Crop Classification with Machine Learning Technique using Sentinel-2 Satellite Data

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1. Introduction

The increased demand for food due to rapid population growth has been identified as a global concern that calls for innovative approaches to achieve sustainable agriculture. Accurate crop-specific information is very important for decision making, and resource allocation, which are vital for realizing food security. The conventional approaches are not sustainable because they often require many resources, are labour intensive, and are time-consuming. Geographical Information Systems (GIS) and remote sensing can provide evidence-based information with good accuracy to boost crop production. Satellite imagery is now available with enhanced spatiotemporal accuracy and Machine Learning (ML) algorithms that enable the production of accurate and efficient crop classification maps to support decision-making at various levels of government, especially in resource allocation. This study focused on the classification of two major crops i.e., sugarcane and cotton using sentinel-2 time series data and Random Forest (RF) algorithm in Orfeo toolbox. These crops are widely used as raw materials in many industries in the world. The presence of the JDW sugar mill industry in Pakistan nearby, which seeks information on sugarcane production, influenced our selection of the study area for this research.

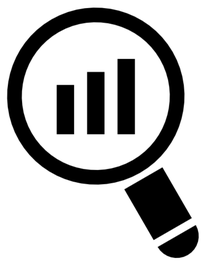
2. Study Objectives

1. Examine the existing land cover types
2. Identify Crop lands
3. Accuracy assessment
4. Estimate the land acreage

3. Material

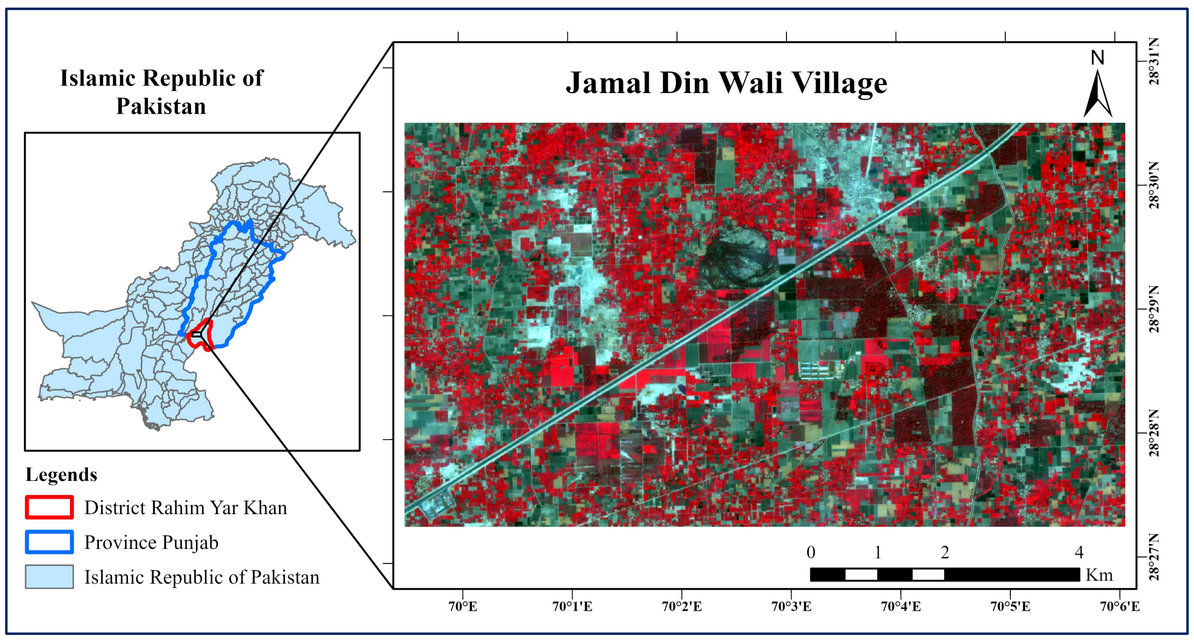
1. Administrative Boundary from DIVA. GIS

2. Sentinel-2 Images from Copernicus Hub



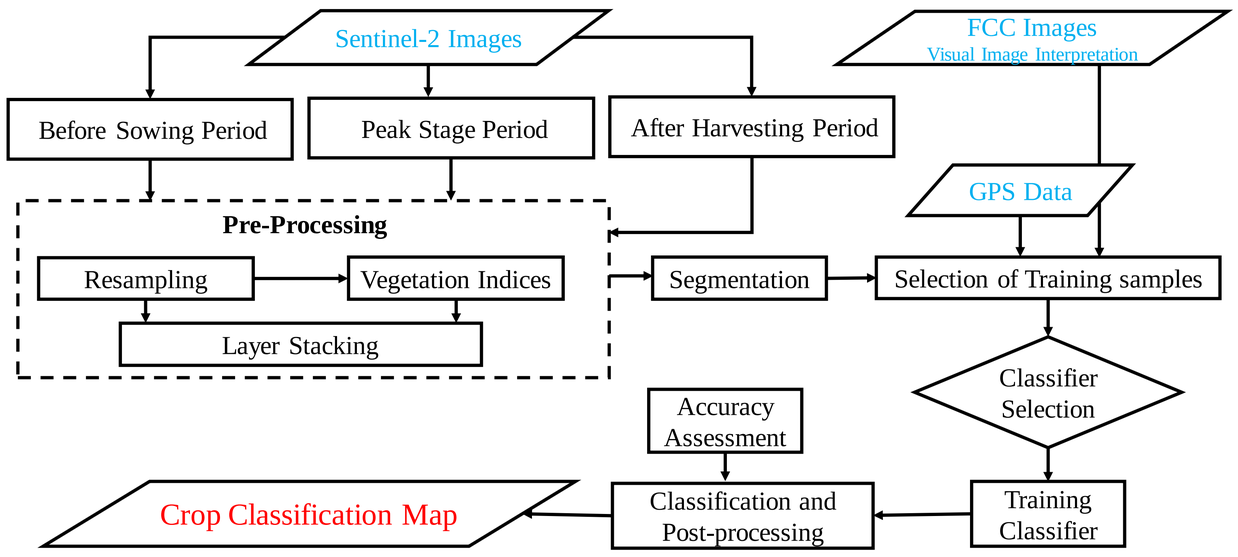
3. GPS Field Data from Farmdar, Pakistan

4. Study Area



Study area Map Sentinel-2 Image False Colour Combination (FCC) 843 bands

5. Methodology



Flowchart crop classification using sentinel-2 Data

6. Results and Discussion

- The results of the classification using uni-temporal satellite images (based on crop cycle) are shown in Figure 1. Eight landcover classes are shown, which sugarcane is the dominant crop in the study area (green color) and other non-agricultural classes such as built-up and roads. The classification result from the multi-temporal image (Figure) gives a better accuarcy of 84.75% (Figure 4) because of the improved temporal resolution that captures the crops phenological differences or changes. The multi-temporal data also performs better in classifying sugarcane than the other unitemporal images with a producer accuracy of 87.3%**.** The stable land cover classes, bare soil and road, have a consistent accuracy throughout the seasons. The final crop classification map (Figure 3), produced by post processing of Figure 2, shows that sugarcane and cotton are the dominant crops, then other vegetation which includes mostly orchards and finally grass. The "other" group contains the other land cover types.

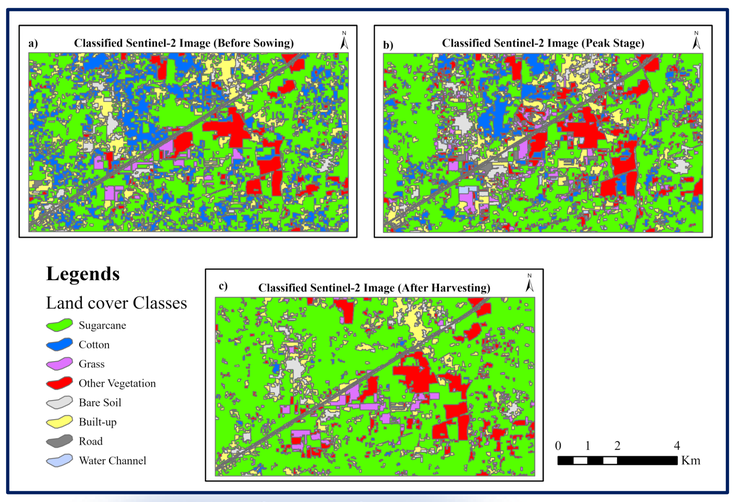


Figure 1. Classification of Sentinel-2 Images

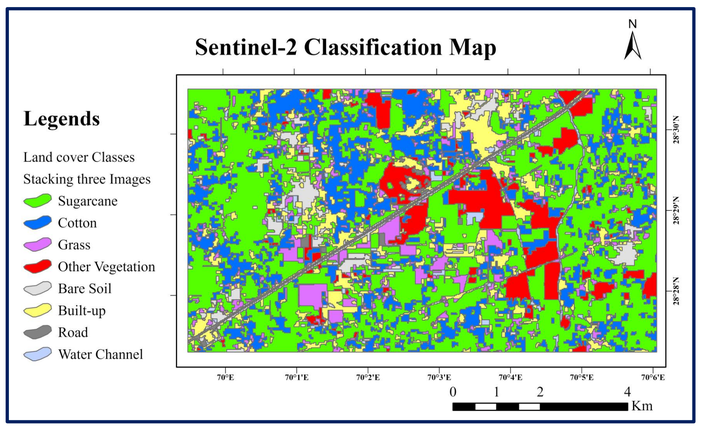


Figure 2. Classification Map of Sentinel-2 Image (stacking three images)

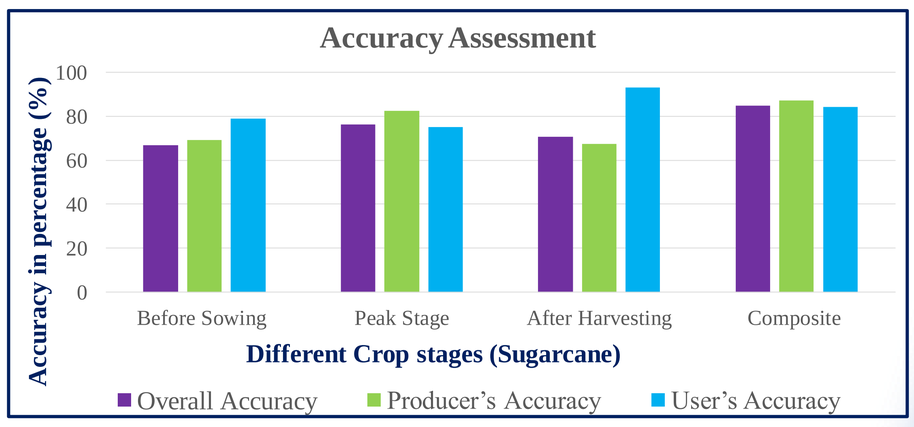


Figure 4. Accuracy comparison of composite with three of classified images

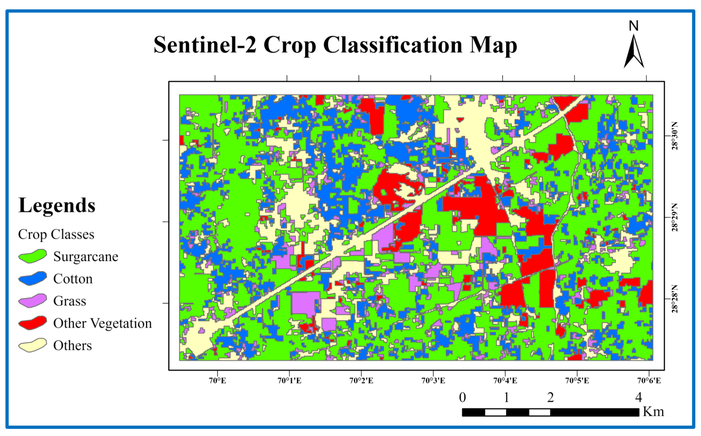


Figure 3. Crop Classification Map of Sentinel-2 Image

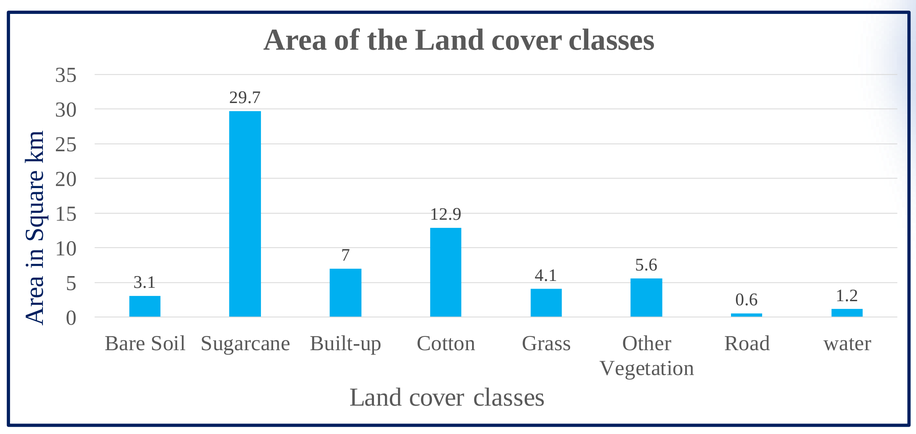


Figure 5. Area of each land cover classes

7. Conclusions

- Using **multi-temporal satellite imagery** is better for **crop classification** because of the rapid phenological properties of crops and the varying weather conditions.
- The study area is really agro-intensive, majorly **dominated** by **sugarcane and cotton.**
- For the **improvement** of this classification, **model training** sample size can be **increased**.

8. Recommendations

- We recommend collecting **training samples** from the field in **multiple time phases** to capture the crop phenology better, therefore enhancing the classification accuracies.
- The use of **hyperspectral imagery** from satellite or **drone** will give a better result in distinguishing sugar cane from other crop types.

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