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# Cashew area mapping using Sentinel-2 in Ariyalur District of Tamil Nadu, India

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## ABSTRACT

A research study was conducted for mapping Cashew plantation in Ariyalur district of Tamil Nadu using Sentinel-2 data. Extensive demand for raw Cashew, favours the district in large production area of Cashew. High-resolution, cloud-free Sentinel-2 data was acquired and pre-processed with GIS tools. Significant dB values for Cashew plantation was identified by using ground truth data collected during the survey, which was then further used to classify the Cashew pixels in the study area using supervised classification methodology. The Cashew area in Ariyalur district was found to be 26844 ha during the year 2021. Accuracy assessment was done using Confusion matrix with the ground truth points collected. The overall classification was done with an accuracy of 85 *per cent* and kappa score of 0.7.

Key words : Sentinel-2, Cashew, Area mapping, Supervised classification

# Introduction

Cashews are high value dry fruits and high demand for raw cashew nut was the most prominent factor that favoured cashew cultivation in Tamil Nadu (Venkattakumar, 2009). The term remote sensing replaces conventional method of crop area estimation. The growing innovations in Remote sensing technology aids in crop acreage estimation, crop status monitoring, mapping, identification of biotic and abiotic stresses (Eugenio *et al.*, 2020). Spatial estimation of Cashew area helps in decision making and sustainable production in different levels of agreement. Crop discrimination is not convincing for most agricultural monitoring systems. Assessing crop area is difficult due to socio-economic conditions, crop-destruction methodology and spatial similarity. Remote sensing based crop assessment came into existence to over-come traditional survey methods (Shewalkar *et al.*, 2014). Comparing Sentinel data with Landsat data for crop area estimation and stress-detection, Sentinel was preferred due to its technical features and availability of the data (Segarra *et al.*, 2020). The use of Sentinel data in crop discrimination and crop area estimation produced accuracy 4 to 5 *per cent* greater than Landsat data (Forkuor *et al.*, 2014).

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Sentinel-2 provides multi-spectral, high resolution imageries with thirteen different bands in electro-magnetic spectrum (Drusch et al., 2012). High spatial and spectral characteristics of Sentinel-2 data enhance GIS operations to the next level (Pesaresi et al., 2016). Ground truth observations collected in the study area were used to obtain Cashew pixels from pre-processed satellite images. Cashew growing areas can be demarcated from the study area by using specialised GIS tools. Optical remote sensing products are used in discriminating land use – land cover, due to their visible spectral range. Since, Cashew is a plantation crop, the cropping season is not limited to time period. This provides us contentment in acquiring cloud free satellite data. To enhance Supervised classification, ground truth data was used, through which area estimation and accuracy assessment can be done.

### Materials and Methods

#### Study area

Ariyalur is the most important cashew producing district in Tamil Nadu, accounting for over 36 *per cent* of total production. This district is bordered by Cuddalore on the north, Thanjavur on the south,

Perambalur and Tiruchirappalli on the west and Nagapattinam on the east. The geographical area of the Ariyalur District is 1,93,338 hectares. The total cropped area is 1,11,874 hectares. The study area is clearly shown in Fig.1.

### Satellite data

Since, the cloud cover restricts the spatial visibility, satellite imageries are obtained during summer season, where comparatively less cloud cover is achieved. There are 13 spectral bands in Sentinel-2, out of which we use only 3 bands and their corresponding wavelength is depicted in Table .1. The satellite data was downloaded from Copernicus Open Access Hub (Figs.2.). The downloaded data was then optimized through a series of pre-processing techniques (Fig.3.) – (i) *Composite Bands* - to obtain an RGB image (ii) *Mosaic to new raster* - to obtain

 
 Table 1. Sentinel-2 Bands and their corresponding wavelengths

Sentinel-2 Bands	Wavelength (mm)	
Band 3 – Green	559.8 mm	
Band 4 – Red	664.6 mm	
Band 8 – NIR	832.8 mm	

Source: sentinel.esa.int



Fig. 1. Study area map of Ariyalur district

a single image of different downloaded scenes (iii) *Extract with Mask* – to get a Sentinel-2 image of Ariyalur district with less cloud cover.

# Ground truth Data Collection

Ground truth points of Cashew plantations were collected in the study area. A total of 150 points were collected during ground truth survey which were then used for training and validation purposes. A total of 120 Cashew points and 30 Noncashew points were collected.

# Supervised Classification

The most commonly used methodology for classifying images are Supervised classification and Unsupervised classification. Higher accuracy is achieved in Supervised classification when compared to Unsupervised classification (Kavzoglu, 2009). Supervised classification is a quantitatively analyzing technique where the pixels are segregated into different spectral regions based on pixel values that corresponds to their ground cover class (McDermid *et al.*, 2005).

## Accuracy assessment

Classification accuracy is done using Error matrix and Kappa statistics. The pixels of agreement and non-agreement are compiled in the form of error matrix (Lillesand, 1994). Overall accuracy, producer's accuracy, user's accuracy and Kappa Coefficient can be computed through this error matrix (Congalton, 1991).



Fig. 2. Methodology for Mapping Cashew Area from Sentinel-2 data

# **Results and Discussion**

## Cashew area estimation

The estimated Cashew area in Ariyalur district was 26,844.9 hectares (Fig.3.1.), while the statistical area from Department of Economics and Statistics was found to be 30,393 hectares. The estimated area was 11.67 deviated from the Statistical data (Table .1.). The area distributed within the blocks was uneven. Sendurai (8954 ha) and Andimadam (8741.9 ha) were distributed with high cashew plantation area. Other blocks Jayamkondam (2751 ha), Ariyalur (1700.4 ha), T.Palur (1761 ha), Thirumanur (2936.3



Fig. 2. Overview of Sentinel-2 data acquisition for Ariyalur district of Tamil Nadu

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District	Estimated area (in Ha)	Statistical area (in Ha)	Deviation (in per cent)
Ariyalur	26,844	30,393	-11.67

Table.1. Comparison of output with standard data from DES

ha) has comparatively less, which indicates the chances of growth of other major crops of Ariyalur district (Table.2.). 60 *per cent* of the Cashew points were used for Accuracy assessment purpose. These points were validated with classified output. Similarly, Sugavaneshwaran *et al.* (2021) used Sentinel-2 data and sentinel-1A SAR data for *Kharif* paddy area estimation at Cauvery delta zone of Tamil Nadu and estimated that 82231.93 ha while using optical data.

Name	Block area (In ha)
Andimadam	8741.9
Sendurai	8954.0
Jayamkondam	2751.0
Ariyalur	1700.4
T.Palur	1761.0
Thirumanur	2936.3
Total	26844.9

#### Accuracy Assessment

A standard confusion matrix was applied to Cashew/Non-cashew validation points collected during ground truth with classified image. An overall accuracy of 85 *per cent*, producer's accuracy and user's accuracy for cashew was 87.2 *per cent* and 93.2 *per cent* respectively was obtained, and producer's accuracy and user's accuracy for non-cashew was 76.9 *per cent* and 62.5 *per cent* respectively was obtained. Kappa index of 0.7 was achieved, which shows a good qualification accuracy (Table .3.). The results were conformity with the findings of Kaplan *et al.* (2017) mapping of wetlands using Sentinel-2 satellite imagery with an overall accuracy of 99 *per* 

Table 3. Confusion Matrix for accuracy assessment



Fig. 3. Cashew area Map for Ariyalur District

*cent* and kappa score of 0.95. Whereas Mariana *et al.* (2017) reported that cropland mapping in three different climatic conditions using Sentinel-2 data produced accuracy ranging from 78.08 *per cent* to 96.19 *per cent*.

## Conclusion

The optical data was used to map the area of Cashew plantation in Ariyalur district. Spatially estimated cashew area is 26844.9 hectares which found to be 11.67 *per cent* deviated from the statisti-

Actual class from		Predicted class from the map		
survey		Cashew	Non-Cashew	Accuracy
	Cashew	82	12	87.2%
	Non-Cashew	6	20	76.9%
	Reliability	93.2%	62.5%	85%
	2	Average accuracy		82.1%
		Average reliability		77.8%
		Overall accuracy		85%
		Kappa index		0.7

cal area from Department of Economics and Statistics, Government of Tamil Nadu for the year 2019-2020. An overall accuracy of 85 *per cent* was achieved with a kappa index of 0.7. The estimated area is found to be in good agreement with actual Cashew spread.

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