Original Research Article

MANGO AREA MAPPING FROM VERY HIGH-RESOLUTION SATELLITE DATA IN MAJOR BLOCKS OF KRISHNAGIRI DISTRICT, TAMIL NADU

Abstract

A research study was carried out for mapping mango plantation in the major blocks of Krishnagiri district, Tamil Nadu using LISS IV data. A district with a substantial mango production area benefit from the high demand for raw mango. Very high-resolution satellite data from LISS IV was acquired and pre-processed with GIS tools. Ground truth data gathered during the survey was utilized to identify significant dB values for mango plantations, which were then used to classify the mango pixels in the study region using supervised classification methodology. The Mango area in major blocks of Krishnagiri district was found to be 9077.9 ha during the year 2023. Accuracy assessment was done using Confusion matrix with the ground truth points collected. The overall classification was done with an accuracy of 91.2 *per cent* and kappa score of 0.62.

Keywords: LISS IV, Mango, Area mapping, Supervised classification

1. Introduction:

Mango are high value crops grown as plantations and as individual trees. Mango (*Mangifera indica*) is the most important commercially grown crops of India (Pasha *et al.*, 2023). India produces 12.5 million tonnes of Mangoes annually (40 per cent of the world production) (Kulshreshtha *et al.*, 2023). Tamil Nadu ranks fifth in the production of Mangoes with an area of 1,25,100 ha and productivity of 4.30 t/ha which accounts for 5 lakh tonne yearly. The Major varieties are Banglora, Banganapalli, Neelum, Rumani, Mulgoa, Alphonso. The crop is majorly grown in Salem, Krishnagiri, Dharmapuri districts of Tamil Nadu.

For several reasons, crop identification and mapping are essential. Planning and management of sustainable resource use involve crop and area estimation monitoring. Regional agricultural boards, insurance companies, and national and international agricultural organisations all produce crop type maps to compile an inventory of the crops that were

cultivated where and when (Gokool *et al.*, 2023). This helps with grain supply forecasting (yield prediction), crop production statistics collection, crop rotation records facilitation, soil productivity mapping, identification of factors influencing crop stress, evaluation of crop damage caused by storms and drought, and activity monitoring in agriculture. The traditional method of estimating crop acreage through survey is typically a time-consuming, inaccurate, and expensive operation(Guan *et al.*, 2023).

(Singh *et al.*, 2016) states that in his study, shows classification accuracy increased from 55% while using LISS III to 77% when using LISS IV. Also, according to classified outputs and NDVI values obtained, April and May months were identified as optimum bio-window for crop identification. Pixel based classification often fails to capture the spectral variability in high resolution images while delineating of horticulture crops, especially orchards. It tends to classify individual pixels on the assumption that individual classes contain uniform spectral behaviour but does not include contextual information like texture, shape etc. High resolution imagery of IRS-Resourcesat 2 - LISS IV have been used (Roy *et al.*, 2018).

2. Materials and Methods:

2.1 Study area:

Among Tamil Nadu's districts, Krishnagiri is the one that produces the most mangoes, accounting for over more than 60 per cent of total production. In Krishnagiri district, major blocks are selected for this study. This district is entirely bounded by Karnataka state in the West and in the North, Andhra Pradesh state and Tiruppatur district in the East and Dharmapuri district in the South. The district extends from 11º 12' N to 12º 49' N latitude and 77º 27' E to 78º 38' E longitude. The total geographic area of Krishnagiri district is 5143 sq. km with an elevation from 300 m to 1400 m above MSL. The study area is clearly shown in Fig.1.

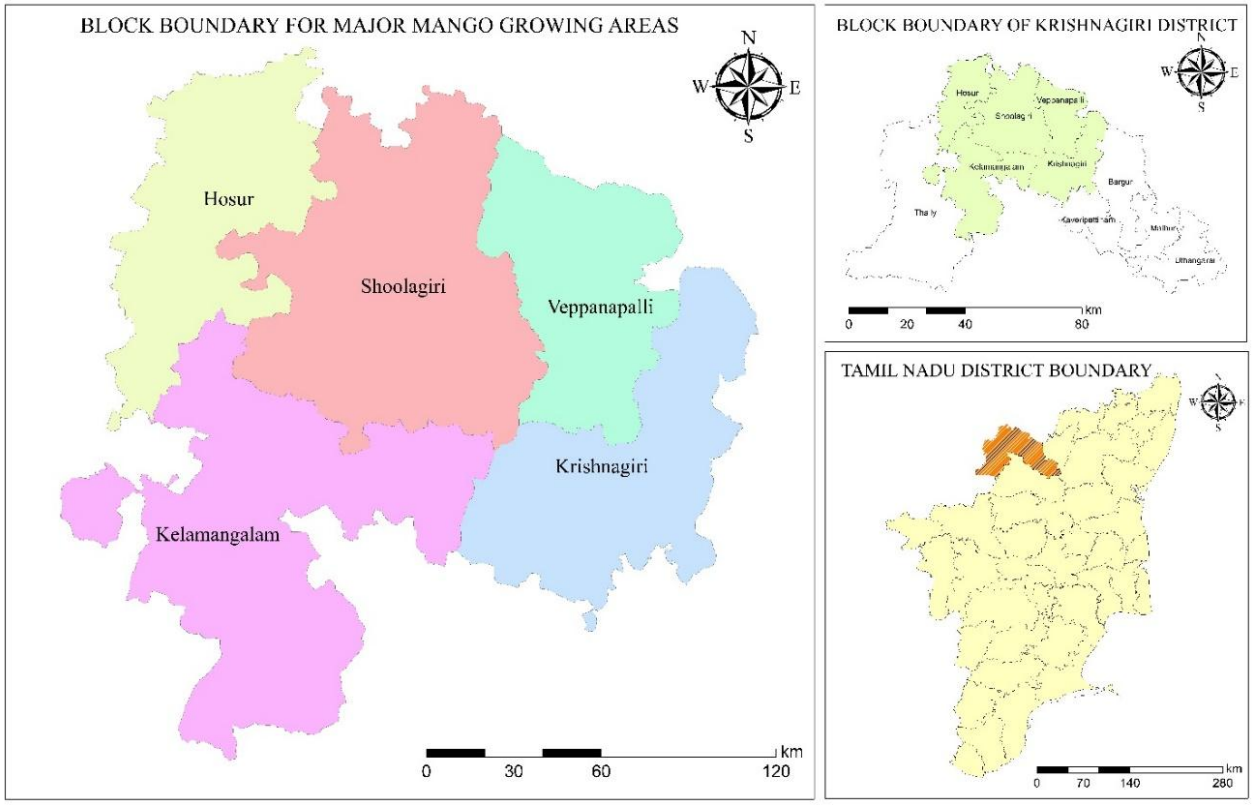

Fig.1. Study area map of Major blocks of Krishnagiri district

2.2 Satellite Data:

LISS-IV is a high resolution multi-spectral sensor operating in three spectral bands (B2 0.52 - 0.59, B3 0.62 - 0.68, B4 0.77 - 0.86) (Table .1.). LISS-IV provides a ground resolution of 5.8 m (at nadir). LISS IV data is bought from NRSC (National Remote Sensing Centre). The data was then optimized through a series of pre-processing techniques (Fig..2.) – (i) *Composite Bands* - to obtain an RGB image (ii) *Mosaic to new raster* - to obtain a single image of different scenes (iii) *Extract with Mask* – to get a LISS IV image of major blocks of Krishnagiri district.

Table 1. LISS IV Bands and their corresponding wavelengths

LISS IV Bands	Wavelength(μm)	Resolution (m)

Band 2 – VIS	0.52 to 0.59	5.8
Band 3 – VIS	0.62 to 0.68	5.8
Band 4 – NIR	0.77 to 0.86	5.8

Source: nrsc.gov.in

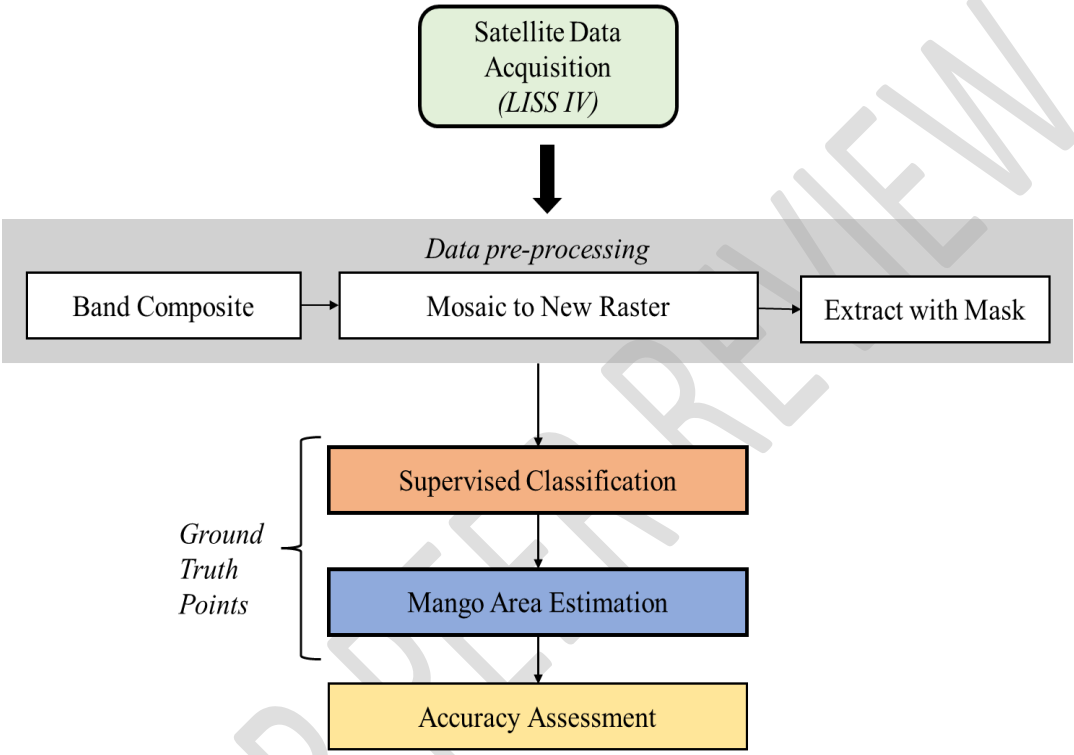

Fig.2. Methodology for Mapping Mango Area from LISS IV data

2.3 Ground truth data collection:

Ground truth points of Mango plantations were collected in this study area. A total of 60 points were collected during ground truth survey which were then used for training and validation purposes. A total of 60 Mango points and 40 non-mango points were collected.

2.4 Supervised Classification:

The two methods of image classification that are most frequently employed are supervised and unsupervised classification. When compared to unsupervised classification, supervised classification achieves a higher level of accuracy (Jiang *et al.*, 2023). A quantitative

analysis method, known as supervised classification divides the pixels into several spectral areas according to the pixel values that correspond to each type of ground cover.(Aliyu *et al.*, 2023).

2.5 Accuracy assessment:

Error matrix and Kappa statistics are used to determine the accuracy of classification. According to (Lillesand *et al.*, 1994), an error matrix is created using the pixels of agreement and disagreement. This error matrix can be used to calculate the Kappa Coefficient, producer's accuracy, user's accuracy, and overall accuracy(Congalton, 1991).

3. Results and Discussion:

3.1 Mango area estimation:

The estimated Mango area in major blocks of Krishnagiri district was 9077.9 hectares (Fig.3.), while the statistical area from **Department of Economics and Statistics** were found to be 9746.2 hectares. The estimated area was 6.85 percent deviated from the Statistical data (Table 2). The area of mango plantation was distributed within the blocks were uneven. The Krishnagiri and Shoolagiri blocks were distributed with high mango plantation area of 2726.3 and 2893.0 hectares, respectively. The second largest mango plantation area were Kelamangalam and Veppanapalli blocks of Krishnagiri district with 1086.0 and 1686.2 hectares, respectively. The Hosur block gave comparatively less, when compared to other blocks with 686.4 hectares, which indicates the chances of growth of other major crops like cut flowers, vegetables, etc., (Table .2.).

60 percent of the Mango points were used for Accuracy assessment purpose. These points were validated with classified outputs. (Sabthapathy *et al.*) used Sentinel-2A data for estimation of Mango and Cashew area for few districts of Tamil Nadu and estimated that 39313.01ha for entire Krishnagiri district. Similar to this, (Kannan *et al.*, 2021) calculated 82231.93 hectares utilizing optical data in the Cauvery delta zone of Tamil Nadu using Sentinel-2 data and Sentinel-1A SAR data.

Table 2. Comparison of output with standard data from DES

District	**Estimated area** (in Ha)	**Statistical area** (in Ha)	**Deviation** (in *per cent*)
Major blocks of Krishnagiri	9077.9	9746.2	6.85

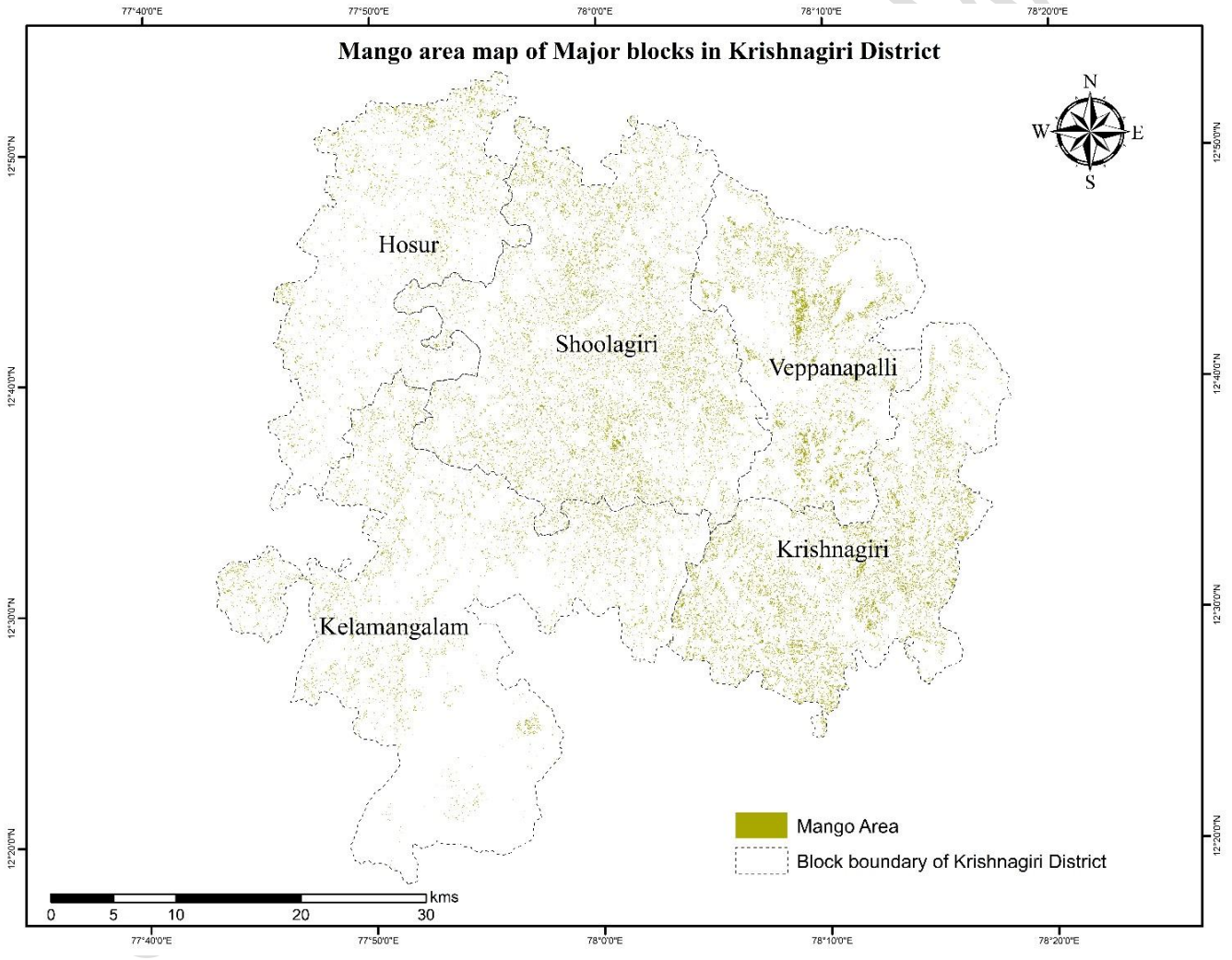

Fig.3.. Mango area Map for major blocks of Krishnagiri District

Table 3.. Mango area of major blocks in Krishnagiri district

Name	Block area (In ha)
Krishnagiri	2726.3
Shoolagiri	2893.0
Hosur	686.4
Kelamangalam	1086.0
Veppanapalli	1686.2
Total	**9077.9**

3.2 Object Based Classification:

Due to the high information richness, per-pixel categorization is less desirable for high-resolution imageries. The categorization accuracy will decline due to the increased variability in higher detailed satellite photos. In contrast to maximum-likelihood classification, object-based classification does not perform statistical analysis on a single pixel. The multi-resolution approach is one of several segmentation methods that is frequently used to distinguish groups of homogenous picture segments, also referred to as objects. The objects are created by spatially segmenting pictures based on their geometrical characteristics, such as form, texture, location, and spectral characteristics.

3.3 Accuracy Assessment:

To the Mango/Non-Mango validation points gathered during ground truth with the categorized image, a typical confusion matrix was used. A total accuracy of 91.2% was obtained, with producer and user accuracy for mango being 79.5 percent and 96.6 percent, respectively. For non-mango, producer and user accuracy were 92.6 percent and 62.5 percent, respectively was obtained. The Kappa index of 0.62 was achieved, which shows a good qualification accuracy (Table 4.). The results mirrored those of (Kaplan and Avdan, 2017) mapping of wetlands using Sentinel-2 satellite imagery, which had a kappa score of 0.95 and an overall accuracy of 99%. While (Belgiu and Csillik, 2018) showed that utilizing high-resolution data, cropland mapping under three different climatic circumstances generated accuracy ranging from 78.08% to 96.19%.

Table 4. Confusion Matrix for accuracy assessment

Actual class from survey	Predicted class from the map			
		Mango	Non-Mango	Accuracy
	Mango	58	15	79.5%
	Non-Mango	2	25	92.6%
	Reliability	96.6%	62.5%	91.2%
Average accuracy				86.1%
Average reliability				79.6%
Overall accuracy				91.2%
Kappa index				**0.62**

4.Conclusion:

The LISS IV satellite data was used to map the area of Mango plantation in major blocks of Krishnagiri District. The area of mango which were spatially estimated was 9077.9 ha which found to be 6.85 percent deviated from the statistical area from Department of Economics and Statistics, Government of Tamil Nadu for the year 2021-2022. An overall accuracy of 91.2 *per cent* was achieved with a kappa index of 0.62. The estimated area is found to be in good agreement with actual Mango spread.

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