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Generating cadastral level digital map of soil macro nutrients of Perambalur block

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Abstract
The study was conducted in Perambalur block to determine the soil nutrient status and to generate cadastral level soil fertility maps. The total geographical area of the respective block is 32076.48 ha and it lies between 11° 31' 53" and 11° 52' 05" N latitude and 78° 17' 21" and 78° 28' 28" E longitudes.The average rainfall of this region is 861mm.Based on the soil analysis, fertility maps were generated at scale (1:5000) using ArcGIS. Based on the surface soil samples, the digital soil nutrient maps at village level were generated by geocoding the nutrient database with survey points and by using geostatistical approach (Kriging). Perambalur block were low in nitrogen (<280 kg ha^{-1}), high to very high in phosphorous (>22 kg ha^{-1}) and medium in soil available potassium 118-225 kg ha^{-1}. The greater utility of cadastral level soil nutrient maps shows the boundaries and ownership details as names of the survey district in block number which are used for individual farm level plans can be prepared and given to the farmers for the balanced fertilizer recommendation and nutrient for higher crop productivity.

Keywords: Soil nutrient mapping, cadastral, geostatistical, kriging, fertilizers, soil fertility and digitization

Introduction
Soil nutrients are considered to be the major contributors of soil fertility. Soil nutrients are the chemical elements that are highly important for improving soil productivity and fertility. Soil nutrients are the predominant factor for achieving high, reliable and self-sustained food production Chikowo *et al*., (2014) [3].
Effective and balanced application of fertilizer and ensuring environmental protection are the two important concepts that mainly emphasize the application of soil nutrients based on soil testing. This will safeguard nutritional food security and make farming practices more sustainable (Kumaraperumal *et al*. (2016) [12].
In the 21st century, geospatial innovations recently emerged as a very important and productive tool with various applications and have been found to be advantageous to conventional methods of soil survey. Geographic Information Systems (GIS) and Global Positioning Systems (GPS) have added new methods to analyse geo-coded data (Hill *et al.*2009) [6]. Based on the data, the problems and potential of an area can be highlighted from the data collected at farm level, the conservation measures needed for the respective area can be indicated, the suitability of the area for different uses can be assessed and finally, viable and sustainable land use options can be prescribed to the farmers and land users at field level (Nidumolu *et al*., 2006) [10]. Evaluation of soil nutrients using remote sensing and GIS methods are used to suggest balanced fertilizer application to increase crop productivity. Digitalization of soil nutrient mapping is done using the available technologies. Various models and prediction are done for generating map. Hence the present investigation was undertaken for mapping soil fertility status of macro nutrients in Perambalur block, Tamil Nadu. Furthermore, NPK map can be used to apply fertilizer to an area, where there is deficiency of NPK for efficient fertilizer management (Ismail *et al.*, 2009) [7].

Materials and Methods
Location of the study area
The study area chosen for this research is Perambalur block of Tamil Nadu.
Perambalur block lies between 11°31'53" and 11°52'05"N latitude and 78° 17'21" and 78° 28'28"E longitudes. The total geographical area is 32076.48 ha, which constitutes about 2.4 per cent of the total area of the Perambalur district (Fig.1). The average rainfall of this region is 861mm. The block has 27 revenue villages.

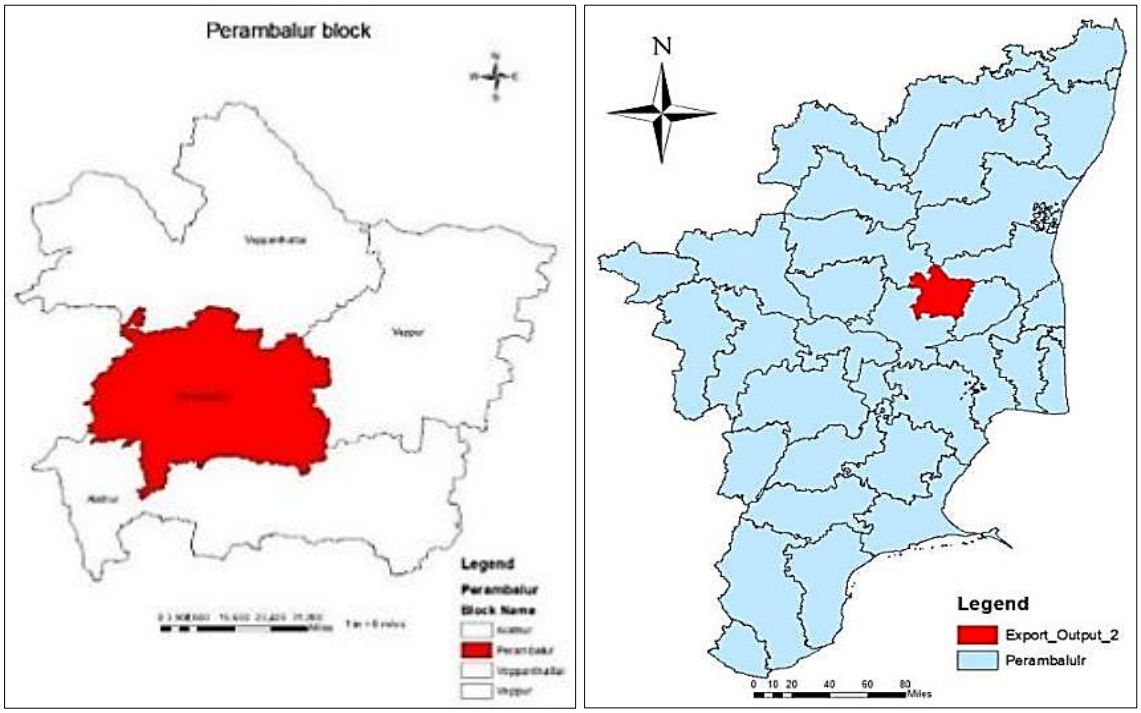

Fig 1: Location map of the study area

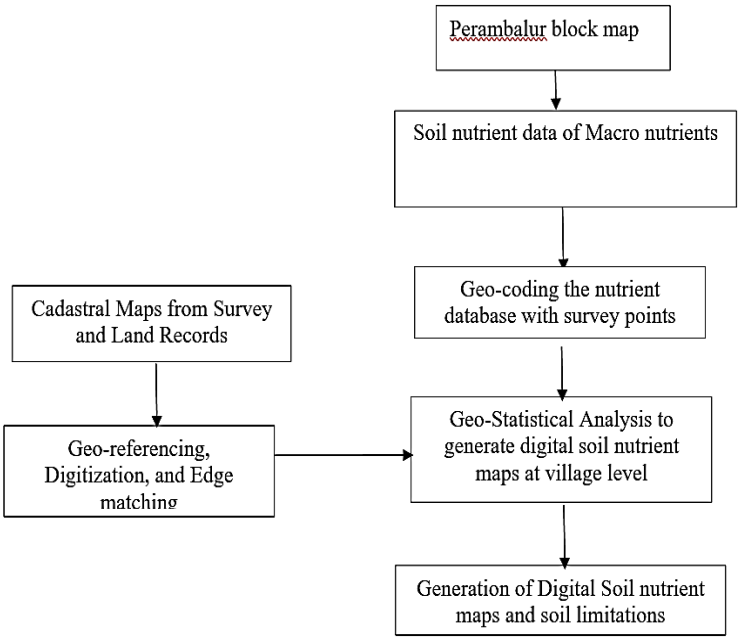

Fig 2: Flow chart of methodology on generating the digital soil nutrient maps

The required topographic map at 1:5000 scale covering the study area was collected from Survey of India and utilised for the study. The Geographic information system (GIS) with Arc GIS 10.1 software was used for database creation and for creating the union of various soil nutrient maps. Geocoding of the nutrient database was done with survey points of Perambalur block. Then by using the technique of geostatistical analysis (Kriging) digital soil nutrient maps at village level was generated. The cadastral level soil nutrient maps were prepared using the detailed information obtained during field survey and laboratory data. Map was reclassified based on ratings of respective nutrients (Fig.2).

Results and Discussion

Nitrogen

The cadastral maps generated from the analytical data of the soil samples in 27 villages of the Perambalur block revealed that the soils were low in soil available nitrogen (Fig.3). The values on soil available nitrogen ranged from 138.37 kg ha^{-1} to 174.52 kg ha^{-1} (Table 1). The soil nitrogen content (138.37 kg/ha) was recorded to be low in Aranarai South village. Meanwhile, Ladapuram west recorded the highest soil nitrogen content of 174.52 kg ha^{-1}. Nitrogen status of Perambalur block soils can be improved by the application of nitrogenous fertilizers and organic manures and also by cultivation of legume crops like greengram, blackgram, cowpea and chickpea *etc.* which biologically fixes nitrogen in soil.

Table 1: Available soil macronutrient content (kg ha^{-1}) at village level of Perambalur block

S. No.	Village name	N	P	K
1	Alangali	155.43	26.11	150.93
2	Ammapalaiyam	169.29	24.90	146.33
3	Aranarai north	153.85	25.45	154.84
4	Aranarai south	138.37	25.56	148.80
5	Ayilur	162.71	25.85	150.67
6	Bommanappadi	167.05	24.65	157.39
7	Chattramanai	162.82	24.57	155.57
8	Elambalur	161.53	25.06	154.51
9	Esanai	151.22	25.30	181.53
10	Kalarampatti	163.12	23.20	151.65
11	Kalpadi north	162.47	25.73	155.37
12	Kalpadi south	157.36	25.15	156.90
13	Kilakarai	154.21	25.44	154.51
14	Ladapuram east	170.47	28.08	139.90
15	Ladapuram west	174.52	28.87	136.98
16	Nochiyam	152.70	27.33	148.98
17	Perambalur north	151.74	25.03	155.39
18	Perambalur south	149.95	26.29	150.94
19	Pudunaduvalur	146.97	26.22	150.09
20	Sengonam	168.96	25.74	156.81
21	Siruvachur	155.89	26.73	151.36
22	Thuraimanagalam	164.75	25.52	157.15
23	Velur	156.74	25.38	153.06
24	Melapuliyur east	163.94	27.74	146.76
25	Melapuliyur west	170.52	28.71	140.54
26	Kurumbalur north	163.48	27.68	145.06
27	Kurumbalur south	161.64	25.49	148.04
	Minimum	138.37	23.20	136.98
	Maximum	174.52	28.87	181.53
	Mean	159.83	28.20	151.21
	SD	7.43	11.97	5.64

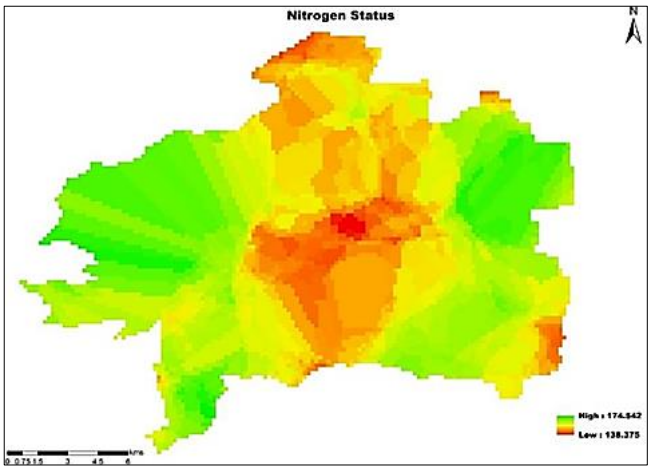

Fig 3: Soil nitrogen status of Perambalur block at village level

Phosphorus

Phosphorus is a prominent component of nucleic acids which play a vital role in plant reproduction and grain production. Phosphorous is also the component of ATP which enables photosynthesis (Bucher, M. 2007) [2]. It facilitates root growth and improves flower formation. The cadastral maps generated from the analytical data of the soil samples of Perambalur block showed that the level of soil available phosphorus were high (Fig.4). Available soil Phosphorus content in different villages of Perambalur block ranged from 23.20 to 28.87 kg ha^{-1}. The soil phosphorous content was recorded to be low in Kalarampatti (23.20 kg ha^{-1}) (Table 1). Concurrently, Ladapuram west recorded the highest soil phosphorous content of 28.87 kg ha^{-1}. Phosphorous is a nutrient that cannot be removed from the soil through leaching because of its strong fixation capacity and slow release nature. (Rychter *et al*., 2005) [13].

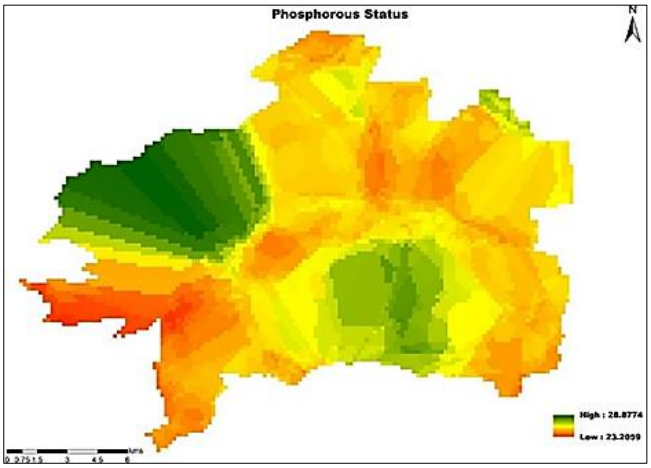

Fig 4: Soil phosphorous status of Perambalur block at village level

Potassium

Potassium is a great regulator of metabolic activities. Potassium regulates the movement of water, nutrient and carbohydrates (sugars) in plant tissue. 'K' is an indispensable constituent for the correct development of plants. The cadastral maps generated from the analytical data of the collected samples in 27 villages of the Perambalur block revealed that the soils of Perambalur block were medium in soil available potassium (Fig.5). The soil potassium content in different villages of Perambalur block ranged from 136.98 to

181.53 kg ha^{-1}. The lowest soil available potassium content (136.98 kg ha^{-1}) was recorded in Melapuliyur west (Table1). Whereas, Esanai recorded the highest soil potassium content of 181.53 kg ha^{-1}. Balanced fertilizer application based on soil test values would regulate K dynamics in the soil. The results are in concordant with the studies of (Belay *et al*., 2002) [1].

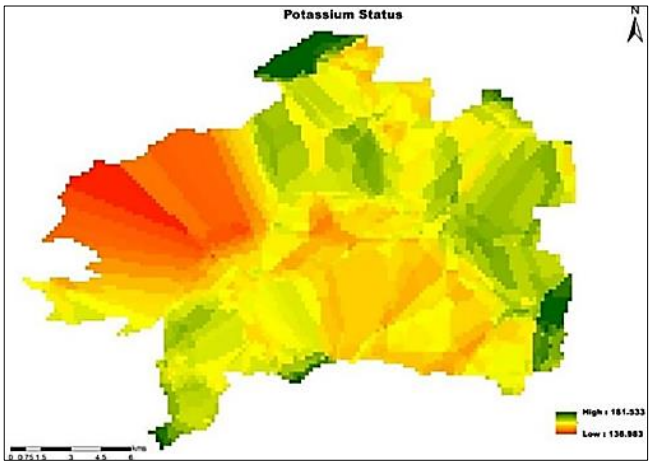

Fig 5: Soil potassium status of Perambalur block at village level

Conclusion

The study on generating cadastral level soil fertility maps on various villages of Perambalur block results that majority of the soils in Perambalur block were low in nitrogen, high to very high in phosphorous and medium in soil available potassium. The areas with low nutrient status need to be improved by fertilizer management. Generating cadastral level soil nutrient maps provide efficient basic information about the soil fertility status of an individual survey number coupled with farmer details of Perambalur block which enables farm level and regional level planning for fertilization. Recommendation of fertilizer rate based on soil test values and soil nutrient maps would facilitate judicious and balanced use of synthetic fertilizers which improve the soil health condition and also ensures environmental protection. The cadastral level soil nutrient maps provide efficient basic information about the soil fertility status for monitoring the fertilizer schedule which remains to be a sound scientific technique for achieving higher crop productivity in Perambalur block.

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