The Pharma Innovation Journal 2022; 11(3): 1179-1195

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(3): 1179-1195

www.thepharmajournal.com
Received: 01-01-2022
Accepted: 04-02-2022

SG Rajput
Department of Soil Science and Agricultural Chemistry, BNPG College, Rath Hamirpur, Uttar Pradesh, India

PPS Yadav
Division of Agriculture Resource, Remote Sensing Application Center, Lucknow, Uttar Pradesh, India

SL Pal
Department of Horticulture, BNPG College, Rath Hamirpur, Uttar Pradesh, India

PK Rajput
Department of Soil Conservation, Janta College, Bakewar Etawah, Uttar Pradesh, India

Dashrath Singh
Department of Soil Science & Agricultural Chemistry, BNPG College, Rath Hamirpur, Uttar Pradesh, India

Corresponding Author:
SG Rajput
Department of Soil Science and Agricultural Chemistry, BNPG College, Rath Hamirpur, Uttar Pradesh, India

Soil fertility mapping at village level using IRSLISS-IV and Cartosat-1 merged data in two *Nyaya panchayat* of Amethi district, U. P.

SG Rajput, PPS Yadav, SL Pal, PK Rajput and Dashrath Singh

Abstract
The study presents a soil fertility mapping carried out in two *Nyaya panchayat,* consisting of 23 villages of Amethi district of Uttar Pradesh. The soil fertility map has been generated by interpreting Resourcesat-1 LISS-IV and Cartosat-1 merged data on 1:10,000 scale, and both *Nyaypanchayat* fertility maps have been mapped. The soil database was integrated with plot (*khasra*) boundary which helps in generating soil information at plot and farmer level. Soil fertility maps were prepared for each parameter under GIS environment using Arc GIS v 10.4. Soils were neutral to very strongly alkaline with non saline to slight salinity. Soil organic carbon content was low to medium OC and available N was low in 2/3 of area. Available nitrogen was low, available phosphorus was low to medium, available potassium was medium to high and sulphur was low to medium. Regarding available micronutrients, zinc and iron were deficient in about half of the sub watershed area whereas, copper and manganese were sufficient in the soils. The mapping of nutrients by GIS technique in the sub watershed revealed that, available N, P, S, Zn and Fe are important soil fertility constraints.

Keywords: Remote sensing, geographic information system (GIS), high resolution satellite data, soil fertility, DTPA Extractable

Introduction
Soil maps presently available in India are generally on 1:50,000 scale, which provide information that are regional in nature, rather than local and site-specific. With the focus of rural development planning having been shifted to village panchayats, it has become imperative that the soil resource information is prepared on a larger scale, with finer level of details so that these can be used for developmental planning at village level (Ravisankar and Thamappa 2004; Rao *et al.* 2004) [18, 16]. Large scale soil mapping in India has been mostly done by traditional methods, using cadastral map (village map) as base (Jagdish Prasad *et al.* 2009; Anil Kumar *et al.* 2010; Sah *et al.* 2010 and Sankar *et al.* 2010) [9, 2, 19, 22]. The scale of these maps varies from 1:4,000 to 1:10,000. However, mapping using village cadaster as base and soil sampling at fixed grid interval requires large number of observations and are time consuming and expensive (Simon, 2010). Due to these reasons, the use of satellite remote sensing data as a base for soil mapping has become common in recent years. The dynamic relationship between physiography and soils is utilized in deriving information on soils from satellite data (Singh and Dwivedi 1986; Kudrat *et al.* 2000) [24, 10]. Dwivedi (2001) [5, 6] has observed that proper identification of land type, drainage pattern and drainage condition, vegetation, land use, slope and relief is essential in the interpretation of satellite image for soil mapping. The use of satellite image has been reported to save about 60-80% time in soil mapping, as compared to manual methods (Liengsakul *et al.* 1993) [12]. Macro and micronutrients are important for maintaining soil health and also increasing productivity of crops (Rattan *et al.* 2008). The soil must supply nutrients for desired growth of plants and synthesis of human food. Increased removal of micronutrients as a consequence of adoption of high yielding varieties (HYVs) and intensive cropping together with shift towards high analysis NPK fertilizers has caused decline in the level of micronutrients in the soil to below normal at which productivity of crops cannot be sustained. The improper nutrient management has, led to emergence of multi-nutrient deficiencies in the Indian soils (Sharma 2004). Keeping in view the close relationship between soil properties and nutrient availability, the present study was undertaken to analyze the influence of soil properties on availability of nutrients for better land use management Amethi district of Uttar Pradesh as information on these aspects is rather scanty and scattered.

With the availability of high resolution satellite data from new IRS satellite sensors like- IRS LISS-IV (5.8 m multispectral), IRS 1D PAN (5.8 m panchromatic), Cartosat-1 PAN (2.5m panchromatic), Cartosat- 2A PAN (1m panchromatic), their use for large scale soil mapping from 1:5000 to 1:12500 scale is becoming common in India (Kudrat *et al*. 2000; Dwivedi *et al.* 2001; Srivastava and Saxena 2004; Ardak *et al.* 2010; Wadodkar and Ravisankar 2011; Sahu *et al.* 2014) [10, 5, 6, 26, 4, 27]. Kunwar *et al.* (2010) have used IKONOS data with 1m panchromatic and 4m multispectral resolution in mapping of natural resources, including soils, on 1:4,000 scale for suggesting alternate land use in a hilly micro-watershed. High resolution LISS IV and Cartosat PAN data have also been used in soil mapping at village level in granitic terrain of Andhra Pradesh (Wadodkar and Ravisankar 2011) [27], and in basaltic terrain of Central India (Sahu *et al.* 2016). Furthermore, GIS generated soil fertility maps may serve as a decision support tool for nutrient management (Iftikar *et al.* 2010). A number of studies on soil fertility mapping have been documented (Ravikumar *et al.* 2004), the utility of satellite data in soil fertility mapping, a study was taken up in two *Nyaya panchayats* covering 23 villages of Amethi district of Uttar Pradesh, using IRS LISS-IV and Cartosat-1PAN data, to prepare soil map on 1:10,000 scale that would facilitate natural resource developmental planning at the village level.

Materials and Methods

Characteristics of the study area

Amethi district came into existence in July 2010 by merging three tehsils of the erst while Sultanpur district and two tehsils of the erstwhile Raebareli district of Uttar Pradesh. The study area of two *Nyaya panchayat*, i.e. Tala and Korari Girdhar Shah, of Amethi district lies between parallels of 81°44'55.186"E / 26°11'23.152"N to 81°47'3.109"E/ 26°6'37.629"N (Fig.1). A total of 23 villages are included in these two *Nyaya panchayat*, falling in block and district Amethi. Geographical area of these villages is 3567 ha. The distance of the study area from the district headquarter Amethi is 6 km.

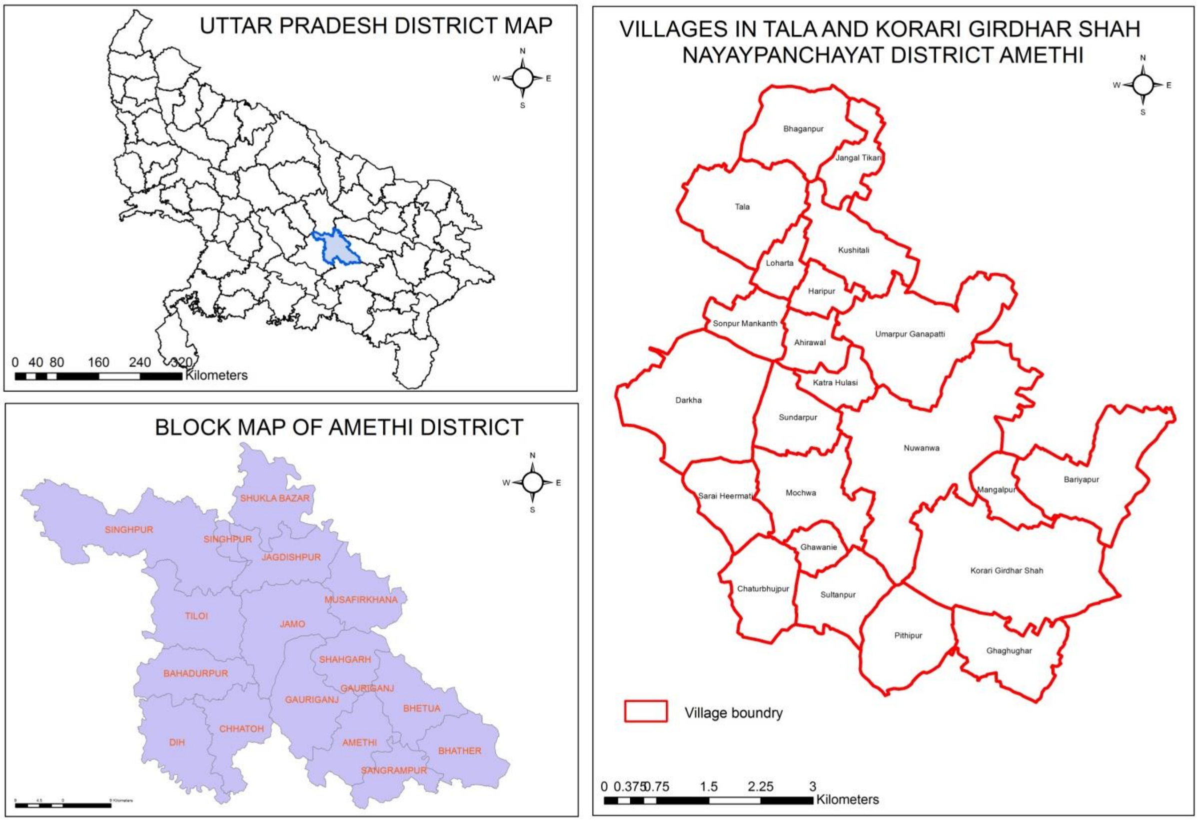

Fig 1: Location map of Tala & korari Girdhar shah Nayapanchayats in Amethi district UP

The climate of Amethi district is semi-arid sub- tropical monsoon type. The cold days start from 15 November and last up to 15 March. However, severe cold days are in December and January. Hot summer months are May and June. Monsoon sets generally by the end of June and lasts up to the first week of October. The average annual rainfall of the past 6 years (2010-2015) is 775 mm, about 80% of which is received between June and September. Mean maximum temperatures of 41.1 °C and 38.9 °C are recorded in the months of May and June, which are the hottest months. The month of April is also quite hot with a mean temperature of 38.1 °C. The mean minimum temperatures in the month of December and January are 7.7 °C and 7.9°C, respectively. The soil temperature regime of the study area is *Hyperthermic* and the soil moisture regime is *Ustic* (Anonymous, 1988) [3].

Block Amethi is a part of Lower Gangetic Plains. River Ganga has transported alluvial sediments especially from the Outer Himalayas and the Shivaliks. During the process of deposition of alluvium, water courses have been changed gradually. The present ox-bows and the buried channels at places are examples of the changes in water courses. The general slope is from north-west to south-east. The central part is slightly elevated, on which the Amethi distributary of Sharda Sahayak canal is located. The land is very gently sloping out from the distributary towards the north-east and the south-west. The land use/land cover in the study area comprises mainly of agricultural land, fallow land, plantation, water body and sodic wastelands. About 68% of the area is covered by seasonal crops and about 15% by orchards and plantations.

Data used

Digital data of Indian Remote sensing Satellite (IRS) P6 LISS-IV with 5.8 m resolution and Cartosat-1 with 2.5m resolution of April 2011 were used. Ancillary data referred include Survey of India topographical maps 63F/12 and 63F/16 (1:50,000 scale). Cadastral maps of all the 23 villages falling within the two *Nyaya panchayat* were taken from the District Office, Amethi.

Methodology

A detailed soil mapping of Tala and Korari Girdhar Shah *Nyaya panchayat* was carried out using IRS LISS-IV and Cartosat-1 PAN data. Arc/Info based Geographic information system (GIS) with ERDAS IMAGINE 10image processing software have been used in the present investigation. Both the data sets were geo- referenced, rectified and then merged. On-screen interpretation was performed on the merged satellite image. Based on the image characteristics which include location, tone and color, size, shape, texture, pattern, and association, landform/physiography of the area and land use, six image interpretation units were delineated. Image characteristics of the delineated units are given in Table-1.

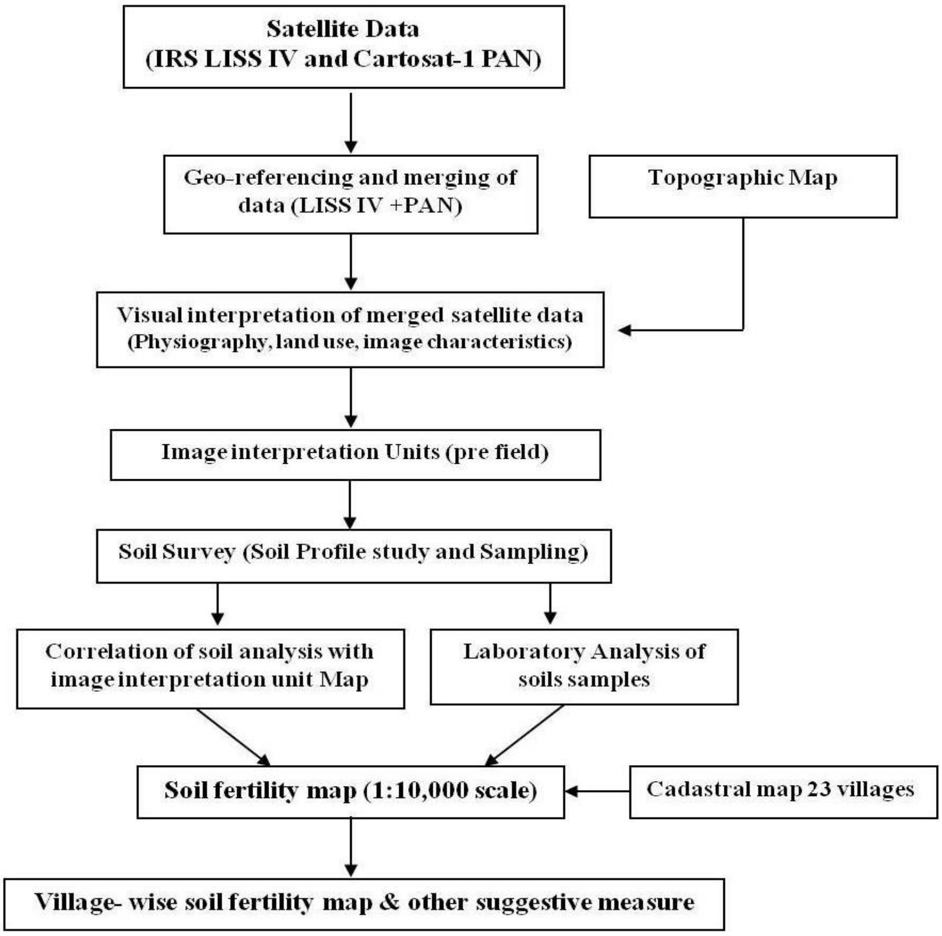

Fig 2: Methodology flow chart for village- level soil fertility information generation.

Soil sampling was carried out in the study area using the image interpretation unit map and a correlation between image characteristics, physiography and soil characteristics was established in the field. Based on the above six soil unit's soil Surface samples were collected using a hand held GPS at the 15 cm soil depth in each unit, about total 450 soil samples collected at cadastral level of two *Nayapanchayat*.

The soil samples were air-dried, ground (<2 mm) and analyzed for chemical and fertility parameters. The pH (1:2) and electrical conductivity (EC) (1:2) of soils were measured using standard procedures as described by Jackson (1973). Organic carbon (OC) was determined using the ammonium acetate method (Helmke and Sparks 1996). Available potassium (K) was determined using the ammonium acetate method (Helmke and Sparks 1996). Available sulphur (S) was measured using 0.15% calcium chloride ($CaCI_2$) as an extractant (Tabatabai 1996). Aphosphorus (Olsen P) was measured using sodium bicarbonate ($NaHCo_3$) as an extractant (Olsen and Sommers 1982). Available nitrogen (N) was estimated from soil organic C values as organic C has been used as an indes of available N (Sahrawat *et al.* 2010). Micronutrients (Fe, Zn, Cu and Mn) were extracted by DTPA reagent using the procedure outlined by Lindsay and Norvell (1978). Preliminary interpreted soil boundaries were modified in the light of field and laboratory information and the final soil map with legend was prepared.

Plot level information on Cadastral map

The field/ farmer level utilization of soil map can be achieved only if the soil information is available with field numbers (called *khasra* numbers in Uttar Pradesh) on the village map. To achieve this, the information on roads, habitation, field/

'khasra' boundaries, canal, rail lines etc. was taken from the village cadastre, digitized, and overlaid on the soil map unit along with habitation boundaries for all the study villages. A sample map of village Bhaganpur prepared with *'khasra'* numbers and soil information is presented in Fig-4. From the ownership of *'khasra'* numbers in the village register, farmer level information can also be generated. The database on soils of each plot (*khasra*) and each farmer will be useful in resource potential assessment of every plot of the village.

Results and Discussion

Tala Nyaypanchayat

The soils of Tala Nyaypanchayat of Amethi the district are generally loamy in texture at the surface, clay loam in sub-surface, the soils were 55.5 ha (2.9%) and 207 ha (8.56%) area affected by sodocity and salinity problems (Fig. 3 and 4) (Patil *et al*, 2017). The soil organic carbon content of Tala were categorized as high 65.5 ha (2.87%), medium 473.6 ha (45.3%), medium-low 96.6 ha (5.61%), low 421 ha (32.1%) and very low 91.9 ha (4.1%) shows in fig. 5, The higher value of OC in forest land use was probably because of addition of litter and slower oxidation of the fresh organic material. The low organic matter content in this area due to faster degradation and consequent removal of organic matter coupled with lesser nitrogen fertilization leading to nitrogen deficiency. Govindarajan and Datta Biswas (1968). The available phosphorus content (Fig. 6), the area observed (Table 3.1) high 18.3 ha (1.62%), medium 694.5 ha (55.8%), medium-low 208.8 ha (14.1%), low-high 12.61 ha (1.52%), low 213.3 ha (19.15%) and very low 1.25 ha (0.18%). However, agricultural lands exhibited higher available due possibly to application of phosphatic fertilizers to crops by farmers. Whereas low availability of P in Sunderpur, Haripur and Bhaganpur village is due to its fixation due by $CaCO_3$, it is due to the presence of sesquioxides and low activity clays (Patil and Dasog 1999). The available potassium content in this Nyaypanchayat high 149.3 ha (13.5%), medium-high 27.8 ha (2.0%), medium 876.4 (72.8%), low 21.0 ha (1.1%), very low 74.3 ha (2.9%) category (Fig. 7). In Darka village distributed between low and very low status in soils signifies higher leaching regime as evidenced by low base saturation in these soils. The available potassium was low because of lesser finer fractions in their A horizons and predominance of K rich micaceous and feldspar minerals in parent materials. Ravi Kumar (2006).

The available sulphur content of Tala Nyaypanchayat, the area (Fig. 8) dominated of marginal status as 568 ha (53.0%) followed by low 447 ha (28.2%) marginal-low 106.6 ha (9.1%) and medium 25.7 ha (2.0%).The available S in soils of all the ten villages was low in Bhaganpur village (39.88%), the area is divided equally between the low and medium status in highlighting the importance of mapping the area rather than the statistic derived from soil analysis similar result found in Bhavnagar district of Gujarat by Rajput and Polara (2012).

The available Fe categorized as sufficient 896.0 ha (78.8%), sufficient-low 27.4 ha (1.9%), marginal 144.6 ha (6.4%), marginal-low 79.6 ha (5.1%) and low 1.21 ha (0.15%) (Fig.9). The available Mn categorized as sufficient, marginal and marginal-sufficient as 997.1 ha (82.8%), 130.1 ha (7.4%) and 21.7 ha (2.1%) area respectively (Fig. 10). Low soil pH coupled with the ferromanganese nature of the parent material, on which these soils developed might have contributed for sufficiency of extractable Mn as observed also by Prasad and Sahi (1989). The available Zn categorized (Fig. 11) as sufficient 672 ha (48.0%), sufficient-low 29.5 ha (3.55%), marginal 403 ha (37.4%) and low 43.5 ha (3.33%), The former two are deficient in Zn and the last one is sufficient guided by the critical value of 0.6 mg kg-1 as these soils are alkaline in nature resulting in decreased solubility and mobility (Vijayashekhar *et al.* 2000); and most of available Cu content is sufficient as 1016.9 ha (81.0%) followed by sufficient-medium and marginal-sufficient 62.7 (7.5%) and 69.2 ha (3.73%) respectively (Fig. 12).

Korari Girdhar Shah Nyaypanchayat

The soils of Korari Nyaypanchayat of Amethi the district are generally loamy in texture at the surface, clay loam in sub-surface, of these soils were 207 ha (8.55%) and 182.0 ha (7.09%) area affected by sodocity and salinity problems (Fig. 13 and 14). The soil organic carbon content of Korari were categorized as high to medium 8.45 ha (0.52%), medium 320.3 ha (15.5%), low to medium 126.1 ha (7.1%), low 1386.0 ha (60.4%), low to high 59.9 ha (2.5%), and very low 229.6 (7.0%) Mapping of available Fe by GIS revealed that, it was deficient in the entire study area in figure of Korari Girdhar Shah Nyaypanchayat, and available phosphorus content, the area observed high 24.4 ha (1.22%), high to medium 33.4 ha (0.79%), medium 1407.7 ha (59.8%), medium to low 397.8 ha (17.7%), low 285.6 ha (13.0%) and very low 8.29 ha (0.55%) and shows in fig.17. The available potassium content in this Nyaypanchayat high 364.3 ha (14.9%), high to medium 198.4 ha (7.69%), medium 1541.9 (69.5%), low 25.6 ha (0.92%) category. The available sulphur content of Korari Nyaypanchayat (Fig. 18), the area dominated of marginal status as 1211.7 ha (53.3%) followed by marginal to low 289.6 ha (7.7%) and low 628.9 ha (32.1%). The available Fe categorized as sufficient 1091.6 ha (53.4%), sufficient to low 238.5 ha (6.9%), marginal 265.8 ha (10.2%), marginal to sufficient 485.8 ha (19.0%) and low 48.5 ha (3.5%) (Fig. 19) This type of variation may be due to the soil management practices and cropping pattern adopted by different farmers (Srikant *et al.*, 2008). The available Mn categorized as sufficient, marginal, marginal to sufficient, marginal to low and low as 1268.3 ha (58.6%), 378.7 ha (13.4%) and 375.4 ha (13.6%), 43.5 ha (3.1%) and 64.3 ha (4.3%) area respectively (Fig. 20). Mapping of available Mn by GIS revealed that, it was sufficient in the entire study area. Sufficient content of manganese was observed by Ravikumar *et al*. (2007b) in Vertisols of Malaprabha command area, Pulakeshi *et al*. (2012) in the soils of northern transition zone of Karnataka derived from chlorite schist The available Zn categorized (Fig. 21) as sufficient 1665.0 ha (71.2%), sufficient to low 128.9 ha (10.1%) and marginal 336.3 ha (11.7%). The content of Zn increases with low pH and high organic carbon content but decreases with increase in pH. Since, most of the soils are alkaline, low in OC and dominated by $CaCO_3$, zinc may be precipitated as hydroxides and carbonates, as a result their solubility and mobility might have decreased and reduced the availability (Patil *et al.*, 2006 and Pulakeshi *et al.*, 2012)., and most of available Cu content is sufficient as 2130.2 ha (93.0%) respectively (Fig. 22). Rajput and Polara (2012) observed sufficient status of available copper in soils in Bhavnagar district in Gujarat.

Table 1: Categorization of physico-chemical properties and fertility status of Tala Nyaypanchayat of Amethi district

Parameter	Village / Categories	Ahirwar		Bhaganpur		Dharka		Haripur		Jangal		Sonpur		Tala		Suderpur		Kusauli		Lohrata		Overall	
		Area		Area		Area		Area		Area		Area		Area		Area		Area		Area		Area	
	Categories	ha	%	ha	%	ha	%	ha	%	ha	%	Ha	%	ha	%	ha	%	ha	%	ha	%	Ha	%
PH	Normal	65.15	94.11*	127.61	82.50	244.09	82.95	48.30	93.41	71.27	90.69	75.75	91.10	184.17	92.90	106.00	95.43	125.16	88.40	45.97	82.45	1093.5	89.39
	Sodic	Nil	Nil	16.86	10.90	32.54	11.06	Nil	Nil	1.19	1.51	2.98	3.58	Nil	Nil	1.78	1.60	0.11	0.08	Nil	Nil	55.46	2.87
EC	Normal	65.15	94.11	127.61	82.50	244.09	82.95	48.30	93.40	71.28	90.69	75.75	91.10	184.17	92.90	106.00	95.43	125.16	88.40	45.97	82.44	1093.5	89.39
	Tolerant	Nil	Nil	16.86	10.90	32.54	11.06	Nil	Nil	1.19	1.52	2.98	3.58	Nil	Nil	1.78	1.61	Nil	Nil	Nil	Nil	55.35	2.87
OC	High	Nil	Nil	4.89	3.16	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	51.44	25.95	Nil	Nil	0.41	0.29	8.78	15.74	65.52	4.51
	Medium	23.68	34.20	16.82	10.87	16.04	5.45	48.30	93.40	5.72	7.28	52.99	63.73	127.45	64.29	23.47	21.13	121.92	86.12	37.19	66.70	473.58	45.32
	Medium-low	Nil	Nil	25.68	16.60	53.24	18.09	Nil	Nil	1.68	2.14	16.00	19.24	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	96.60	5.61
	Low	41.47	59.90	80.22	51.86	138.22	46.97	Nil	Nil	63.88	81.28	6.76	8.13	5.28	2.66	82.53	74.30	2.83	2.00	Nil	Nil	421.18	32.71
	Very low	Nil	Nil	16.86	10.90	69.13	23.49	Nil	Nil	1.19	1.52	2.98	3.58	Nil	Nil	1.78	1.61	Nil	Nil	Nil	Nil	91.94	4.11
P	High	3.58	5.17	11.73	7.59	Nil	Nil	Nil	Nil	2.18	2.77	Nil	Nil	Nil	Nil	0.77	0.69	Nil	Nil	Nil	Nil	18.26	1.62
	Medium	59.86	86.47	32.12	20.77	174.68	59.37	30.73	59.43	22.73	28.93	24.36	29.30	156.94	79.16	45.16	40.65	102.33	72.28	45.62	81.82	694.53	55.82
	Medium-low	0.08	0.12	65.21	42.16	68.92	23.42	0.07	0.14	26.13	33.25	23.19	27.89	21.96	11.08	Nil	Nil	3.12	2.20	0.13	0.24	208.82	14.05
	Low-High	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	12.61	15.16	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	12.61	1.52
	Low	0.37	0.54	35.41	22.89	33.03	11.23	17.50	33.83	21.42	27.25	18.58	22.34	5.27	2.66	61.85	55.69	19.70	13.91	0.21	0.38	213.34	19.07
	Very low	1.25	1.81	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	1.25	0.18
K	High	3.96	5.72	37.41	24.19	36.96	12.56	17.50	33.83	14.13	17.97	15.60	18.76	Nil	Nil	23.47	21.13	0.11	0.08	0.21	0.38	149.34	13.46
	High-Medium	Nil	Nil	1.35	0.87	15.67	5.33	Nil	Nil	10.79	13.73	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	27.81	1.99
	Medium	61.20	88.40	105.70	68.33	140.63	47.79	30.80	59.57	47.55	60.51	58.42	70.26	184.17	92.90	77.14	69.45	125.05	88.33	45.75	82.06	876.41	72.76
	Low	Nil	Nil	Nil	Nil	16.27	5.53	Nil	Nil	Nil	Nil	4.71	5.66	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	20.98	1.12
	Very low	Nil	Nil	Nil	Nil	67.11	22.81	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	7.17	6.46	Nil	Nil	Nil	Nil	74.28	2.93
S	Medium	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	3.53	4.50	Nil	Nil	2.42	1.22	Nil	Nil	19.70	13.91	Nil	Nil	25.65	1.96
	Marginal	49.79	71.92	54.27	35.09	137.50	46.73	48.30	93.40	15.32	19.49	43.49	52.30	10.06	5.08	88.38	79.56	84.42	59.63	37.19	66.70	568.71	52.99
	Marginal-low	Nil	Nil	61.68	39.88	Nil	Nil	Nil	Nil	36.92	46.98	Nil	Nil	5.28	2.66	Nil	Nil	2.71	1.91	Nil	Nil	106.59	9.14
	Low	15.37	22.20	28.52	18.44	139.13	47.28	Nil	Nil	16.69	21.24	35.24	42.38	166.41	83.94	19.40	17.47	18.32	12.94	8.78	15.74	447.87	28.16
Fe	Sufficient	65.15	94.11	117.41	75.91	98.11	33.34	48.30	93.40	48.54	61.77	62.73	75.44	184.17	92.90	100.61	90.58	125.05	88.33	45.97	82.44	896.03	78.82
	Sufficient-Low	Nil	Nil	25.68	16.60	Nil	Nil	Nil	Nil	1.68	2.14	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	27.36	1.87
	Marginal	Nil	Nil	1.35	0.87	125.28	42.58	Nil	Nil	10.79	13.73	Nil	Nil	Nil	Nil	7.17	6.46	Nil	Nil	Nil	Nil	144.60	6.36
	Marginal-low	Nil	Nil	Nil	Nil	53.24	18.09	Nil	Nil	10.26	13.06	16.00	19.24	Nil	Nil	Nil	Nil	0.11	0.08	Nil	Nil	79.61	5.05
	Low	Nil	Nil	0.02	0.01	Nil	Nil	Nil	Nil	1.19	1.52	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	1.21	0.15
Mn	Sufficient	65.15	94.11	117.43	75.92	193.48	65.75	48.30	93.40	49.74	63.28	67.17	80.78	184.17	92.90	100.61	90.58	125.05	88.33	45.97	82.44	997.06	82.75
	Marginal	Nil	Nil	16.15	10.44	83.15	28.26	Nil	Nil	11.94	15.20	11.56	13.90	Nil	Nil	7.17	6.46	0.11	0.08	Nil	Nil	130.08	7.43
	Marg-sufficient	Nil	Nil	10.89	7.04	Nil	Nil	Nil	Nil	10.79	13.73	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	21.68	2.08
Zn	Sufficient	49.488	71.48	127.61	82.50	180.52	61.35	0.07	0.14	71.28	90.69	Nil	Nil	74.26	37.46	85.08	76.60	84.31	59.55	0.13	0.24	672.74	48.00
	Sufficient-Low	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	29.53	35.52	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	29.53	3.55
	Marginal	15.67	22.63	16.86	10.90	96.12	32.66	48.23	93.26	1.19	1.52	49.19	59.16	75.15	37.91	22.70	20.44	40.84	28.85	37.06	66.46	403.00	37.38
	Low	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	34.75	17.53	Nil	Nil	Nil	Nil	8.78	15.74	43.53	3.33
Cu	Sufficient	65.15	94.11	144.47	93.40	223.39	75.92	48.30	93.40	72.47	92.21	Nil	Nil	184.17	92.90	107.78	97.03	125.16	88.40	45.97	82.44	1016.8	80.98
	Suff.-medium	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	62.73	75.44	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	62.73	7.54
	Marg-sufficient	Nil	Nil	Nil	Nil	53.24	18.09	Nil	Nil	Nil	Nil	16.00	19.24	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	69.24	3.73

Table 2: Categorization of Physico-chemical properties and fertility status of Korari Girdhar Shah Nyaypanchayat of Amethi district

Parameter	Village / Categories	Katrahulsi		Bariapur		Chaturbhujpur		Ghaghupur		Korari		Mangalpur		Mochwa	
		Area		Area		Area		Area		Area		Area		Area	
		ha	%	Ha	%	ha	%	ha	ha	%	%	ha	%	ha	%
pH	Normal	55.85	94.88*	167.87	76.80	106.48	85.44	104.90	386.67	84.51*	75.44	289.06	73.84	54.27	81.72
	Sodic	Nil	Nil	39.28	17.97	2.00	1.60	20.61	1.64	0.36	14.82	72.51	18.52	6.39	9.62
EC	Normal	55.85	94.88	167.87	76.80	106.48	85.44	108.26	386.94	84.57	77.86	291.70	74.51	54.27	81.72
	Tolerant	Nil	Nil	34.32	15.70	2.00	1.60	17.25	1.31	0.29	12.41	69.87	17.85	3.13	4.71
	Not Suitable	Nil	Nil	4.96	2.27	Nil	Nil	Nil	0.06	0.01	Nil	Nil	Nil	3.27	4.92
O.C.	High-Medium	Nil	Nil	Nil	Nil	8.09	6.49	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
	Medium	53.29	90.53	Nil	Nil	27.67	22.20	Nil	78.73	17.21	Nil	2.26	0.58	Nil	Nil
	Medium-low	0.48	0.82	Nil	Nil	0.14	0.11	Nil	19.79	4.33	Nil	Nil	Nil	Nil	Nil
	Low	2.09	3.55	167.87	76.80	72.58	58.24	104.90	201.87	44.12	75.44	284.04	72.55	54.27	81.72
	Low-High	Nil	Nil	39.28	17.97	Nil	Nil	20.61	Nil	Nil	14.82	Nil	Nil	Nil	Nil
	Very low	Nil	Nil	Nil	Nil	Nil	Nil	Nil	87.92	19.22	Nil	75.27	19.23	6.39	9.62
P	High	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0.69	0.15	Nil	Nil	Nil	Nil	Nil
	High-Medium	0.48	0.82	Nil	Nil	Nil	Nil	Nil	19.79	4.33	Nil	Nil	Nil	Nil	Nil
	Medium	40.84	69.38	174.30	79.74	83.36	66.89	91.42	280.31	61.26	65.75	354.45	90.54	57.32	86.31
	Medium-low	Nil	Nil	Nil	Nil	6.84	5.49	19.45	Nil	Nil	13.99	Nil	Nil	Nil	Nil
	Low	14.53	24.68	27.89	12.76	18.27	14.66	14.63	87.46	19.12	10.52	7.12	1.82	0.08	0.12
	Very low	Nil	Nil	4.96	2.27	Nil	Nil	Nil	0.06	0.01	Nil	Nil	Nil	3.27	4.92
K	High	16.69	28.35	Nil	Nil	28.29	22.70	Nil	126.76	27.70	Nil	10.03	2.56	0.03	0.05
	High-Medium	2.61	4.43	Nil	Nil	24.34	19.53	6.00	102.54	22.41	4.32	2.76	0.70	Nil	Nil
	Medium	36.56	62.11	181.76	83.15	55.85	44.82	119.50	159.01	34.75	85.94	348.78	89.09	60.41	90.97
	Low	Nil	Nil	25.39	11.62	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0.22	0.33
S	Marginal	40.25	68.38	121.48	55.58	35.65	28.61	48.95	176.77	38.63	35.20	206.07	52.64	35.37	53.26
	Marginal-low	2.13	3.62	Nil	Nil	41.83	33.57	Nil	189.02	41.31	Nil	12.79	3.27	0.03	0.05
	Low	13.48	22.90	85.67	39.19	31.00	24.88	76.55	22.52	4.92	55.05	142.72	36.46	25.26	38.04
Fe	Sufficient	55.37	94.07	66.76	30.54	53.24	42.72	53.14	101.31	22.14	38.22	185.12	47.29	57.01	85.85
	Sufficient-Low	0.48	0.82	Nil	Nil	24.15	19.38	0.27	125.38	27.40	0.19	59.18	15.12	0.14	0.21
	Marginal	Nil	Nil	28.81	13.18	7.47	5.99	65.92	83.44	18.24	47.41	27.96	7.14	3.43	5.16
	Marginal- Suff.	Nil	Nil	111.58	51.05	23.47	18.83	6.16	78.18	17.09	4.43	89.32	22.82	0.08	0.12
	Low	Nil	Nil	Nil	Nil	0.14	0.11	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Mn	Sufficient	55.37	94.07	80.76	36.95	59.34	47.62	44.70	257.06	56.18	32.15	128.51	32.83	50.92	76.68
	Marginal	0.48	0.82	17.82	8.15	9.47	7.60	80.64	20.49	4.48	58.00	196.01	50.07	6.36	9.58
	Marginal-Suff.	Nil	Nil	103.61	47.40	15.38	12.34	0.16	110.70	24.19	0.12	37.06	9.47	0.12	0.18
	Marginal-low	Nil	Nil	Nil	Nil	0.14	0.11	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
	Low	Nil	Nil	4.96	2.27	24.15	19.38	Nil	0.06	0.01	Nil	Nil	Nil	3.27	4.92
Zn	Sufficient	39.20	66.60	200.05	91.52	105.76	84.87	119.06	272.06	59.46	85.63	293.44	74.95	25.71	38.71
	Marginal	14.53	24.68	0.05	0.02	2.57	2.06	Nil	4.71	1.03	Nil	Nil	Nil	28.93	43.56
	Marginal-Suff.	2.13	3.62	7.05	3.23	0.14	0.11	6.44	111.55	24.38	4.63	68.13	17.40	6.02	9.06
Cu	Sufficient	55.85	94.88	207.15	94.77	108.47	87.04	125.50	388.31	84.87	90.26	361.57	92.36	60.66	91.34
pH	Normal	161.50	94.74	91.37	85.14	102.65	86.01	251.71	92.51	42.62	95.87	107.48	70.91	1922.42	84.45
	Sodic	1.56	0.91	14.00	13.04	7.80	6.54	Nil	Nil	Nil	Nil	41.98	27.70	207.77	8.55

EC	Normal	163.05	95.65	96.36	89.79	102.25	85.67	251.71	92.52	42.62	95.87	112.15	73.99	1939.51	85.33
	Tolerant	Nil	Nil	9.01	8.40	7.81	6.54	Nil	Nil	Nil	Nil	37.31	24.61	182.01	7.09
	Not Suitable	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	8.29	0.55
O.C.	High-Medium	Nil	Nil	Nil	Nil	0.36	0.30	Nil	Nil	Nil	Nil	Nil	Nil	8.45	0.52
	Medium	15.02	8.81	3.81	3.55	1.16	0.97	114.65	42.14	Nil	Nil	23.67	15.62	320.25	15.51
	Medium-low	0.06	0.03	43.35	40.39	49.64	41.59	12.61	4.63	Nil	Nil	Nil	Nil	126.07	7.07
	Low	146.43	85.90	53.22	49.59	47.84	40.08	124.45	45.74	42.62	95.87	83.81	55.29	1385.98	60.38
	Low-High	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	59.89	2.52
	Very low	1.56	0.91	4.99	4.65	11.46	9.60	Nil	Nil	Nil	Nil	41.98	27.70	229.57	6.99
P	High	Nil	Nil	Nil	Nil	0.06	0.05	Nil	Nil	Nil	Nil	23.67	15.62	24.42	1.22
	High-Medium	0.06	0.03	Nil	Nil	0.49	0.41	12.61	4.63	Nil	Nil	Nil	Nil	33.42	0.79
	Medium	90.36	53.01	35.91	33.46	74.82	62.69	Nil	Nil	16.11	36.24	108.47	71.56	1407.66	59.76
	Medium-low	57.46	33.71	60.66	56.52	0.07	0.05	239.10	87.88	14.26	32.08	Nil	Nil	397.83	17.67
	Low	15.18	8.91	8.80	8.20	35.02	29.34	Nil	Nil	12.26	27.58	17.32	11.43	258.56	13.01
	Very low	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	8.29	0.55
K	High	13.65	8.01	4.99	4.65	59.61	49.95	98.38	36.16	5.85	13.16	Nil	Nil	364.28	14.87
	High-Medium	0.06	0.03	43.35	40.39	4.15	3.47	12.61	4.63	Nil	Nil	Nil	Nil	198.41	7.69
	Medium	149.35	87.61	57.03	53.14	46.70	39.12	140.72	51.72	36.77	82.71	149.46	98.60	1541.90	69.52
	Low	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	25.61	0.92
S	Marginal	103.19	60.53	12.82	11.95	106.11	88.91	207.84	76.39	28.35	63.77	88.86	58.62	1211.71	53.27
	Marginal-low	Nil	Nil	Nil	Nil	3.66	3.06	40.14	14.75	Nil	Nil	Nil	Nil	289.60	7.66
	Low	59.87	35.12	92.55	86.24	0.69	0.58	3.72	1.37	14.27	32.11	60.60	39.98	628.90	32.06
Fe	Sufficient	97.27	57.06	26.32	24.52	31.60	26.48	250.25	91.98	36.29	81.63	77.92	51.41	1091.61	53.38
	Sufficient-Low	0.06	0.03	26.90	25.06	0.49	0.41	1.45	0.53	Nil	Nil	Nil	Nil	238.49	6.86
	Marginal	Nil	Nil	3.81	3.55	15.42	12.92	Nil	Nil	Nil	Nil	29.56	19.50	265.82	10.24
	Marginal- Suff.	65.73	38.56	Nil	Nil	62.94	52.74	Nil	Nil	6.33	14.24	41.98	27.70	485.77	19.04
	Low	Nil	Nil	48.34	45.04	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	48.48	3.47
Mn	Sufficient	159.10	93.33	17.31	16.13	46.41	38.89	250.25	91.98	41.68	93.75	76.90	50.73	1268.31	58.56
	Marginal	2.40	1.41	12.82	11.95	1.65	1.38	Nil	Nil	0.02	0.04	30.58	20.17	378.74	13.36
	Marginal- Suff.	1.56	0.91	Nil	Nil	62.40	52.28	1.45	0.53	0.93	2.09	41.98	27.70	375.35	13.63
	Marginal-low	Nil	Nil	43.35	40.39	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	43.49	3.12
	Low	Nil	Nil	31.89	29.71	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	64.33	4.33
Zn	Sufficient	148.77	87.27	62.02	57.79	53.50	44.83	211.57	77.76	42.62	95.87	91.21	60.17	1664.97	71.19
	Marginal	12.72	7.46	Nil	Nil	49.15	41.18	Nil	Nil	Nil	Nil	16.27	10.73	128.94	10.06
	Marginal- Suff.	1.56	0.91	43.35	40.39	7.80	6.54	40.14	14.75	Nil	Nil	41.98	27.70	336.29	11.75
Cu	Sufficient	163.05	95.65	105.37	98.18	110.45	92.55	251.71	92.52	42.62	95.87	149.46	98.60	2130.18	92.99

*****The remaining area of the village is under habitation and water bodies

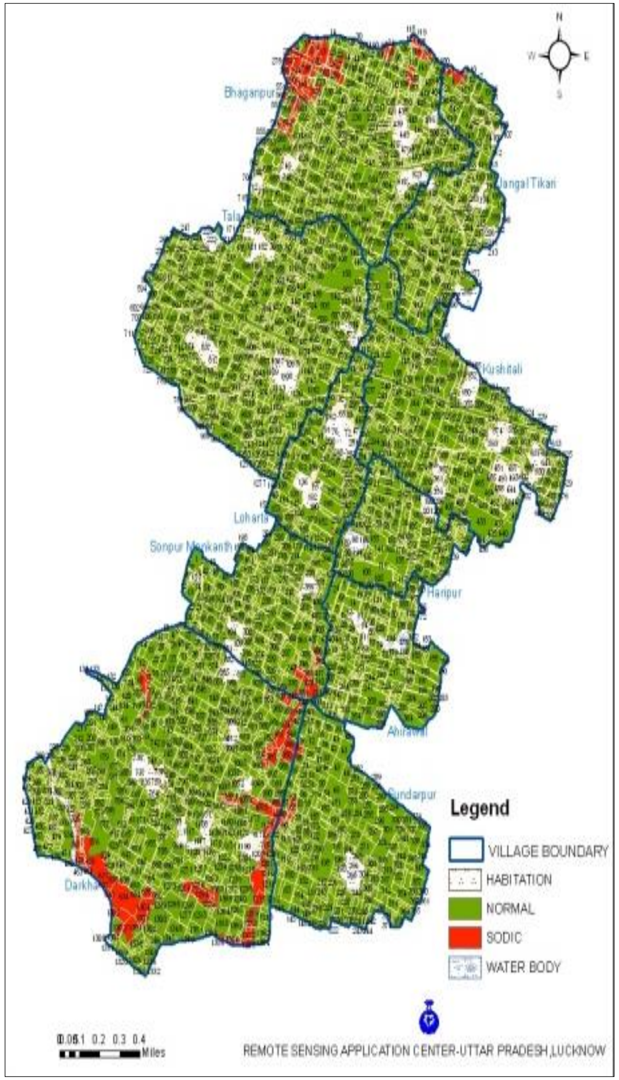

Fig 3: Soil pH map of Tala Nayapanchayat district Amethi

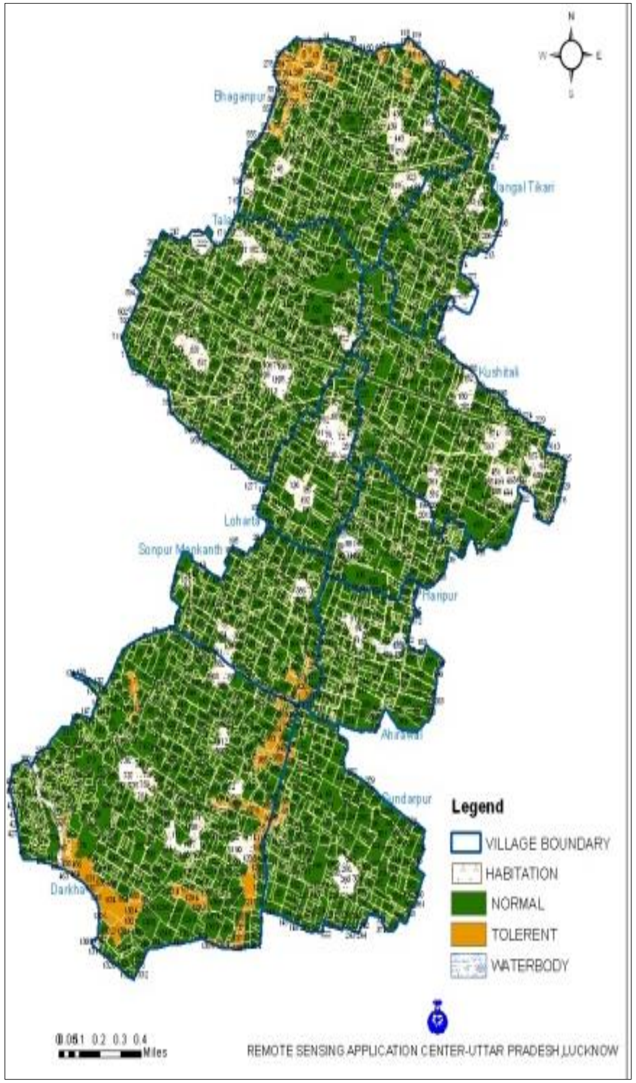

Fig 4: Soil EC map of Tala Nayapanchayat district Amethi

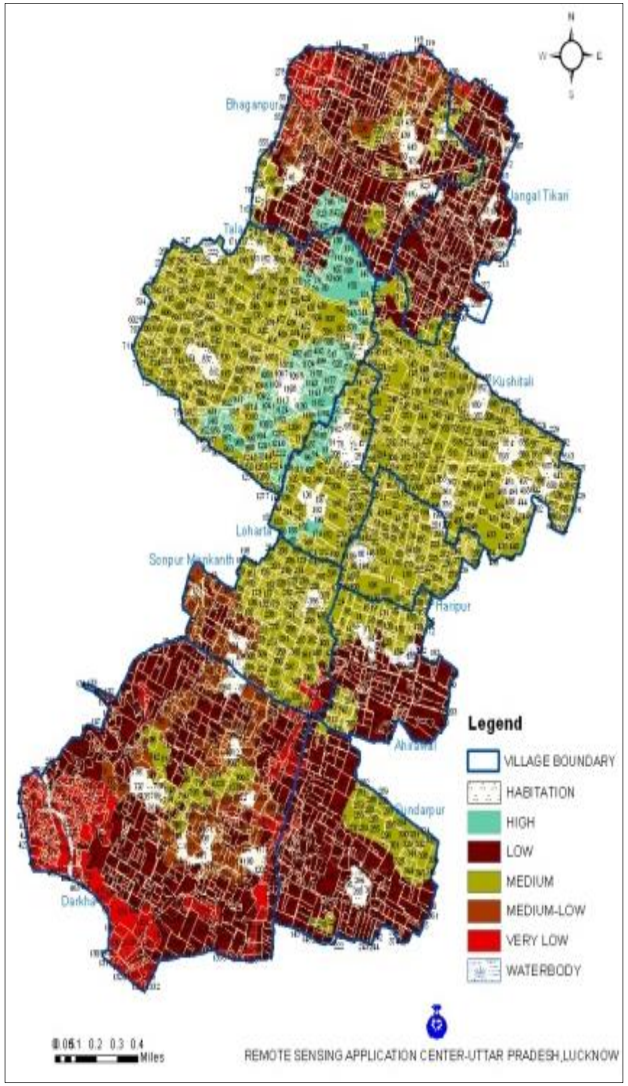

Fig 5: Soil organc map of Tala Nayapanchayat district Amethi

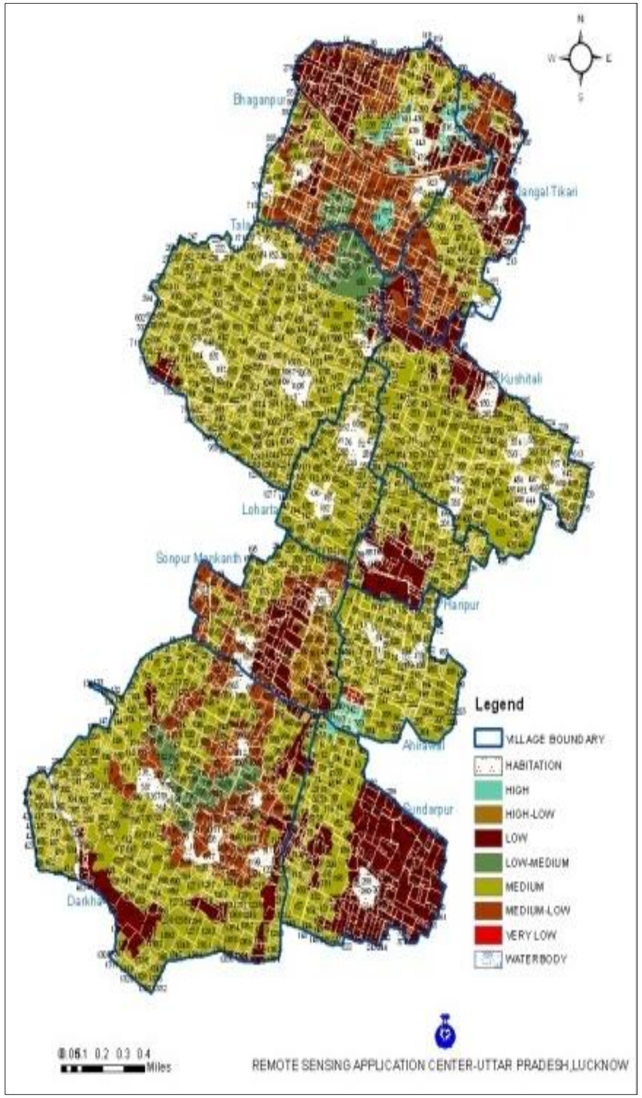

Fig 6: Soil phosphorus map of Tala Nayapanchayat district Amethi

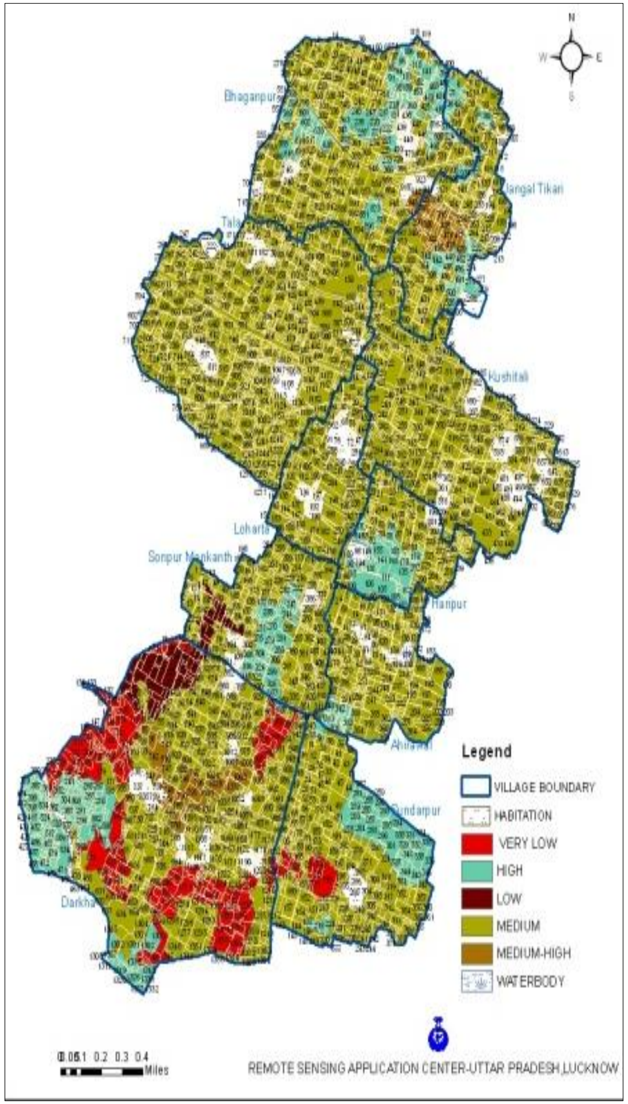

Fig 7: Soil potassium map of Tala Nayapanchayat district Amethi

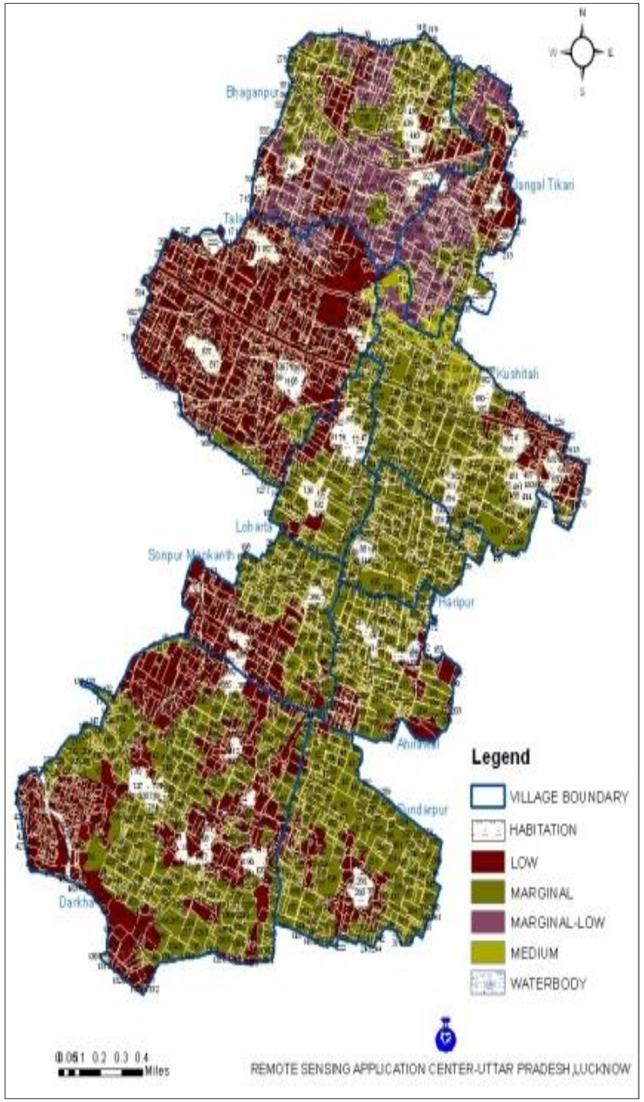

Fig 8: Soil sulphur map of Tala Nayapanchayat district Amethi

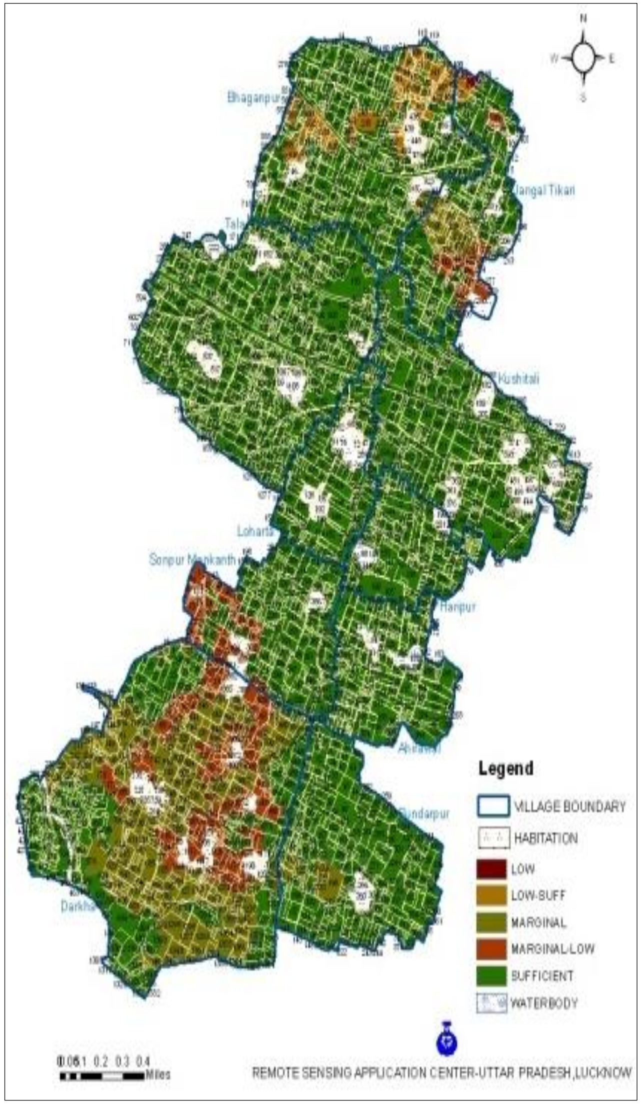

Fig 9: Soil iron map of Tala Nayapanchayat district Amethi

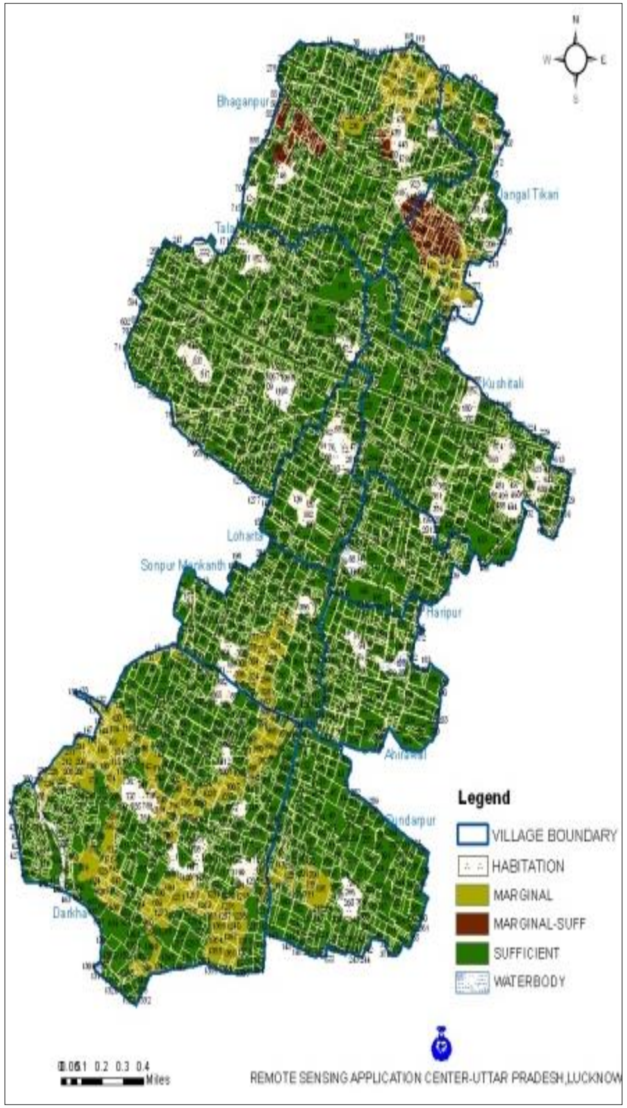

Fig 10: Soil mangansese map of Tala Nayapanchayat district Amethi

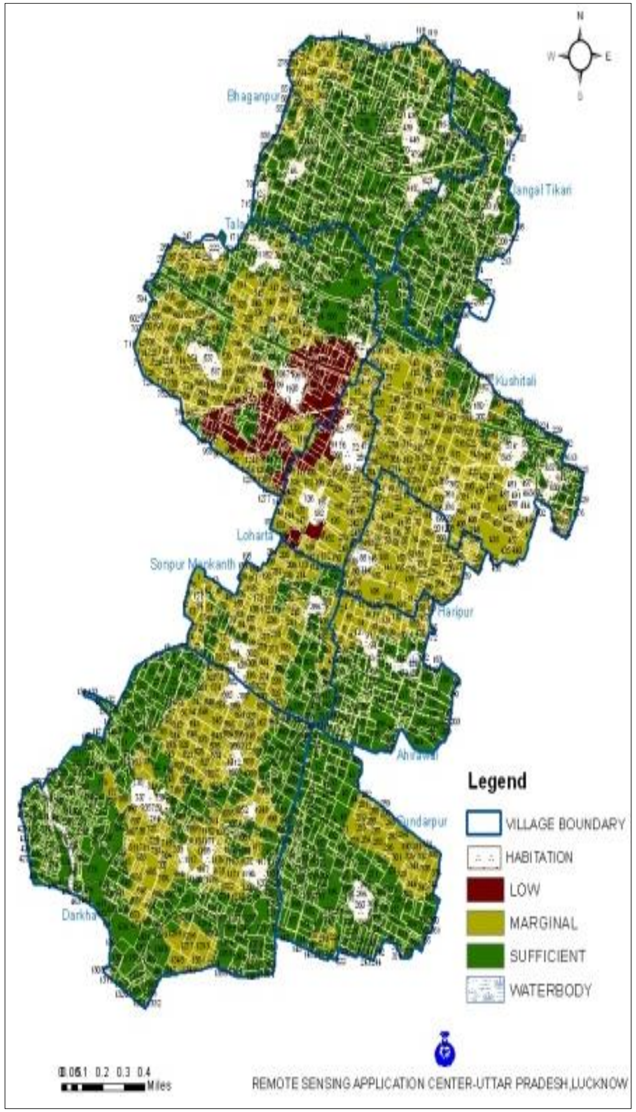

Fig 11: Soil zinc map of Tala Nayapanchayat district Amethi

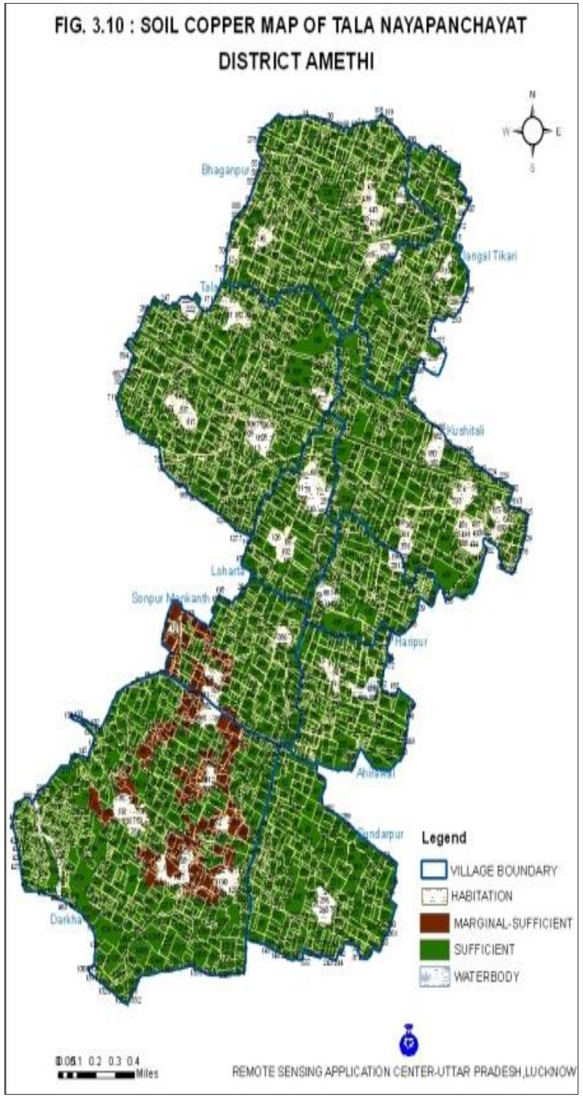

Fig 12: Soil copper map of Tala Nayapanchayat district Amethi

Village wise Soil Fertility Maps of Tala Nayapanchayat

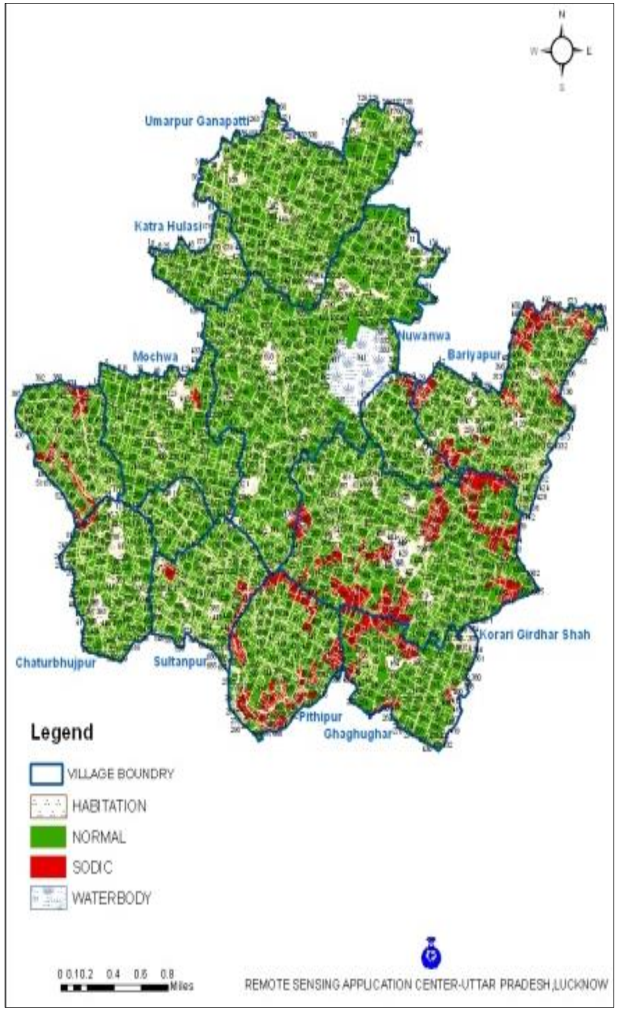

Fig 13: Soil pH map of Korari Nayapanchayat district Amethi

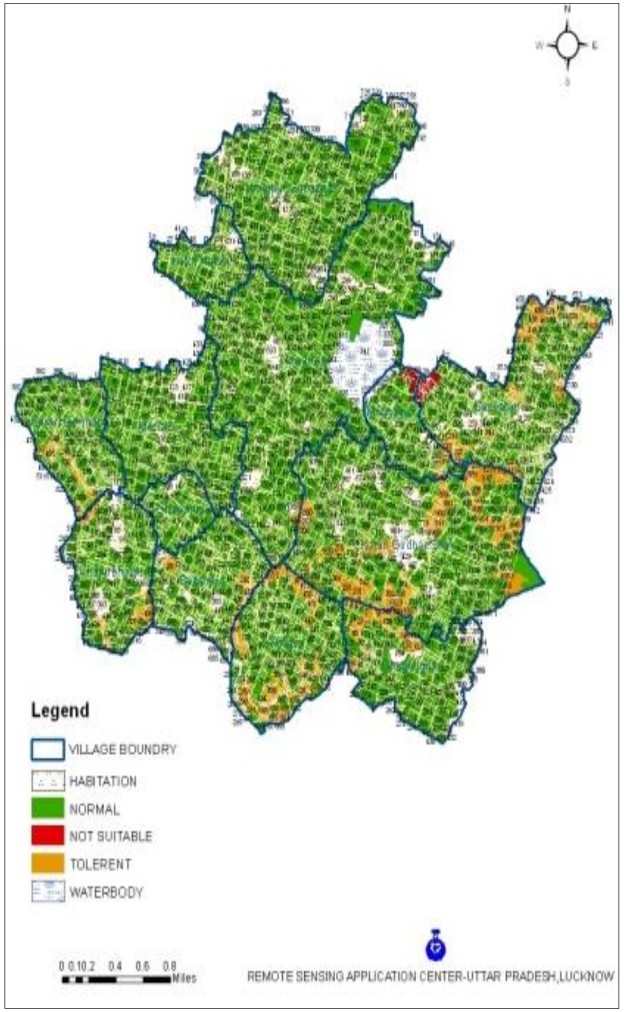

Fig 14: Soil EC map of Korari Nayapanchayat district Amethi

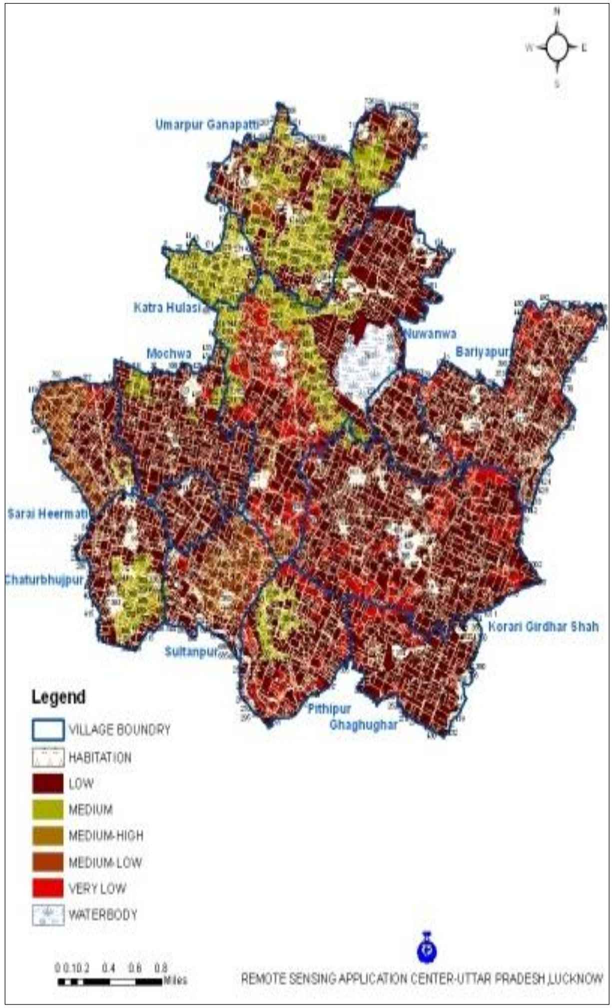

Fig 15: Soil EC map of Korari Nayapanchayat district Amethi

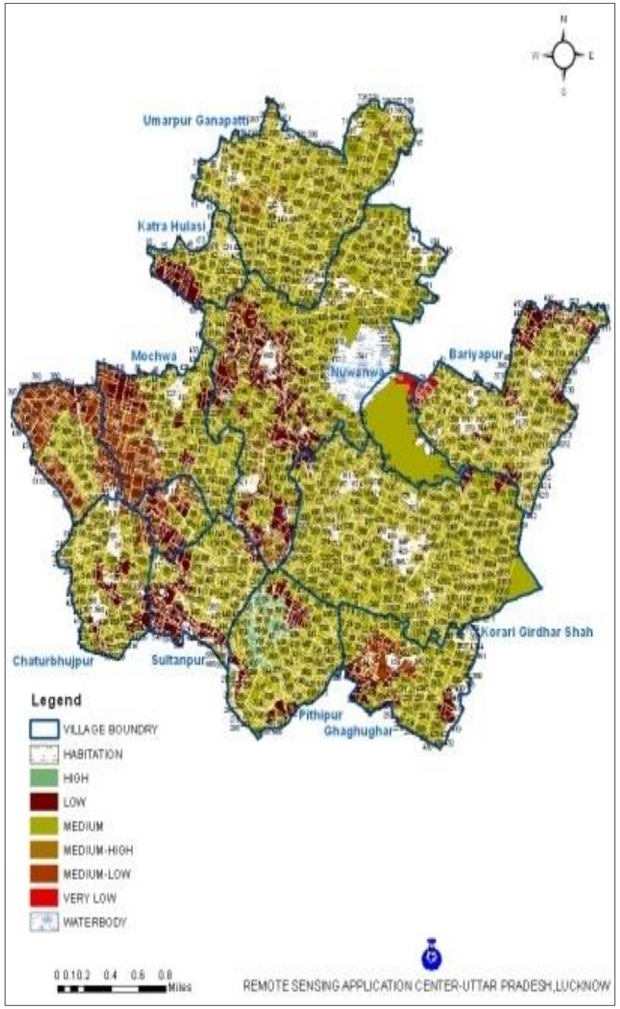

Fig 16: Soil phosphorus map of Korari Nayapanchayat district Amethi

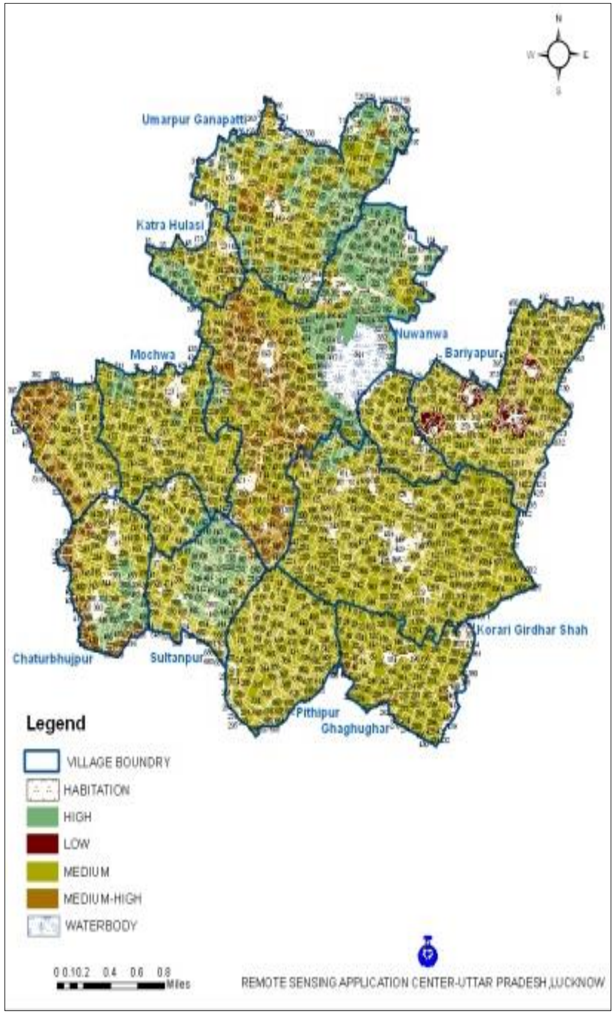

Fig 17: Soil potassium map of Korari Nayapanchayat district Amethi

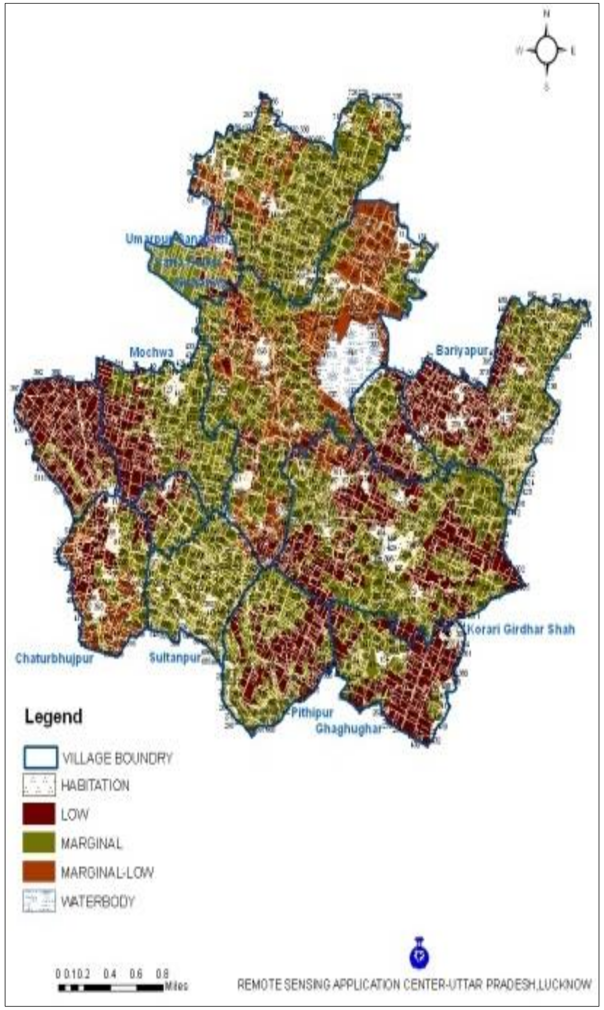

Fig 18: Soil sulphur map of Korari Nayapanchayat district Amethi

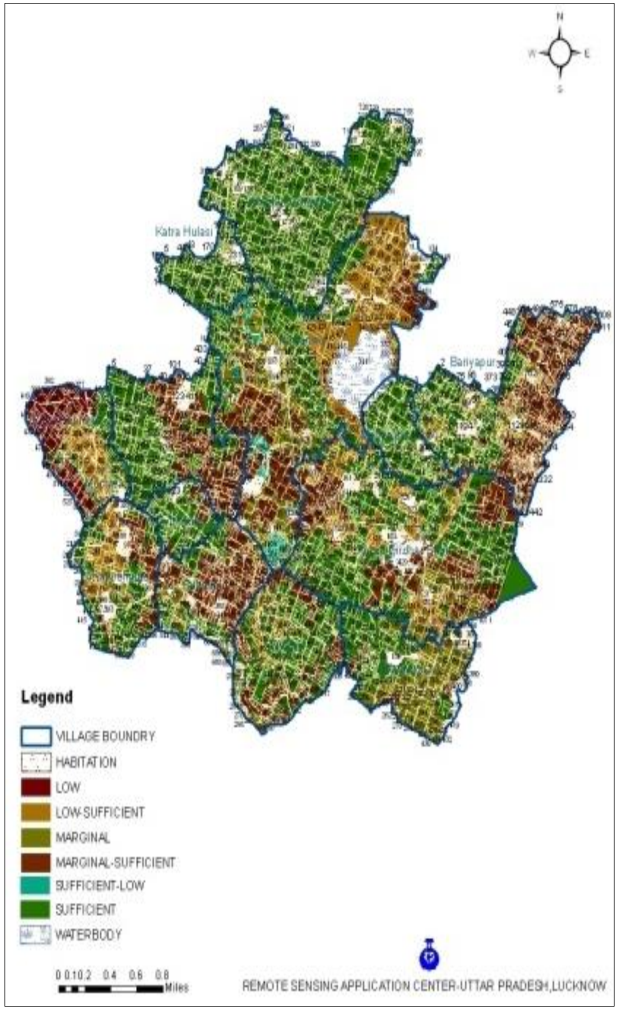

Fig 19: Soil iron map of Korari Nayapanchayat district Amethi

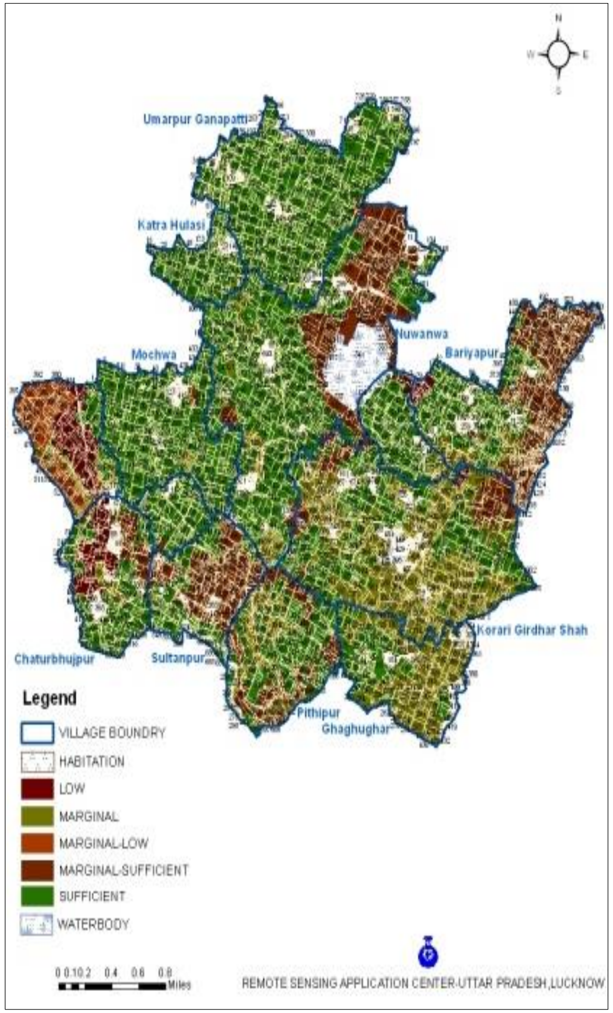

Fig 20: Soil mangansese map of Korari Nayapanchayat district Amethi

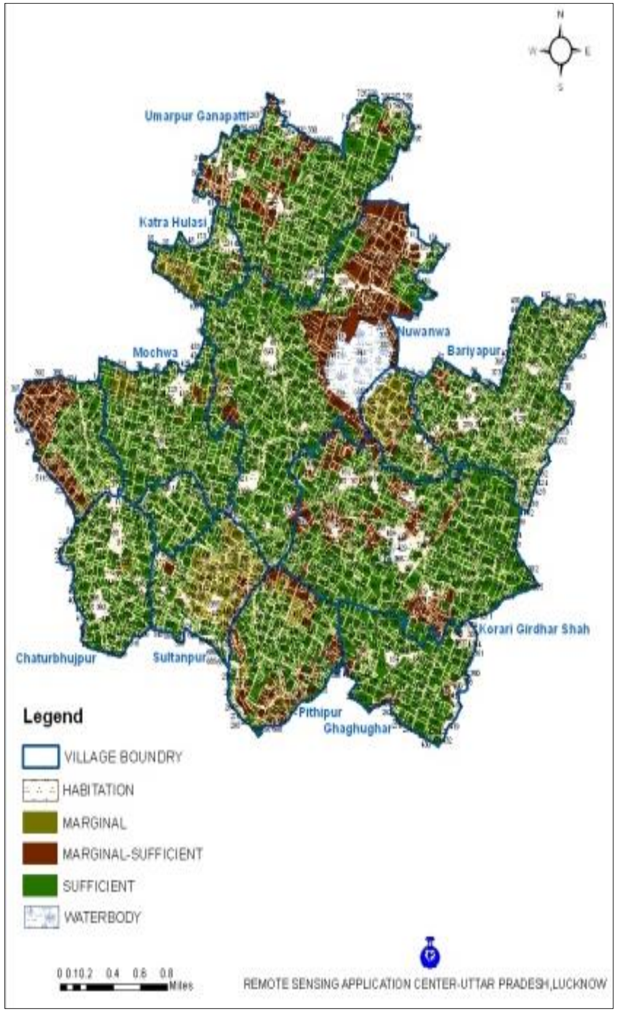

Fig 21: Soil zinc map of Korari Nayapanchayat district Amethi

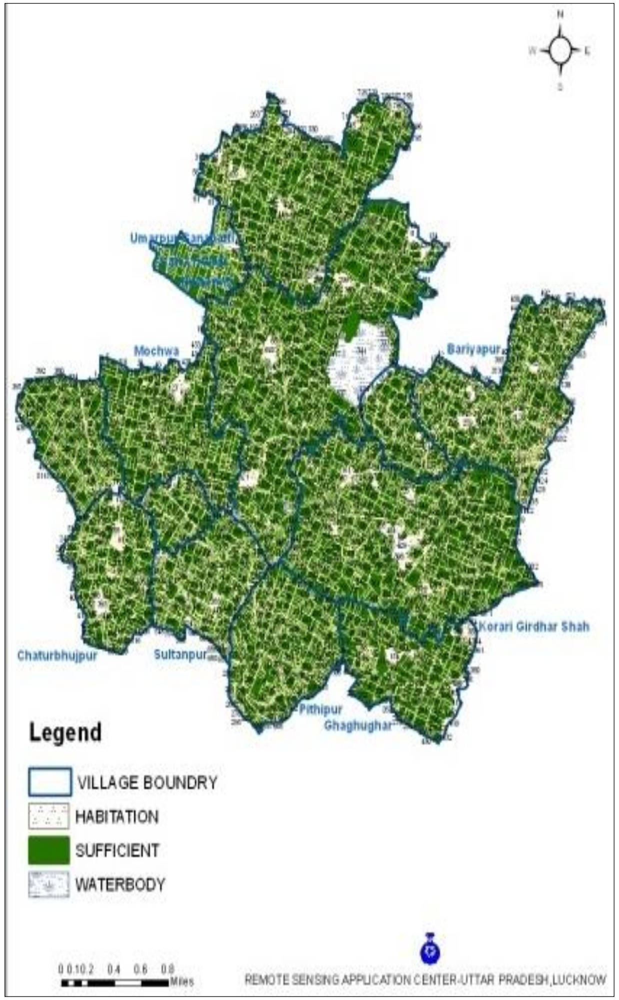

Fig 22: Soil copper map of Korari Nayapanchayat district Amethi

Village wise Soil Fertility Maps of Korari Girdhar Shah Nayapanchayat

Conclusion
In conclusion that the IRS LISSIV and Cartosat-1 PAN data is helpful in generating village level soil fertility map and its resource information on 1:10,000 scale. The soil reaction of all farm soils was alkaline which is attributed to the presence of leaching of salts from the soil along with runoff and drainage water due to moderately low rainfall existing in the area deposition of salts from the physiographic units. The organic carbon content in all the farms was low to medium due to low vegetative cover the soil erosion and warmer climate leading to low accumulation of organic carbon in the study area. The available nitrogen, phosphorus and potassium were low, low to medium and medium respectively. The low nitrogen content is attributed to the low organic carbon due to warmer climate and low vegetative cover coupled with little nitrogen fertilization.

Acknowledgements
The authors are grateful to the Director, RSAC-UP, and Project Manager, DST funded Natural Resource Data Management System project at RSAC-UP, Lucknow. The present paper is a part of the study carried out by the authors in the DST, Govt. of India, supported Natural Recourse Data Management System project. Authors also acknowledge the support from Dr. A.N. Singh, former Director, RSAC-UP, in finalization of manuscript.

References
1. AIS&LUS. Soil Survey Manual. (All India Soil & Land Use Survey, IARI, New Delhi), 1970.
2. Anil Kumar KS, Hegde R, Ramesh Kumar SC.Characterization of soils of a micro-watershed in eastern dry zone of Karnataka. Agropedology. 2010;20:182-188.
3. Anonymous. Report on detailed soil survey of block Amethi and district Sultanpur.ShardaSahayak Command Area Development Project, JawaharBhavan, Lucknow, Uttar Pradesh, 1988.
4. Ardak SA, Nagaraju MSS, Prasad J, Srivastava R, Barthwal AK. Characterization and evaluation of land resources in Khapri village of Nagpur district, Maharashtra using high resolution satellite data and GIS. Agropedology. 2010;20:7-18.
5. Dwivedi RS, Ramana KV, Thammappa SS, Singh AN. The utility of IRS 1C LISS-III and PAN merged data for mapping salt-affected soils. Photogrammetric Engineering& Remote Sensing. 2001;**67:**1167-1175.
6. Dwivedi RS. Soil resource mapping: a remote sensing perspective. Remote Sensing Reviews. 2001;20:89-122.
7. Govindarajan SV, Datta Biswas NR. Characterization of certain soils in the subtropical humid zone in the south eastern part of Indian soils of Muchkand basin. J. Indian Soc. Soil Sci. 1968;16:117-186.
8. Jackson ML. 'Soil Chemical Analysis', (Prentice Hall of India Private Inc., New Delhi), 1973.
9. Jagdish Prasad, Ray SK, Gajbhiye KS, Singh SR. Soils of Selsura research farm in Wardha district, Maharashtra and their suitability for crops. Agropedology. 2009;19:84-91.
10. Kudrat M, Tiwari AK, Manchanda ML. Multilevel soil mapping using remote sensing.Technical report. ISRO-NNRMS-TR-101-2000. Indian Space Research Organization, Bangalore, 2000.
11. Kunwar P, Kachhwaha TS, Kumar A, Agrawal AK, Singh AN, Mendiratta N. Use of high resolution IKONOS data and GIS technique for transformation of land use/ land cover for sustainable development. Current Science. 2010;98:204-212.
12. Liengsakul M, Mekpaiboonwatana S, Pramojanee P, Bronsveld K, Huizing H. Use of GIS and remote sensing for soil mappingand for locating new sites for permanent cropland- Acasestudyin the highlands of northern Thailand. Geoderma. 1993;60:293-307.
13. Patil PL, Kuligod VB, Gundlur SS, Jahnavi Katti IN, Nagaral P, Shikrashetti HM, *et al*. Soil fertility mapping by GIS in Mevundi sub watershed under Northern dry zone of Karnataka for site specific recommendations. J. Farm Sci. 2017;30(2):200-205.
14. Prabhavati K, Dasog GS, Patil PL, Sahrawati KL, Wani SP Soil Fertility Mapping using GIS in Three Agro-climatic Zones of Belgaum District, Karnataka, Journal of the Indian Society of Soil Science. 2015;63(2):173-180.
15. Rajput SG, Polara KB. Fertility Status of Cultivated Soils in Coastal Bhavnagar District of Saurashtra Region of Gujarat, Journal of the Indian Society of Soil Science. 2012;60(4)317-320.
16. Rao BRM, Fyzee MA, Wadodkar MR. Utility of remote sensing data for mapping soils at various scales and levels.In'Soils and Crops'. (Eds.L. Venkataratnam, T. Ravisankar, and R. Sudarshana, National Remote Sensing Agency, Hyderabad), 2004.
17. Ravi Kumar MA, Patil PL, Dasog GS. Characterization and mapping of soil resources of 48A distributaries of Malaprabha right bank command, Karnataka for land use planning. Karnataka Journal of Agricultural Sciences. 2004;22:81-88.
18. Ravisankar T, Thamappa SS. Satellite data interpretation and analysis for soil mapping. In 'Soils and Crops'. (Eds.L. Venkataratnam, T. Ravisankar, and R. Sudarshana. National Remote Sensing Agency, Hyderabad), 2004.
19. Sah KD, Sarkar D, Seal A, Singh DS. Micro-level planning for optimal land use in coastal area of West Bengal- A case study. Agropedology. 2010;20:19-29.
20. Sahu, Nisha, Singh SK, Obi Reddy GP, Kumar N, Nagaraju MSS, Srivastava R. Large scale soil resource mapping using IRS P-6 LISS IV and Cartosat-1 DEM in basaltic terrain of Central India. Journal of the Indian Society of Remote Sensing. 2016;44:811-819.
21. Sahu, Nisha, Obi Reddy GP, Kumar N, Nagaraju MSS, Srivastava R, Singh SK. Characterization of landforms and landuse/land cover in basaltic terrain using IRS-P6 LISS-IV and Cartosat-1 DEM data: A case study. Agropedology. 2014;24:166-178.
22. Sankar M, Sivasamy R, Dadhwal KS. Land resources data and its evaluation for village level land use planning. Agropedology. 2010;20:1-6.
23. Simon P. 'Remote sensing in geomorphology', (OxfordBook Company, Jaipur), 2010.
24. Singh AN, Dwivedi RS.The utility of Landsat imagery as an integral part of the database for small scale soil mapping. International Journal of Remote Sensing. 1986;7:1099-1108.
25. Soil Survey Staff. Simplified Guide to Soil Taxonomy. (USDA-Natural Resources Conservation Service, National Soil Survey Center, Lincoln, Nebraska), 2013.
26. Srivastava R, Saxena RK.Technique of large scale soil

mapping in basaltic terrain using satellite remote sensing data. International Journal of Remote Sensing. 2004;25:679-688.
27. Wadodkar MR, Ravisankar T. Soil resource database at village level for developmental planning. Journal of the Indian Society of Remote Sensing. 2011;39:529-536.