ArcGIS, Erdas Imagine, Google Earth Pro

4. METHODOLOGY

Classification of different crops using remote sensing technology primarily depends on the growing stages of crops and on crop season. Nagpur district takes multiple crops in Rabi season which includes gram, wheat, jowar, maize including chilli etc. For the classification of multiple crops, we used time-series data. There are two different classification techniques namely Supervised and Unsupervised classification. Supervised classification refers to the classification which uses training samples collected by the user in which software uses training pixels as references for classifying all other pixels of an image. Where the unsupervised classification uses software algorithms for classification of an image without any human intervention.

Different temporal images of the Rabi season were downloaded for the month October, November, December and January of the year 2021 & 2022. Selected data were used for analysis with less than 20% of cloud cover. False colour composite images were obtained from band-2(Blue), band-3(Green), band-4(Red) & band-8(Visible and Near Infrared). Near-infrared (B8) band is good at reflecting chlorophyll which shows healthy vegetation in bright red. Raster layer of agriculture mask and Orchard mask layer are applied on stacked NDVI image of agriculture fields for masking out only agricultural area for classification. NDVI images of different dates are layer stacked together in order to obtain NDVI profile of crops.

The Present study uses an unsupervised classification technique with the K-means clustering method. 50 classes were used with 0.999 convergence threshold for image processing. Where k-means is an algorithm that partitions 'n" observations into 'k' clusters in which each observation belongs to the cluster with the nearest centroid. The images are classified into clusters having similar pixels values. Mean NDVI reflectance value is calculated each class. For NDVI profile generation of each crop and for crop identification, NDVI versus different month graph is created for each class. Based on the NDVI reflectance values of crops and their varying curve within the course of crop growth, different crops were identified.

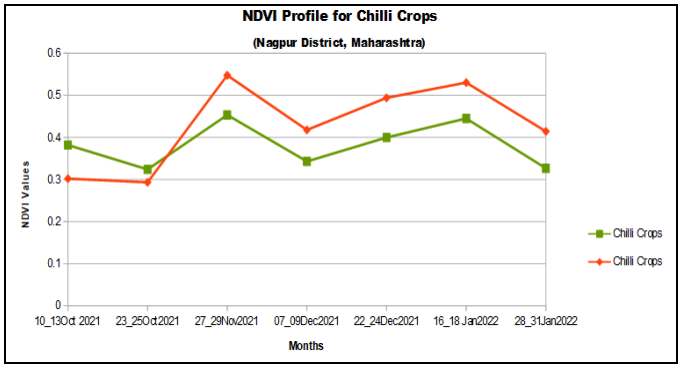

Chart-1: Graphical representation of identified Chilli crops (Rabi Season: 2021-2022)

Major crops taken in Rabi season are Gram and Wheat which are taken abundantly. Some chilli fields are also taken in the district. Chilli crops are standing crops of Rabi season which can be easily interpreted based on their NDVI profile.

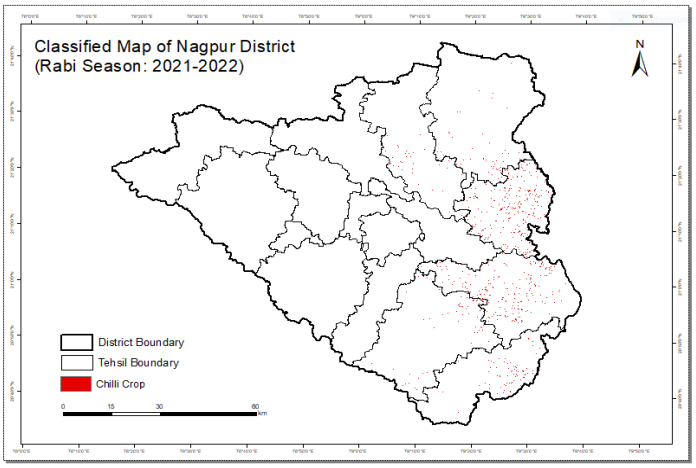

Fig-2: Classified Map of Nagpur District for Chilli crop (Rabi Season: 2021-2022)

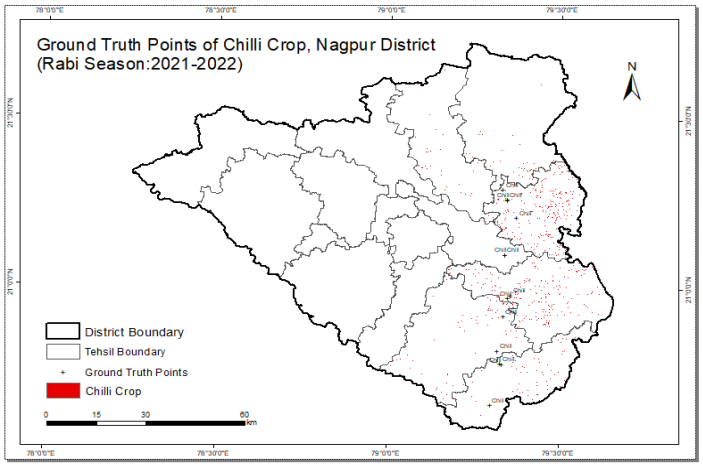

Fig-3: Ground Truth points of Nagpur District for Chilli crop (Rabi Season: 2021-2022)

5. RESULTS

The estimated Chilli acreage is based on NDVI reflectance values obtained from sentinel-2 satellites. All chilli fields are identified as standing crop in Rabi season for the study area whose NDVI profile graph is increasing. Chilli crops are also identified by basic image interpretation where yellow patches near some of the Chilli fields shows the dried chillies were placed nearby. Classification is achieved by studying the NDVI curve obtained for each class according to the crop growth timeline. The Accuracy of classification is verified by ground truth points. According to crop statistics we observed that acreage estimated for chilli crop is about 6461.55 hectares in the growing Rabi season.

Table -1: Crop Statistics for Chilli crop, Nagpur (Rabi Season: 2021-2022)

Tehsil	Chilli Acreage as per Classification (Hectare)
Mauda	1712.31
Kuhi	1483.57
Ramtek	1034.77
Kalameshwar	903.83
Umred	597.11
Bhiwapur	496.44
Parseoni	233.62
Total (Nagpur)	6461.55

6. CONCLUSION

Time-series image classification can be used for multiple crop identification. NDVI image helps in identifying accurate crop fields with the help of multiple dates NDVI profile curve. The Obtained curve is based on NDVI reflectance value. K-Means unsupervised classification is performed with 50 classes is sufficient to identify different chilli crops and for estimating chilli crop acreage of the district. NDVI profile curve obtained for each class is observed according to crop duration and crop health.

REFERENCES

[1] Carlos, A. O. V., Paul M., Paul A. (2002).Agricultural Crop classification using the spectral-temporal response surface, Anais XI SBSR, Belo Horizonte, Brasil, 05-10 abril 2003, INPE, p. 255-262.

[2] Rei S., Yuki Y., Hiroshi T., Xiufeng W., Nobuyuki K., Kanichiro M. (2018). Crop Classification from sentinel-2-derived vegetation indices using ensemble learning, J. Appl. Remote Sens. 12(2), 026019 (2018), doi: 10.1117/1.JRS.12.026019.

[3] Nobuyuki K., Hiroshi T., Xiufeng W. & Rei S. (2019). Crop classification using spectral indices derived from Sentinel-2A imagery, Journal of Information and Telecommunication, DOI: 10.1080/24751839.2019.1694765.

[4] Bhuyar N., Acharya S., Theng D. (2020). Crop Classification with Multi-Temporal Satellite Image Data, International Journal of Engineering Research & Technology, Vol. 9, 2278-0181.

[5] Dimo D., Fabian L., Mirzahayot I., Galina S., Christopher C. (2017). SAR and optical time series for crop classification, DOI: 10.1109/IGARSS.2017.8127076.

[6] Jingduo S., Minfeng X., Yichuan M., Long W., Kaiwei L., Xingwen Q. (2019). Crop Classification Using Multitemporal Landsat 8 Images, DOI: 10.1109/IGARSS.2019.8899274.

[7] Raiyani K., Goncalves T., Rato L., Salgueiro P., Marques da Silva J. R.,.(2021). Sentinel-2 Image Scene Classification: A Comparison between Sen2Cor and a Machine Learning Approach. Remote Sens.2021, 13,300. DOI: 10.3390/rs13020300.

[8] Hejmanowska B., Kramarczyk P., Glowienka E., Mikrut S. (2021). Reliable Crops Classification Using Limited Number of Sentinel-2 and Sentinel-1 Images. Remote Sens. 2021,13,3176. DOI: 10.3390/rs13163176.

[9] Katharina H., Daniel S., Sibylle I. (2018). A Progressive Crop-Type Classification Using Multitemporal Remote Sensing Data and Phenological Information. Journal of Photogrammetry, Remote Sensing and Geoinformation Science.2018, 86:53-69.DOI: 10.1007/s41064-018-0050-7.

[10] LatLong.net. Nagpur, India. https://www.latlong.net/place/nagpur-india-622.html

[11] MapsofIndia.com.https://www.mapsofindia.com/nagpur/businesseconomy/agriculture.html

[12] District Nagpur. About District. https://nagpur.gov.in/

[13] Indian Village Directory. Nagpur. https://villageinfo.in/maharashtra/nagpur/nagpur-rural.html

[14] Egyankosh.AccuracyAssessment.https://www.egyankosh.ac.in/bitstream/123456789/39544/1/Unit-14.pdf

[15] Geospatial Technology. What's the difference between a supervised and unsupervised image classification. https://mapasyst.extension.org/whats-the-difference-between-a-supervised-and-unsupervised-image-classification/

[16] Department of Agriculture & farmers Welfare. https://agricoop.nic.in/hi/agriculture-contingency-plan-listing

[17] Department of Agriculture & farmers Welfare. https://agricoop.nic.in/sites/default/files/Maharashtra-SAP_V1.3-2.pdf

[18] InsightsIAS.https://www.insightsonindia.com/agriculture/role-of-agriculture-in-indian-economy/

[19] Agriculture Contingency Plan for District: NAGPUR. https://agricoop.nic.in/sites/default/files/MH18-%20Nagpur.pdf

[20] Krishi Vigyan Kendra, Nagpur. http://kvknagpur.org.in/AboutNagpur.html

[21] Nagpur district. https://en.wikipedia.org/wiki/Nagpur_district

[22] AgricultureSeasons.https://gazetteers.maharashtra.gov.in/cultural.maharashtra.gov.in/english/gazetteer/Nagpur/agri1.html#:~:text=The%20kharif%20season%20which%20commences,is%20received%20during%20this%20season