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# GIS Based Mapping for a Better Crop Planning for Perumpadappu Block of Ponnani Kole Lands in Kerala

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## Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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## ABSTRACT

Kole lands are one of the biggest saline, humid tropical wetland ecosystems. It spreads across Thrissur and Malappuram districts of Kerala state. They serve as a water storage structure during rainy season. After rains, the stored water is dewatered and circulated in various Kole *padasekarams* and channels to cultivate paddy. However, the problem is the lack of a proper water management plan resulting in crop loss. The current study is conducted in the Perumpadappu block of Ponnani Kole lands in Malappuram district. In this study, both GIS and Remote sensing technology have been collaborated to plan the crop calendar. The cropping calendar of Ponnai Kole was developed mainly for 37 Kole *padashekarams* of Perumpadappu block. Data about elevation, transportation, irrigation, weather and soil were collected to arrive at the crop calendar. Together, by adopting participatory rural appraisal methods and local knowledge were integrated. The final crop calendar was wetted with farmers and experts.

Keywords: Kole lands; Padashekarams; Ponnani; Perumpadappu.

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## 1. INTRODUCTION

Kole wetland is one of the most important areas that come under the Central Asian-Indian Flyway [1]. The Kole wetlands form one of the rice granaries of Kerala state. "Kole" is a Malayalam word which indicates bumper yields of high returns if the flood does not damage the crops (Johnkutty and Venugopal, 1993). It forms a part of 13632 hectares of the Vembanad-Kole wetland ecosystem, which was designated as a Ramsar site in 2002. The Kole lands were generally flat, shallow lagoons which slowly got silted up.

Kole lands spread over Thrissur and Malappuram districts of Kerala state, extending from the northern banks of the Chalakudy river to the southern banks of the Bharathapuzha river in the North [2]. It is located below mean sea level, i.e., 0.5m to 1m. The Kole area lies between 10°20' and 10°40'N latitudes and 75°58' and 76°11'E longitudes. Rice is the major crop cultivated in the Kole lands, which produces a fairly good yield due to the presence of high organic matter [3]. The soils in Kole lands are considered ultra-acidic hydromorphic acid clays [4]. A peculiar type of cultivation is practiced in Kole lands, especially from December to May [5]. The National Bureau of Soil Survey and Land Use Planning classifies Kole lands under agroecological unit 6 (AEU 6) [6]. The area is divided into various padashekarams and is cultivated from June to November. A major portion of Kole land is submerged in water.

Ponnani Kole lands extend from the Choondal panchayath in Thrissur district to Tavanur panchayath in Malappuram district. It consists of two block panchayats, i.e., Perumpadappu block and Ponnani block of Malappuram districts. It consists of an area of around 3445 ha [7,8]. The Perumpadappu block consists of five Krishibhavans, whereas the Ponnani block consists of four Krishibhavans. Beneath each Krishibhavans, around 10 to 12 padashekhara samithis were functioning.

Padashekhara samithis are the organisation of farmers in a community registered under any law, now in effect to encourage the production of paddy and related crops. While taking an overview of Thrissur Kole lands, it had major and minor irrigation projects. Whereas in the case of Ponnani Kole lands, the irrigation projects are less. Also, the occurrences of flood and drought lead to consistent crop loss. Hence with these

backdrops, the present study aims to develop a crop calendar for the Perumpadappu block of Ponnani Kole lands, keeping in view the direct contributions of kole lands in maintaining environmental cycles related to hydrology, nutrient flows and soil formation [9]. This is done by assessing the features like location, soil, transportation, elevation and irrigation.

## 2. METHODOLOGY

The present study was carried out in the Perumpadappu block of Ponnani Kole lands in the Malappuram district of Kerala state. A total of five Krishibhavans under the Perumbadappu block were taken for the study. They are Alamcode Krishibhavan, Maranchery Krishibhavan, Nanammukku Krishibhavan, Perumpadappu Krishibhavan and Veliyamkode Krishibhavan. A total of 37 Kole Padashekharams were present under the Perumpadappu block. The data was collected from the Agricultural Officers and farmers of respective Padashekhara samithis through interview schedules and by conducting field visits and Participatory Rural Appraisal (PRA). The total sample size of 100 was selected purposively for the study. In this study, Geographical Information Systems (GIS) and Remote Sensing were also collaborated to develop the crop calendar (Fig. 1).

The criteria such as elevation, irrigation and transportation were collected and input map layers for each criterion were prepared for analysis in a GIS environment. Now, these input data layers for the study were delineated by scanning, digitisation and registration through Google earth pro and open-source Quantum Geographic Information System (QGIS). The layers were projected in Universal Transverse Mercator (UTM) projection system (WGS 84/UTM Zone 43N) and finally made into a vector format. The total area of the Perumpadappu block was calculated using the unique value report tool in the QGIS Platform to find out the area covered in each class. Essential criteria considered for the study, such as irrigation, elevation, transportation, soil and Kole land locations from different sources are summarised in Table 1.

## 3. RESULTS AND DISCUSSION

The five Krishibhavans under Perumbadappu block were taken for the study. They were Alamcode Krishibhavan, Maranchery Krishibhavan, Nanammukku Krishibhavan,

Perumpadappu Krishibhavan and Veliyamkode Padashekharams were present under the Krishibhavan. A total of 37 Kole Perumpadappu block.

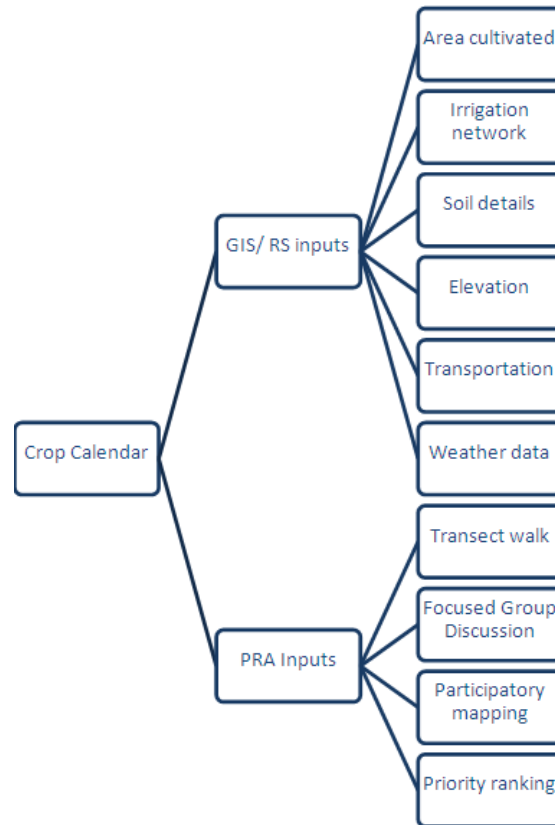


Fig. 1. Conceptual diagram for data collection

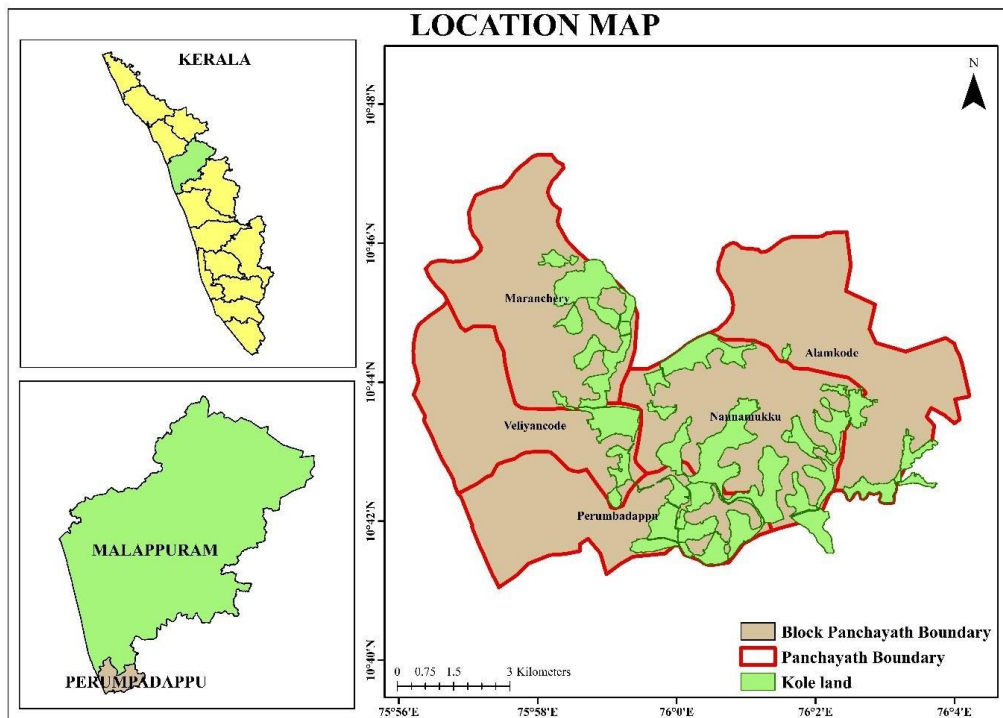


Fig. 2. Location map of Perumpadappu block KOLE lands

**Table 1. GIS data collection source and description**

Data Sets	Description	Sources
Aster Digital Elevation Model Resolution 30 m	Downloaded	USGS Earth Explorer ( <a href="https://earthexplorer.usgs.gov">https://earthexplorer.usgs.gov</a> )
Irrigation	Vector line – ESRI Shape file	Open street map-QGIS platform
Transportation	Vector line – ESRI Shape file	Open street map-QGIS platform
Elevation	Derived from DEM 30m	DEM 30m
Kole land location	Digitised	Field data/Google Earth

### 3.1 Cultivated Area

The cultivated area was calculated separately from GIS and Krishibhavan data. The list of Kole padasekarams under respective krishibhavans with the area under cultivation is given in the below Table 2 and Fig. 3. From the data obtained, we can see that 25 per cent of the total area in these padasekarams in Perumbadappu block remains uncultivated. And when we take padasekaram wise data, it can be observed that out of 37 padasekarams, 4 padasekarams have 50% or more areas uncultivated. Hence, bringing more area under cultivation is a necessary step to increase production.

### 3.2 Irrigation

The Kole lands lie 0.5 to 3.0 m below the mean sea level. Nooradi thodu and Beeyam Kayal are the major irrigation source in Ponnani Kole region. The main tributaries that join the Nooradi thodu are Vettikkadavu thodu, Othallur sub canal, Panthavoor stream, Manoor thodu and Pothannur thodu. During the summer season, all these tributaries get dried up. Hence, rice cultivation in the summer season is done by storing the water in Nooradi thodu with the help of Beeyam regulator. In the flood season, the inflow into the river basin submerges all Kole lands. In this period, the canals in Kole lands act as drainage channels by channelizing flood water to the Arabian Sea through Beeyam regulator.

After receiving the North East (Oct-Nov) monsoon, depending upon the water level in the Nooradi thodu, the Beeyam regulator will get closed. Hereafter, water from the padasekarams will be pumped to the Nooradi thodu, and the cultivation in the padasekarams starts. In the low-lying padasekarams, cultivation will begin only at the end. The problem observed in this area is the poorly developed bunds. It often results in the collapse of bunds and flooding of the fields at the time of sowing. This is noticed in 3 pasasekarams in the last year. Further out of the 37 padasekarams, only in six padasekarams, the traditional petti and para for water lifting are

replaced with modern pumps. Hence, strengthening bunds and replacing the conventional petti and para with more efficient pumps are necessary.

### 3.3 Soil

Kole soils are the products of weathering of river alluvial deposits and colluvium. These deposits are having clayey texture in nature and inhabits the flood plain. The flood plain is a deposition basin lying below the sea level and vulnerable to floods. The dominating factors influenced the soil formation in the Kole area were parent material and relief. The Kole soils are potential acid sulphates soil (100-150 cm) deep, similar to that of Kuttanad soils [3].

Kole lands subsurface shows fine sandy deposits of sedimentary origin. The percentage of clay content on the surface of these soils were high, also the ill drained situations and continuous deposition of sediments have arrested the development of soil profile. The Table 3 shows the soil fertility status of different panchayaths of Perumpadappu block.

From Table 3, it is understood that Maranchery panchayath is having high pH and low Organic Carbon, whereas in Alamcode, Maranchery and Perumpadappu panchayath Potassium element is low or deficient in soil and in Maranchery, Perumpadappu, Nannamukku and Veliyamcode panchayth Magnesium and Boron element are very low or deficient in soil.

### 3.4 Elevation

Elevation is one of the most important edaphic factors required for assessing cropping pattern. It also influences the water management and runoff. Therefore, elevation is one of the major aspects in developing the cropping pattern. Elevation for Kole land was determined from Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Digital Elevation Model (DEM) data of resolution 30 metres. The elevation range of the Perumpadappu Kole lands lies between 0 to -3 m. Hence, this factor must be considered while preparing a crop calendar.

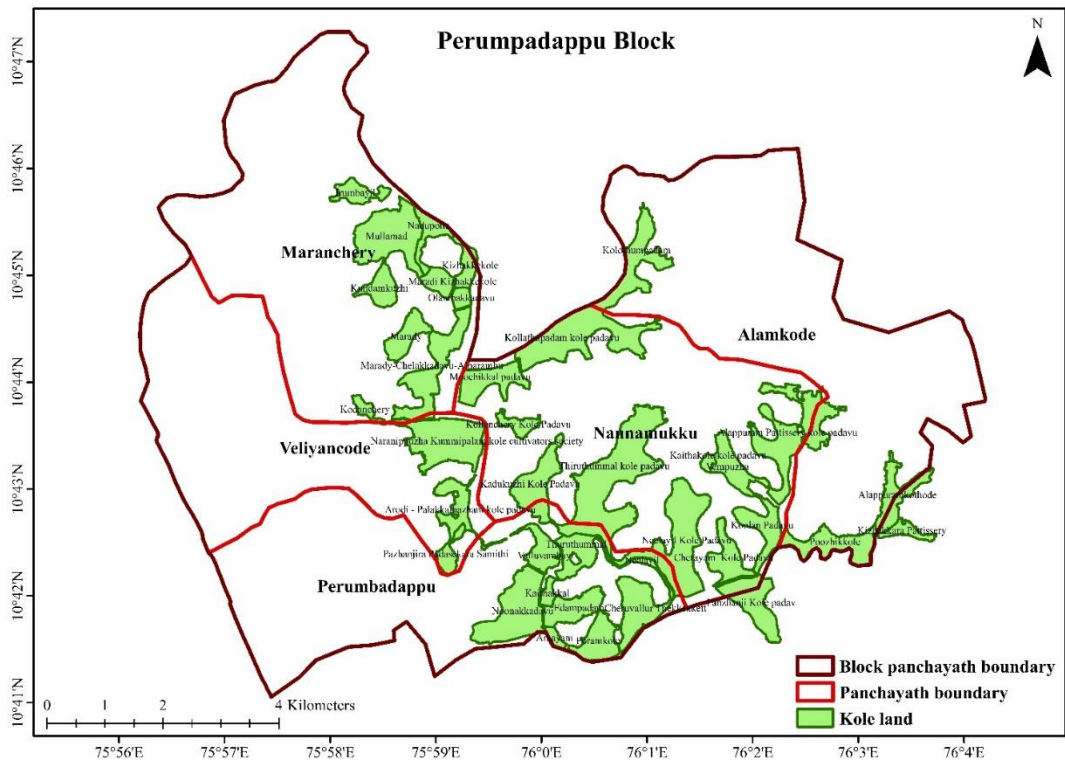


Fig. 3. Map showing list of Kole padashekharms in Perumpadappu block

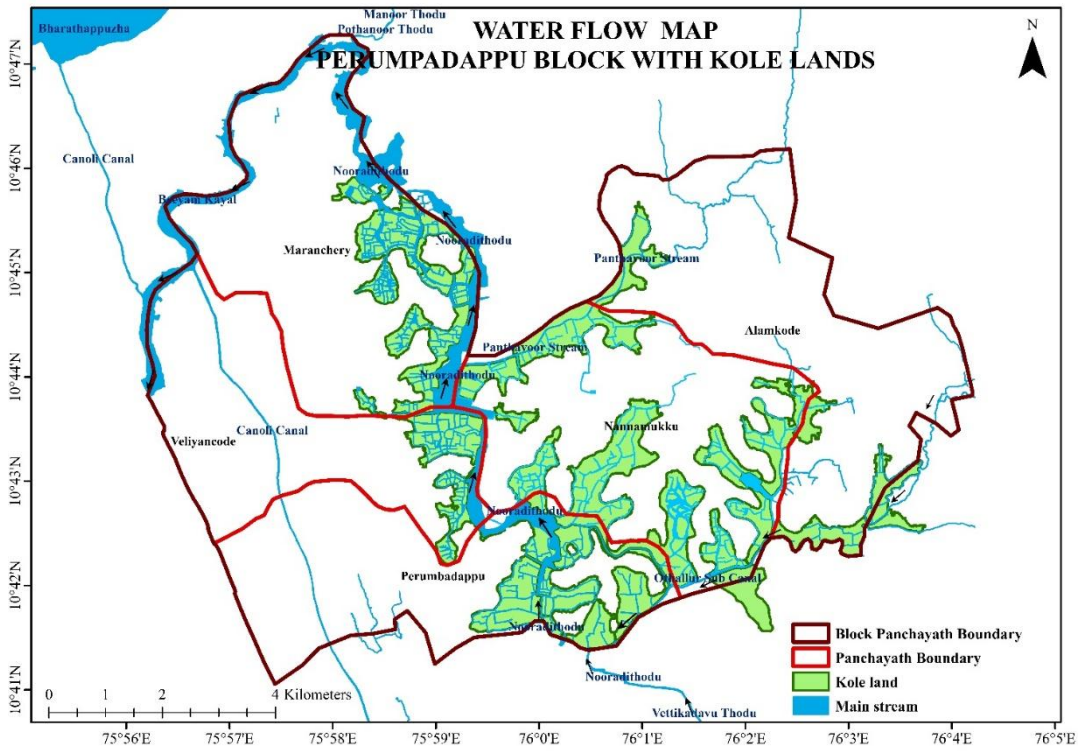


Fig. 4. Irrigation map of the Kole padashekharms in Perumpadappu block

**Table 2. List of Kole padashekharms in Perumpadappu block**

<b>Panchayath</b>	<b>Kole Padashekharms</b>	<b>Area as per GIS (Ha)</b>	<b>Area cultivated as per Krishibhavan data (Ha)</b>	<b>Uncultivated area (Ha)</b>
Alamcode	Alappuramkothode	44.00	42.00	2.00
Alamcode	Kizhikkara Pattissery	15.00	14.00	1.00
Alamcode	Kolothupadam	63.00	54.00	9.00
Alamcode	PoozhikKole	54.00	46.00	8.00
Maranchery	Mullamad	93.00	90.00	3.00
Maranchery	Irumbayil	24.00	4.20	19.80
Maranchery	Kodanchery	10.00	10.00	0.00
Maranchery	Kundamkuzhi	29.00	24.00	5.00
Maranchery	Maradi KizhakkeKole	20.00	16.00	4.00
Maranchery	Marady	32.00	26.00	6.00
Maranchery	Marady-Chelakkadavu-Alparambu	77.00	20.00	57.00
Maranchery	Nadupotta	24.00	24.00	0.00
Maranchery	Olambakkadavu	10.00	10.00	0.00
Nanammukku	Alappuram Pattissery Kole padavu	109.00	60.00	49.00
Nanammukku	Cherayam Kole Padavu	38.00	37.00	1.00
Nanammukku	Kadukuzhi Kole Padavu	58.00	7.00	51.00
Nanammukku	KaithaKole Kole padavu	6.00	6.00	0.00
Nanammukku	Kollathupadam Kole padavu	115.00	54.00	61.00
Nanammukku	Kollenchery Kole Padavu	16.00	13.00	3.00
Nanammukku	Koolan Padavu	40.00	37.00	3.00
Nanammukku	Moochikkal padavu	47.00	24.00	23.00
Nanammukku	Neelayil Kole Padavu	119.00	92.00	27.00
Nanammukku	Panzhanji Kole padav	56.00	40.00	16.00
Nanammukku	Thiruthummal Kole padavu	176.00	141.00	35.00
Nanammukku	Vempuzha	38.00	37.00	1.00
Perumpadappu	Amayam Kadavath Kole	7.00	6.00	1.00
Perumpadappu	Cheravalloor PuramKole	41.00	36.00	5.00
Perumpadappu	Edampadam	42.00	34.00	8.00
Perumpadappu	Kaithakkal	9.00	4.00	5.00
Perumpadappu	Neelayil	10.00	6.70	3.30
Perumpadappu	Noonakkadav	93.00	87.00	6.00
Perumpadappu	Pazhanchira	17.00	14.50	2.50

Panchayath	Kole Padashekharms	Area as per GIS (Ha)	Area cultivated as per Krishibhavan data (Ha)	Uncultivated area (Ha)
Perumpadappu	Thekkekkett	56.00	48.00	8.00
Perumpadappu	Thuruthummal	36.00	33.60	2.40
Perumpadappu	Valluvambayi	31.00	20.00	11.00
Veliyamkode	Arodi - Palakkathazham Kole padavu	40.00	40.00	0.00
Veliyamkode	Naranippuzha Kummipalam Kole cultivators society	94.00	80.00	14.00
<b>Total</b>		<b>1789.00</b>	<b>1338.00</b>	<b>451.00</b>

**Table 3. Uncultivated area of various Kole padashekharms of Perumpadappu block**

Sl. No	Uncultivated area (%)	No. of Padashekharms
1	Less than 0%	6
2	0-10%	8
3	10-20%	13
4	20-30%	2
5	30-40%	2
6	40-50%	2
7	50-60%	1
8	60-70%	0
9	70-80%	1
10	80-90%	2
11	90-100%	0
12	100%	0
	<b>Total</b>	<b>37</b>

**Table 4. Soil fertility status of different panchayaths of Perumpadappu block**

Panchayath	pH	OC	K	P	Ca	Mg	S	B	Cu	Zn
Alamcode	5.1-7.3	M	L	A	A	A	A	A	A	A
Maranchery	5.6-7.30	L	L	A	A	D	A	D	A	A
Perumpadappu	4.5-7.30	M	L	A	A	D	A	D	A	A
Nannamukku	4.5-7.30	M	M	A	A	D	A	D	A	A
Veliyamcode	5.1-7.3	M	A	A	A	D	A	D	A	A

Red – Low/ Deficient, Yellow – Medium, Green – High / Adequate

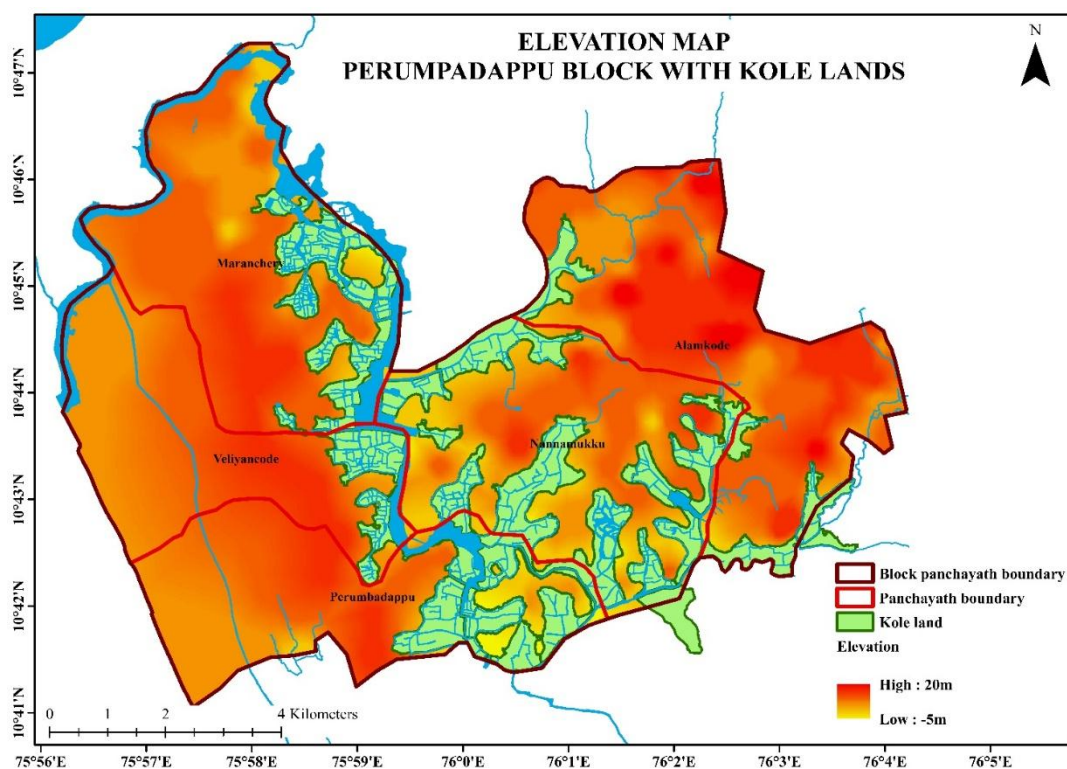


Fig. 5. Elevation map for Perumpadappu Kole lands

### 3.5 Transportation

Kole lands have a well-connected transport system (Fig. 6). Major roadways connecting the Ponnani Kole lands are Thrissur Kunnankulam road, Guruvayoor Althara Ponnani road, Velliyankode Maranchery road, Changaramkulam Chelakkadavu road, Kololambu Thekkethala road, Kundukadavu Veliancode road and Cheravalloor Perumpadappu bund road. So, transportation of materials into and from Kole land is not a problem.

### 3.6 Weather

The daily weather data of the Perumpadappu block of Ponnani Kole lands were collected from NASA power data access. Hereafter, the data were analysed to understand the North-East monsoon pattern in the study area. From the analysis, it was found that an average of 399 mm of rain was there from Oct to Dec in the area during the last forty years.

From the data presented in Fig. 6, it was also found that 50% of the North-East monsoon came on Oct 26th. Further analysis found that the average last 150 mm of rainfall was on Oct 31<sup>st</sup>.

Hence, after discussion with the group members, it was decided to start the cultivation on Nov 1st of every year. It will avoid flooding of fields and resultant crop loss.

### 3.7 Preparation of Crop Calendar

After considering the factors mentioned above, like the area under cultivation, the elevation of the padasekarams, weather data and the irrigation network present, the individual padasekarams were classified into five major groups. The group discussion with the members and officials of the padasekara samithis also added input into this classification. The planting dates were arrived after considering the weather data, field area and distance from major water sources (Table 5) (Fig. 8). The final crop calendar thus prepared was vetted with the farmer and official group.

The widely recommended variety for the padasekaram is Uma developed from Kerala Agricultural University with a duration of 120 days. The second recommended variety is Jyothi, with a duration of 110 days; the third is Manurathna, with 100 days duration. The decision to cultivate a particular variety should be taken considering the weather and other conditions.

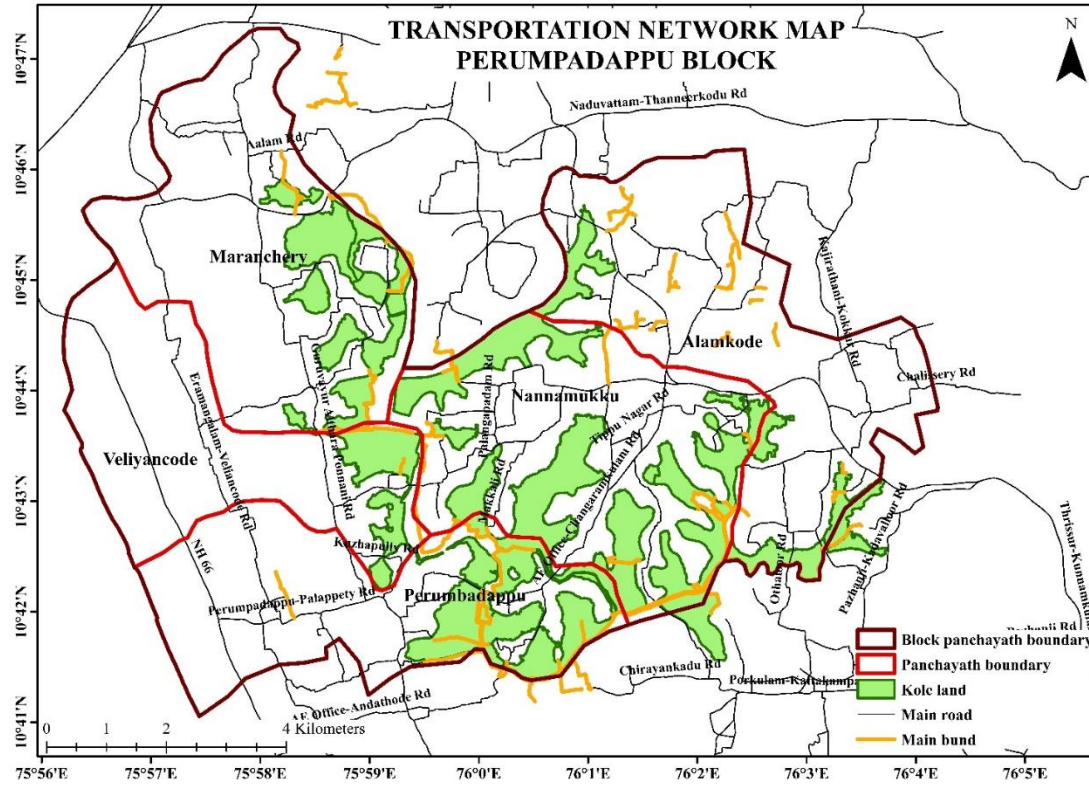


Fig. 6. Transportation map of Kole padashekharms in Perumpadappu block

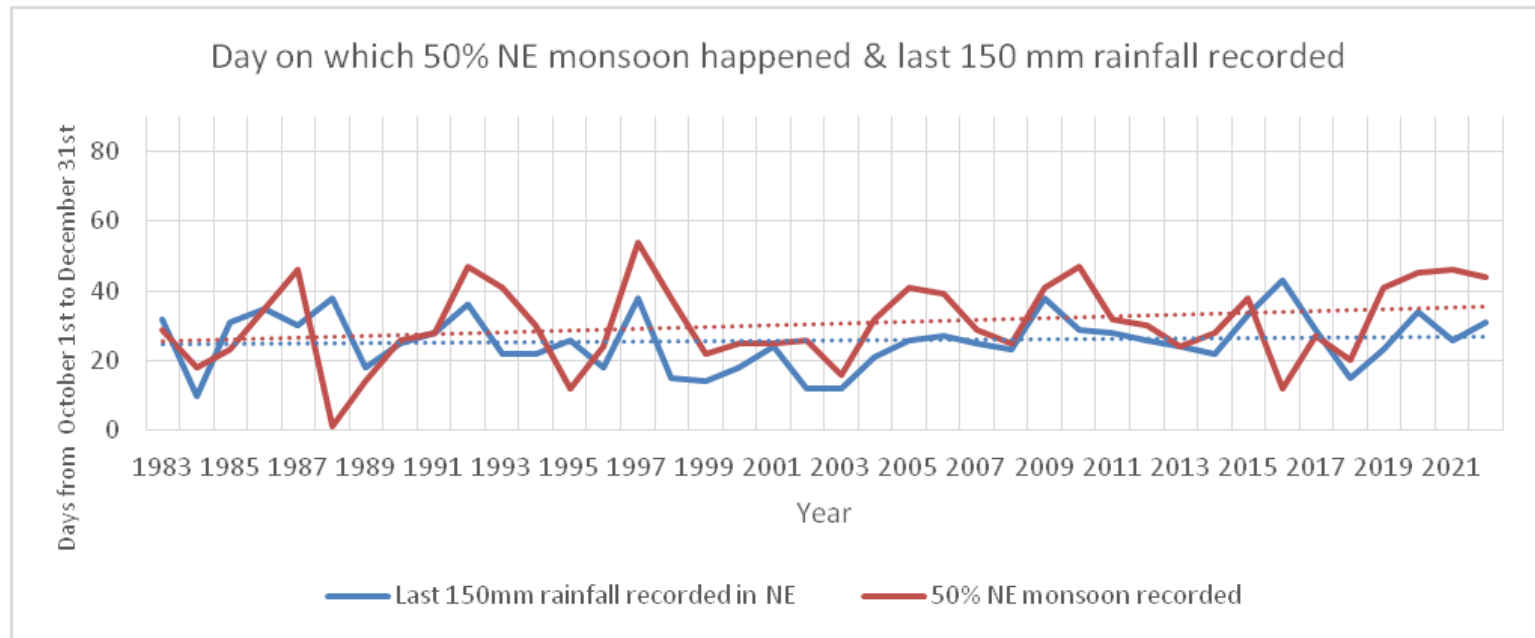


Fig. 7. Rainfall Data of Perumpadappu block Kole lands

**Table 5. Crop calendar for Kole padashekharms of Perumpadappu block**

Sl. No	Major grouping	Name of Panchayath	Name of Padashekaram	Proposed date of planting
1	Group 1	Alamcode	Alappuramkothode	1/11
2	Group 1	Alamcode	Kizhikkara Pattissery	1/11
3	Group 1	Alamcode	Kolothupadam	1/11
4	Group 1	Alamcode	PoozhikKole	1/11
5	Group 5	Maranchery	Mullamad	29/11
6	Group 5	Maranchery	Irumbayil	29/11
7	Group 4	Maranchery	Kodanchery	22/11
8	Group 5	Maranchery	Kudamkuzhi	29/11
9	Group 5	Maranchery	Maradi Kizhakke Kole	29/11
10	Group 4	Maranchery	Marady	22/11
11	Group 4	Maranchery	Marady Chelakkadavu Alparambu	22/11
12	Group 5	Maranchery	Nadupotta	29/11
13	Group 5	Maranchery	Olambakkadavu	29/11
14	Group 2	Nanammukku	Alappuram Pattissery Kole Padavu	8/11
15	Group 2	Nanammukku	Cherayam Kole Padavu	8/11
16	Group 3	Nanammukku	Kadukuzhi Kole Padavu	15/11
17	Group 2	Nanammukku	KaithaKole Kole Padavu	8/11
18	Group 1	Nanammukku	Kollathupadam Kole Padavu	1/11
19	Group 4	Nanammukku	Kollencherry Kole Padavu	22/11
20	Group 2	Nanammukku	Koolan Padavu	8/11
21	Group 4	Nanammukku	Moochikkal Padavu	22/11
22	Group 2	Nanammukku	Neelayil Kole Padavu	8/11
23	Group 2	Nanammukku	Pazhanji Kole Padavu	8/11
24	Group 2	Nanammukku	Thiruthummal Kole Padavu	8/11
25	Group 2	Nanammukku	Vempuzha	8/11
26	Group 3	Perumpadappu	Amayam Kadavath Kole	15/11
27	Group 3	Perumpadappu	Cheravalloor PuramKole	15/11
28	Group 3	Perumpadappu	Edampadam	15/11
29	Group 3	Perumpadappu	Kaithakkal	15/11
30	Group 2	Perumpadappu	Neelayil	8/11
31	Group 3	Perumpadappu	Noonakkadav	15/11
32	Group 4	Perumpadappu	Pazhanchira	22/11

Sl. No	Major grouping	Name of Panchayath	Name of Padashekaram	Proposed date of planting
33	Group 3	Perumpadappu	Thekkekkett	15/11
34	Group 3	Perumpadappu	Thuruthummal	15/11
35	Group 3	Perumpadappu	Valluvambayi	15/11
36	Group 4	Arodi Palakkathazham Kole padavu	Veliyamkode	22/11
37	Group 4	Naranippuzha Kummipalam Kole cultivators society	Veliyamkode	22/11

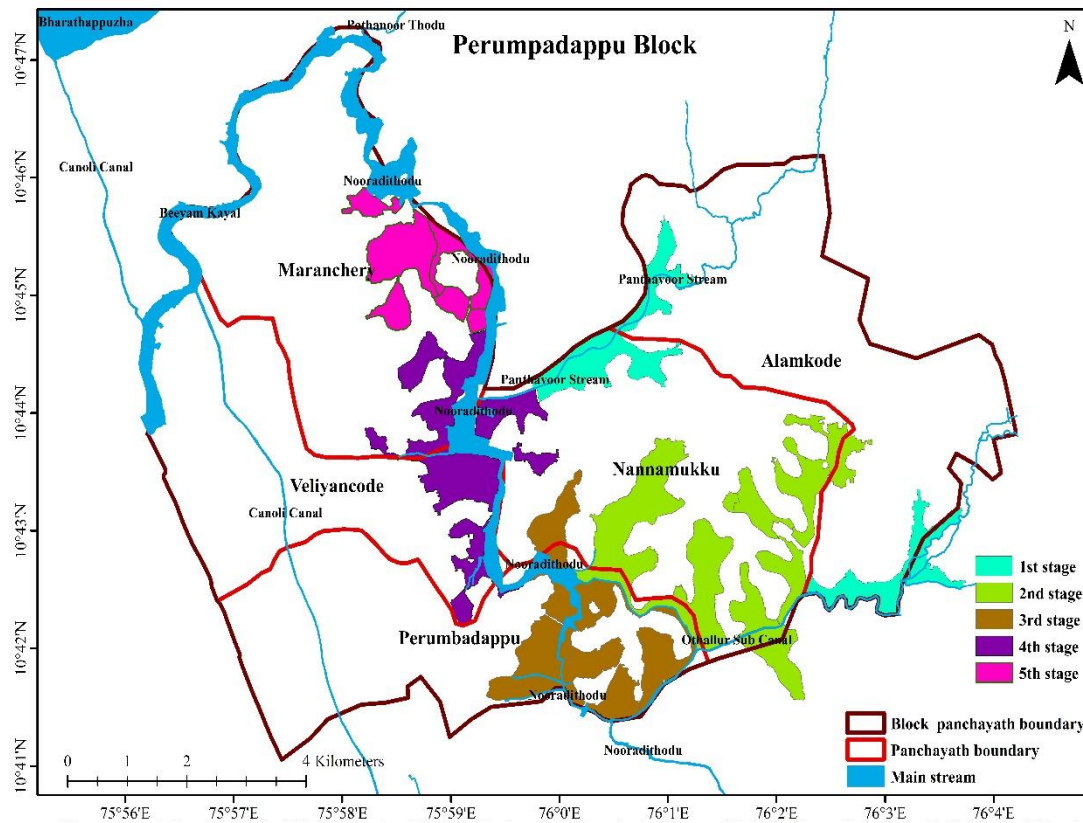


Fig. 8. Grouping of KOLE padashekarams of Perumpadappu block into 5 major groups

#### 4. CONCLUSION

Kole lands are considered as the rice bowl of Thrissur and Malappuram districts. Even though the land is highly fertile, the potential yield is not achieved by majority of the farmers because of frequent crop loss. The major reason for crop loss was identified as poor water management plan. A proper water management plan for the Kole lands can happen only with a holistic approach, as several factors are linked to each other.

As part of the study, various factors like area under cultivation, irrigation system, elevation details, weather details, transport network and soil fertility details were thoroughly analysed. The result shows ways to improve the area under cultivation, increase the water use efficiency and better management of the area to get maximum yield. The use of GIS tools makes the study more comprehensive.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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