

A CROPPING SYSTEM ANALYSIS FOR PALACODE TALUK USING REMOTE SENSING AND GIS

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ABSTRACT

A cropping system can be defined as the cropping patterns and their management to derive maximum benefits from a given resource base under specific environmental conditions. Crop rotation is stated as growing one crop after another on the same piece of land in different timings (seasons) without impairing the soil fertility. Remote sensing is the science and art of obtaining the object, phenomenon or area through the analysis of data acquired by a device that is not touched with the object, area or phenomenon under investigation that can be done at any time. While the crop type classification through satellite data, the interpretation of specific crop types can be identified by their spectral response pattern and texture. Multi-date data is essential to derive cropping patterns. Suitable multi date sentinel2 satellite images of kharif, Rabi and summer season was collected. Suitable dates were selected based on crop calendar. First satellite image is processed in NDVI to get vegetative and non-vegetative cover maps. Crop pattern distribution maps of Palacode Taluk were prepared by recoding of NDVI image into crop of interest based on ground truth collection. Crop acreage was derived from crop pattern map and it was compared with Department of Agriculture, Dharmapuri. The three cropping pattern maps (kharif, Rabi and summer) were used to generate crop rotation map. A logical class-code combination algorithm was used to derive the crop rotation map. The scope of the project was generation of crop pattern maps and crop rotation map of three different seasons such as kharif, Rabi, and summer seasons.

Key words: Crop pattern, Crop rotation, Remote sensing

I.INTRODUCTION

1. GENERAL

Indian society is agriculture based and its economy is dependent on agriculture. Cropping system analysis is essential for studying the sustainability of agriculture. Area under agriculture is limited. Therefore, it is important to select the right crop in the right season so that maximum profit may be achieved. Timely information about present cropping pattern and cropping pattern change is a pre requisite to devise an ideal cropping pattern within an agro-ecological region. Remote sensing and GIS has become very useful tools for the

management of dynamic agricultural resources. Satellite imagery has made it possible to map croplands and identify crop types at local, regional and global level.

1.2 OBJECTIVES

The objectives for cropping system analysis and management are as follows:

1. To generate crop pattern map of kharif, Rabi and summer seasons for Palacode taluk.
2. To derive crop statistics from crop pattern map and compare with statistics of DOA.
3. To generate crop rotation map for Palacode taluk.

II.STUDY AREA

The Palacode taluk extends to an area of 73,267 h.a, covering 16% of the district's total area. Palacode town is 285-km northwest of Chennai, the State Capital and 25-km from Dharmapuri on the southern side, 33-km from Krishnagiri in the north and 60-km from Hosur, a municipal town on the east. It is about 35 km from Pennagaram in the western side. Because of its geographical centrality in the region, Palacode hold a prominent place in trade activities. Also it is located along the Dharmapuri - Hosur State Highway. Apart from regional roads several Major District Road (MDR), Other District Roads (ODR) and local roads connects Palacode Town with surrounding villages and other urban center such as Pennagaram, Hogenakal and Kaveripattinam in the district and state. Agricultural produce, tomato in particular, is largely grown in Palacode area. A separate local market for tomatoes is maintained by the Palacode Town Panchayat, from which produce is transported to all parts of India. The primary occupation of the workforce is agriculture and trade. Nearly 10,000 strong workforces are dependent on agriculture. Palacode town is located along Athiyamankottai -Hosur State Highway. This town is surrounded on all side by hillocks. The town has gained its importance from Tomato, Mango, Coconut and Banana cultivation. Study area map shown in figure 1.

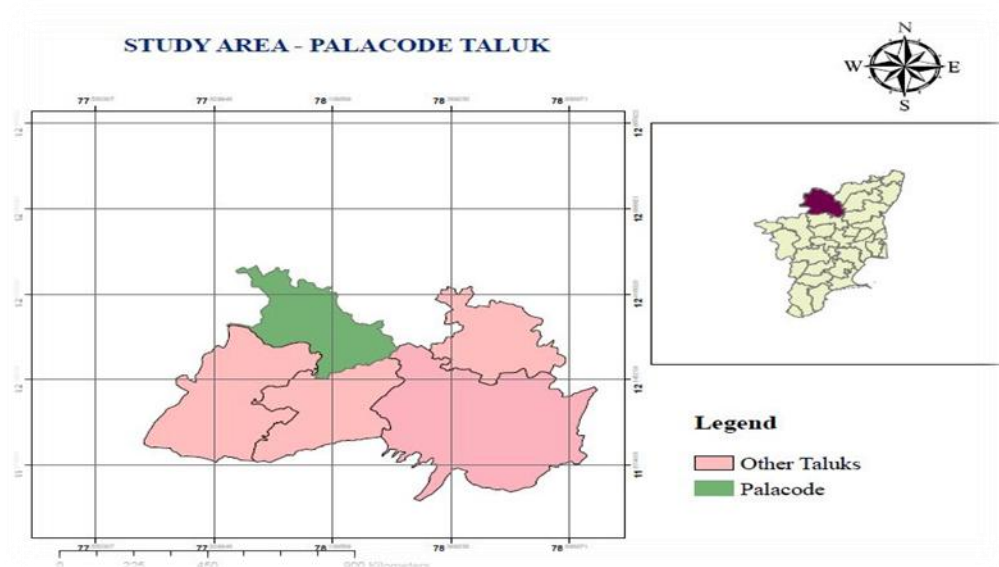


Figure1 Study Area Map

III.METHODOLOGY

3.1 GENERAL

The scope of the project was generation of crop pattern maps of three different seasons such as kharif, Rabi, and summer seasons. The data needed for the project was multi date multi seasonal sentinel images and crop statistics for the year of 2016-2017. Multi-date satellite data was downloaded from USGS website. Crop statistics data was collected from Department of Agriculture Darmapuri. Sentinel satellite images were downloaded for three crop seasons such as kharif, Rabi and summer. Methodology for crop rotation map generation shown in figure 2.

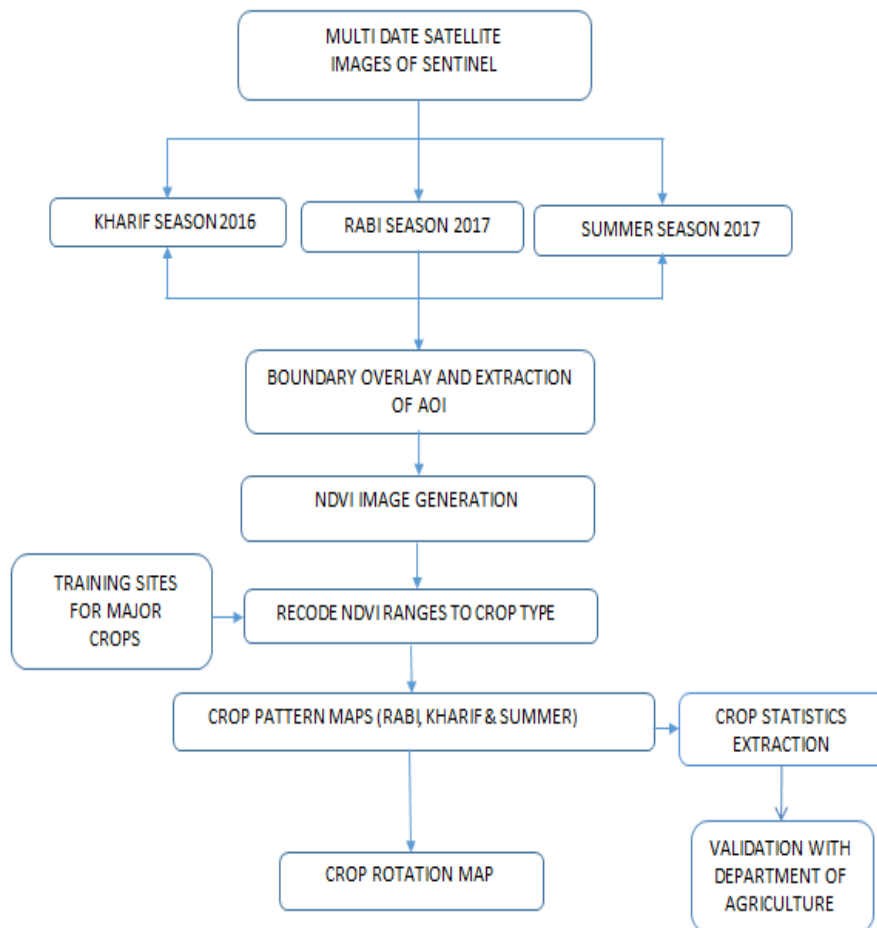


Figure 2 Methodology

The chlorophyll absorption in Red band and relatively high reflectance of vegetation in Near Infrared band (NIR) are using for calculating NDVI. Output of the NDVI method creates a single-band dataset that only shows greenery. Values close to zero represent rock and bare soil and negative values represent water, snow and clouds. Taking ratio or difference of two bands makes the vegetation growth signal differentiated from the background signal. By taking a ratio of two bands drop the values between -1 to +1. Water has an NDVI value less than 0, bare soils between 0 and 0.1, and vegetation over 0.1. Increase in the positive NDVI value means greener the vegetation. In LANDSAT 8 band 4 (red) and band 5 (NIR) have to take for calculation.

$$NDVI = \frac{NIR - Red}{NIR + Red}$$

3.2. DATA REQUIREMENT

Sentinel 2 Satellite imagery of suitable dates are needed to identify crop pattern distribution. Crop calendar is necessary to know the growth duration. Crop statistics collected from Department of Agriculture and it is needed to calculate relative deviation of the crop statistics derived from Remote sensing data. Sentinel 2 gives images in thirteen bands. In that band 3, 4 and 8A were used to create false color composite. Band 4 (red) and band 8A were used for NDVI image generation. 8A band is narrow NIR. It can be used to group the crops. ERDAS Imagine software is used to run NDVI.

3.3. GENERATION OF CROP PATTERN MAP

Sentinel-2 data products were used to generate crop pattern map. Band 4 (Red) and Band 8A (Narrow NIR) were used to generate NDVI image. Suitable cloud free images were selected based on crop calendar collected from DOA agriculture Dharmapuri. The training set selections were taken according to major crop production in the study area. Ground truth were collected for major crops such as paddy, sugarcane, cholam, ragi, red gram, turmeric, groundnut, cotton, lab, coconut plantation, mango and other vegetables. NDVI ranges for major crops were identified based on ground truth. Later the crop type classifications were successfully achieved by recoding the NDVI data from the training sets. NDVI images were recoded into crop of interest. Crop acreage was calculated for major crops and relative deviation was calculated by comparing statistics given by DOA Dharmapuri.

3.4 RECODE NDVI VALUES TO THE CROP OF INTEREST

NDVI ranges for Palacode taluk falls between -0.31 to 0.75. Coconut plantation getting higher NDVI values i.e. above 6.2. Paddy fields give NDVI ranges near to 6.0. Water bodies, roads, and settlement give NDVI values up to 2.0. Fallow land gives NDVI ranges between 2 to 3.5. Grassing takes place in fallow land hence NDVI ranges reach up to 3.5. Sugarcane gives NDVI ranges of 5.5 to 5.8 at summer season and 5.7 to 5.9 at kharif season. Other crops range between 4.0 and 4.8. Perennial trees get NDVI ranges of 4.8 to 5.5.

3.5 CROP ROTATION

Crop rotation is the planting of different crops in recurring succession in the same field. Crop rotations are fundamental to sustainable cropping systems. A well-designed crop rotation creates farm diversity and improves soil conditions and fertility. The study of crop rotation map will be very helpful in making good crop rotations planning. It improves the soil structure some crops have strong, deep roots. Others have many fine, shallow roots. They tap nutrients near the surface and bind the soil. They form many tiny holes so that air and water can get into the soil. It increases soil fertility Legumes (such as groundnuts and beans) fix nitrogen in the soil. When their green parts and roots rot, this nitrogen can be used by other crops such as maize. The result is higher, more stable yields, without the need to apply expensive inorganic fertilizer.

3.6. CROP ROTATION MAP GENERATION

Crop Rotation technique is to identify the specific location of main rotated crops of Kharif, Rabi and summer season. Crop rotation involves three seasons namely kharif, Rabi and summer. Different crop rotation pixels were identified based on class codes algorithms performed on raster calculator. Each crop rotation is prepared as separate raster layer. These raster layers having zero and one values. One indicating particular crop rotation pixels and zero indicates other than that crop rotation pixel. Finally these different combinations were combined to generate crop rotation map. Different crop rotation followed in Palacode taluk shown in figure 4.

IV.RESULT AND DISCUSSION

4.1.CROP PATTERN MAP

NDVI values were recoded to crop of interest. Major crops in kharif season are cholam, pulses, ragi, sugarcane and paddy. Sugarcane is ten months crop and its covers into two seasons. Different rice varieties are sown in this taluk. In Rabi season major crops are turmeric, ragi, vegetables, and rice. Ragi covers most acreage in Rabi season. Vegetables like tomato, brinjal, cauliflower, bitter guard and ladies finger are cultivated. In Rabi and summer season most of agricultural land is left as fallow land for many reasons. In summer season sugarcane is the main crop. So it can easily identifiable. Summer crop pattern give good accuracy than other two. Fallow land NDVI ranges decreased in summer season due to the absence of grass and other vegetation. Crop acreage for three seasons had shown in table 1, 2 and 3.

TABLE 1 CROP ACREAGE KHARIF SEASONTABLE 2 CROP ACREAGE RABI SEASON

CROPS	AREA (Hectares)
Fallow Land	33577.26
Pulses	6269.89
Cholam /Ragi	5593.84
Sugarcane	1401.5
Rice	960.15

CROPS	AREA (Hectares)
Fallow Land	34982.92
Raga/Vegetables	4244.08
Sugarcane	667.96
Other crops	9118.8
Rice	793.75

TABLE 3 CROP ACREAGE SUMMER SEASON

CROPS	AREA (Hectares)
Fallow Land	45973.85
Other crops	7593.129
Sugarcane	1101.75

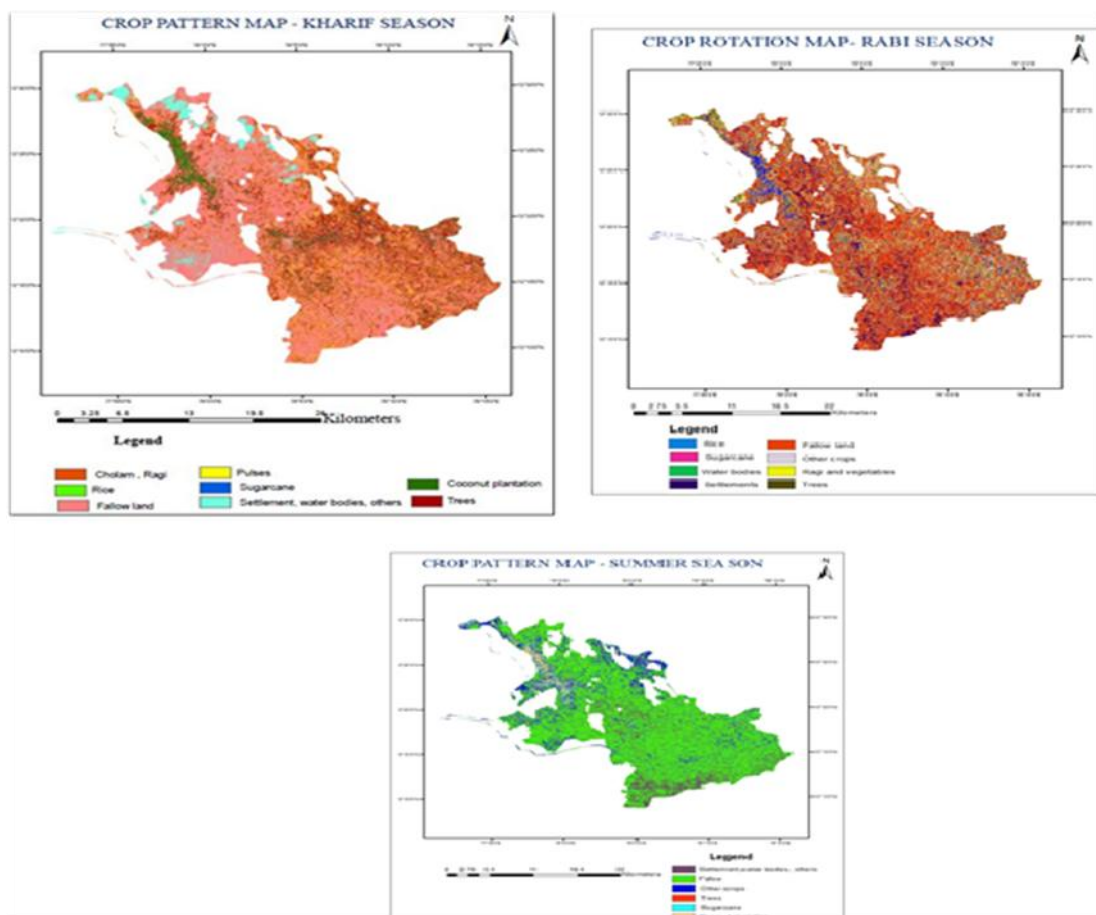


Figure 3 Crop Pattern Maps For Kharif, Rabi And Summer

**4.2. COMPARISON B/W CROP STATISTICS DERIVED FROM RS DATA AND GIVEN BY DOA
 DHARMAPURI**

Crop statistic data collected from Department Of Agriculture, Dharmapuri for the validation of crop pattern map derived from RS data. Formula used to calculate relative deviation is following below:

$$\%RD = \frac{RS - DOA}{DOA} \times 100$$

Kharif season shows higher deviation due to small agricultural fields, mixed crops and crops diversity. Rabi shows lesser deviation while comparing kharif season. Summer shows very less deviation due to less agricultural activities and single crops cultivation. Relative deviation shown in table 4.

TABLE 4 RELATIVE DEVIATION

SEASON	CROP	RS AREA (Hectare)	DOA AREA (Hectare)	% RD
KHARIF	Pulses	6269.89	6120	2.45
	Cholam/Ragi	5593.84	4763	17.45
	Sugarcane	1401.05	1230	13.91
	Rice	960.15	927	3.58
RABI	Raga/Vegetables	4244.08	3869	9.7
	Other crops	9118.8	8754	4.17
	Rice	793.75	742	6.98
SUMMER	Other crops	7593.129	7124	6.59
	Sugarcane	1101.75	1050	4.93

4.3 CROP ROTATION STATISTICS

Pulses are the major single crop in kharif season. Next to pulses ragi and cholam are cultivated much in this season. Cholam/ragi-ragi/vegetables-fallow is the main crop rotation followed in Palacode Taluk. Sugarcane-sugarcane-fallow also the major crop rotation. Crop rotation influenced by rain fall level at particular year. Crop rotation pattern followed in this taluk is listed in table 5.

TABLE 5 CROP ROTATION STATISTICS

S.No	Crop Rotation	Area (hectare)
1	Cholam/ragi-rice-othercrops	10.36
2	Sugarcane based	55.79
3	Rice-ragi/vegetables-fallow	64.44
4	Sugarcane-sugarcane-othercrops	24.49
5	Pulses - rice-sugarcane	2.73
6	Pulses-ragi/vegetables-othercrops	178.89
7	Rice-ragi/vegetables-othercrops	26.77
9	Cholam/ragi -ragi/vegetables-othercrops	250.36
10	Cholam/ragi-ragi/vegetables-fallow	305.07
11	Pulses-rice-fallow	14.98
12	Rice-rice-fallow	19.58
13	Cholam/ragi-fallow-fallow	2460.31
14	Pulses-rice-othercrops	7.9
15	Rice-othercrops-othercrops	14.65
16	Cholam/ragi-othercrops-othercrops	371.28
17	Rice-fallow-fallow	95.54
18	Fallow-fallow-fallow	20462.7
19	Fallow-rice-fallow	49.73
20	Fallow-ragi/vegetables-fallow	480.42
21	Fallow-othercrops-fallow	2067.51
22	Pulses-fallow-fallow	3305.68
23	Sugarcane-sugarcane-fallow	941.59

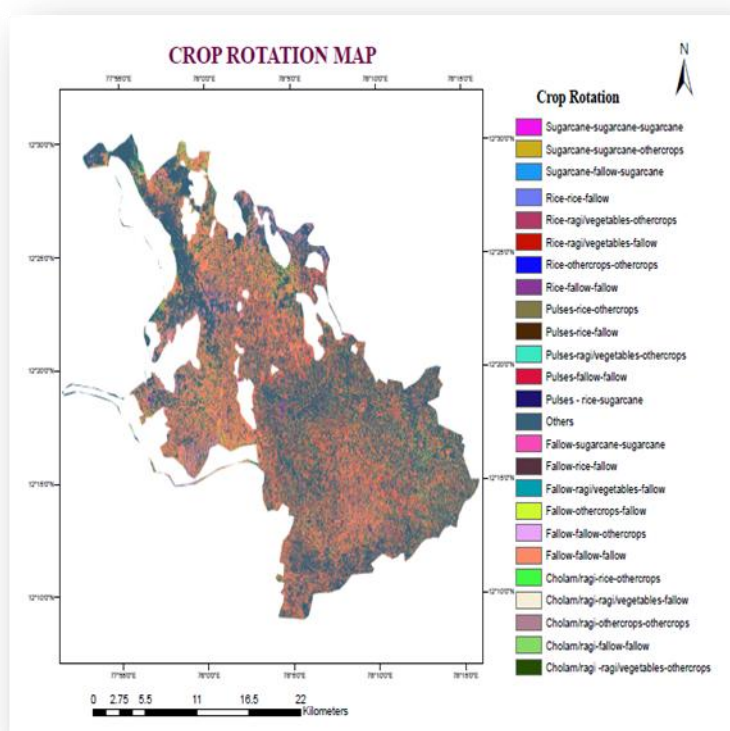


FIGURE 4 CROP ROTATION MAP OF PALACODE TALUK

1.4 CROPPING SYSTEM CLASSIFICATION

Based on water availability, rainfall, temperature, climate and other economic factors plays important role in cropping system. Kharif crops are mostly rain fed crops. Single crop area means agricultural land is utilized in one season and kept fallow for other two seasons. Pulse, ragi, cholam are the major single crops in Palacode cropping system. In Rabi season ragi and vegetables major single crops. In summer season other crops such as cotton, groundnuts are the single crops. Double crop area means agricultural land is utilized for two seasons and kept fallow for one season. Cholan-ragi, Pulses-ragi and sugarcane are the major double crops. Triple crop area means agricultural land is utilized in three seasons. Cholan/ragi- ragi/vegetables-other crops, Pulses-ragi/vegetables- other crops are the major triple crops in the study area. Single, double and triple crop areas are shown in figure1, figure2 and figure3.

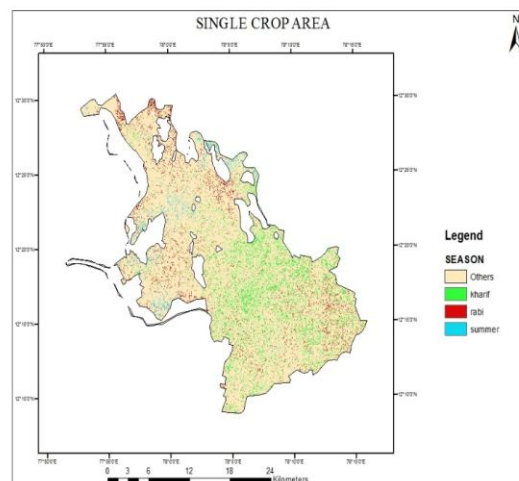


FIGURE 5 SINGLE CROP AREA MAP

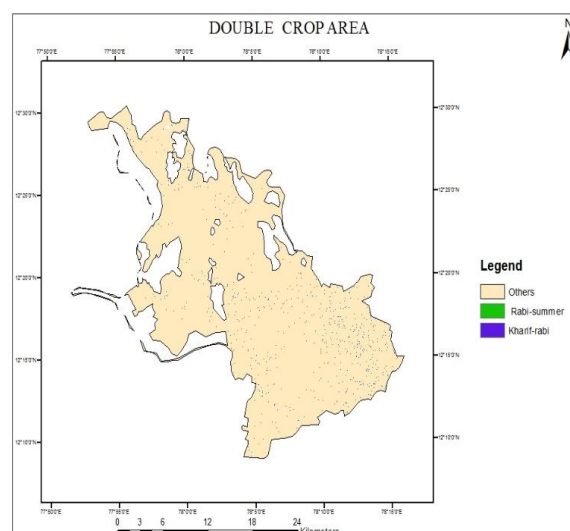


FIGURE 6 DOUBLE CROP AREA MAP

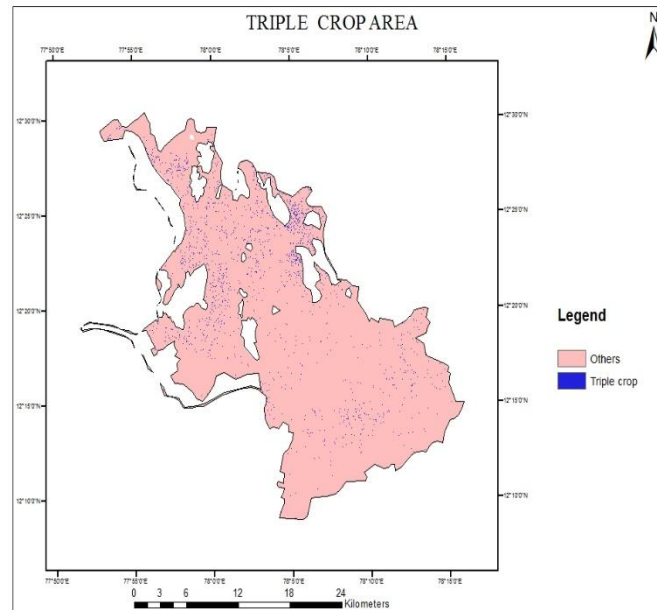


FIGURE 7 TRIPLE CROP AREA MAP

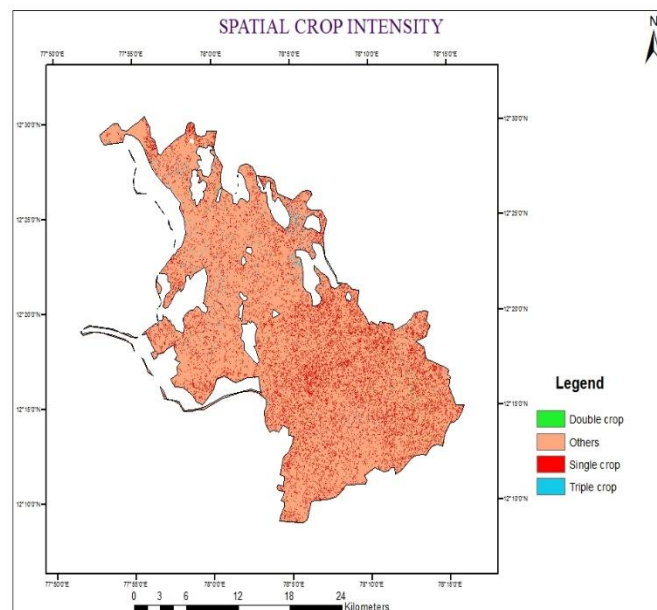


FIGURE 8 SPATIAL CROP INTENSITY

V.CONCLUSION

Cropping pattern and crop rotation study including detailed temporal and spatial information, are needed for agriculture sustainable management, crop monitoring and food security issues. The lack of information on agriculture is the major obstacles hampering efficient policy making and research to achieve food security. The study can be used to examine the cropping pattern of Palacode taluk in different three seasons by using Remote

sensing data. Crop statistics of three seasons can be extracted from crop pattern maps of the three different seasons. This crop statistics can be used to identify the yield of different crops and can analyze the market demand. Crop rotation plays an important function in farming. Utilizing a crop rotation can help keep pests and diseases under control, help to maintain soil quality, and ensure enough nutrients are available to different crops each year.

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