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SOIL FERTILITY EVALUATION IN SOUTHERN TRANSITION ZONE OF KARNATAKA, INDIA

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ABSTRACT

A detailed survey was conducted to assess morphological, physical and chemical properties of surface and subsurface soils of Basavangiri village, in H. D. Kote taluk of Mysuru district, Karnataka, India during 2023-24. Initially, a detailed land resource survey was carried out at 1:7920 scale using Sentinel-2B and LISS IV satellite image. Soil samples from Basavangiri village in southern transitional zone of Karnataka. Totally 49 surface soil samples were collected at 320 m grid interval, characterized for chemical properties. Samples were analyzed for pH, electrical conductivity, organic carbon, major nutrients like available N, P_2O_5, K_2O and micronutrients (Zn, Cu, Fe and Mn). Analytical data was interpreted and statistical parameters like range, mean and standard deviation were calculated. Soil fertility maps were prepared for each parameter under Geographical Information System (GIS) environment using Arc GIS software 8.4.2. Soil reaction was neutral to moderately alkaline (6.5- 8.40) and electrical conductivity was non saline in nature (0.20- 0.80 dSm^{-1}). Soil organic carbon content was low to high (0.60- 1.40 g kg^{-1}), available nitrogen was medium (238- 451.60 kg ha^{-1}) and available phosphorus and potassium was medium to high (13.50- 110.40 and 144.30- 803.40 kg ha^{-1}, respectively). Regarding available micronutrients, copper (1.20- 4.70 ppm), manganese (5.70- 9.50 ppm) and iron (2.60- 14.90 ppm) were sufficient and zinc (0.30- 2.50 ppm) was sufficient in 226 ha of area while, deficient in 52 ha of the area.

Key words : Soil fertility evaluation, Geographical Information System (GIS), Soil Organic Carbon, Available Nitrogen.

Introduction

An intimate knowledge regarding kinds of soil and their spatial distribution is a prerequisite in developing rational land use plan for agriculture, forestry, irrigation, drainage, *etc*. Soil resource inventory through soil survey provides an insight on potentialities and limitations of a soil for its effective utilization. Accurate and scientific inventory of different soils and their distribution helps to predict production potentials based on different soil characteristics namely, texture, depth, structure, stoniness, drainage, acidity, salinity, *etc*. Soil fertility is one of the important factors that control crop yields. Soil characterization of an area in relation to their soil fertility status is important for sustainable agricultural production. Introduction of high yielding varieties in Indian agriculture encouraged the farmers to apply nutrients through fertilizers. However, production response efficiency to fertilizer nutrients declined significantly over the last few decades (Yadav and Meena, 2009). Imbalanced and inadequate fertilizer use without micronutrients can affect crop productivity and soil health (Bangre *et al*., 2020). Nutrient availability is largely influenced by pH, soil texture (Nagaraja and Srinivasamurthy, 2009) and soil organic matter (Saji *et al*., 2006). Hence, preparing soil resource inventory periodically is essential for better utilization of soil and maintenance of its health.

The availability of macro and micronutrients to plants is influenced by several soil characteristics. Soil testing provides information regarding nutrient availability in soils which forms the basis for the fertilizer recommendations for economic production of crops. Soil test-based fertility management is an effective tool for of agricultural soils that have a high degree of spatial variability which finds out the soil fertility related production constraints of the study area and suggests the remedial measures for optimum production of the crops. Moreover, soil characterization in relation to the evaluation of the fertility of the soil of an area is an important aspect on the basis of sustainable agriculture (Singh and Mishra, 2012). To have suitable soil management practice, the farmers should know what amendments are required to optimize the productivity of the soil for specific crops (Kavitha and Sujatha, 2015). The main objective of the study was to prepare a scientific and comprehensive soil fertility map of the studied area. Remote sensing and Geographic information system (GIS) techniques have emerged as effective and powerful tools for generating different spatial information on various natural resources. GIS is a powerful tool which helps to integrate many types of spatial information such as agro-climatic zone, land use, soil management, *etc*., to derive useful information (Adornado and Yoshida, 2008). Furthermore, GIS generated soil fertility maps may serve as a decision support tool for nutrient management (Iftikar *et al*., 2010).

Materials and Methods

Location and agro climate

Basavanagiri are located in H.D. Kote taluk of Mysore district, Karnataka (Fig. 1). The study site lies between North latitude 12° 7' 55" to 12° 5' 45 and 76° 16' 25" to 76° 17' 25" East longitude. Agro climatically, it belongs to Southern transition zone of Central Karnataka plateau, hot, moist semi-arid eco sub region (Velayutham *et al*., 1999). Mean maximum and minimum temperature of H. D. Kote taluk was 29.92°C and 20.40°C, respectively. The mean annual precipitation of the area is 888.15 mm.

The cadastral map showing parcel boundaries was used as the base map. A grid interval of 320 m spacing was overlaid on the cadastral map for the study. There were 49 grids in the studied area covering an area of 309.99 ha. Horizon-wise soil samples were collected from all the pedons and analysed. In study area around 217 samples were collected, out of which 49, 148 and 20 samples were grid, farmers' and profile samples, respectively. The samples were analysed for physico-

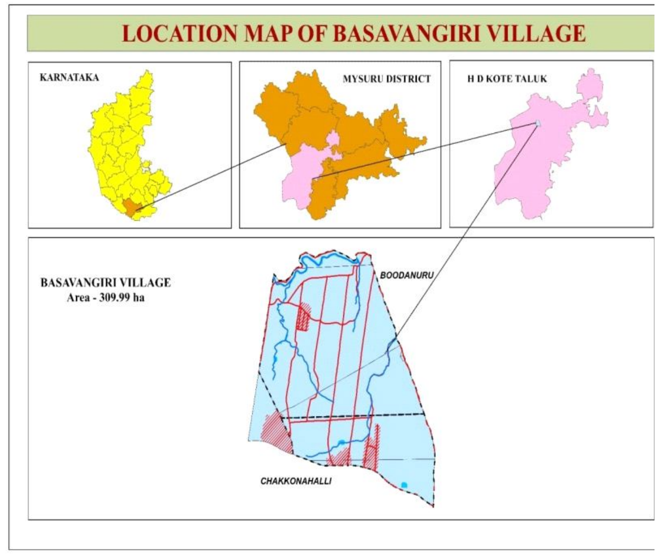

Fig. 1 : Location map of the study area.

chemical parameters and morphological parameters. The pH (1:2.5) and electrical conductivity (EC) of soils were measured using standard procedures as described by Jackson (1973). The available N (Subbiah and Asija, 1956), available P_2O_5 (Olsen *et al*., 1954), available K_2O (Jackson, 1973), organic carbon (Walkley and Black, 1934), contents were analyzed following the standard protocol. The available zinc (Zn), copper (Cu), manganese (Mn) and iron (Fe) were extracted with DTPA extractant (Lindsay and Norvell, 1978) and determined using atomic absorption spectrophotometer (AAS).

Generation of thematic soil fertility maps

Database on soil available nutrient status was prepared using Microsoft excel package and soil fertility maps were generated using Geographic Information System (GIS) Arc GIS software version 8.4.2. Base map of the study area was digitized and geo-referenced. Polygons were superimposed on the geo-referred map. Latitude, longitude and analyzed soil data were entered into attribute table and linked to Arc GIS software for making thematic maps. Standard soil fertility ratings (Table 1) are shown by color differences on the map (Ten Lin-Liua *et al*., 2006; Mirzae *et al*., 2016).

Soil reaction and electrical conductivity

About 30.61 per cent of area in study area was neutral, 57.11 ha area was slightly alkaline in reaction with a mean pH of 7.50 (Table 2). The soils were classified into slightly alkaline, neutral and moderately alkaline among these slightly alkaline soils were dominant and covered an area of 177 ha (57.1%) followed by neutral soils covered 95 (30.61%) (Table 3 and Fig. 2). The alkalinity of these soils mainly attributed to the calcareous nature and prolonged dry spells. Most of the

Table 1 : Soil fertility ratings for different parameters.

Soil reaction (pH) classes		
S. no.	**Classes**	**Rating**
1	Ultra acid	<3.5
2	Extremely acid	3.5 - 4.5
3	Very strongly acid	4.5 - 5.0
4	Strongly acid	5.0 - 5.5
5	Moderately acid	5.5 - 6.0
6	Slightly acid	6.0 - 6.5
7	Neutral	6.5 - 7.3
8	Slightly alkaline	7.3 - 7.8
9	Moderately alkaline	7.8 - 8.4
10	Strongly alkaline	8.4 - 9.0
11	Very strongly alkaline	>9.0

Soil salinity classes (EC) (dS m^{-1})		
S. no.	**Classes**	**Rating**
1	Non-saline	< 2
2	Low	2 - 4
3	Medium	4 - 8
4	High	8 - 12
5	Very high	12 - 16
6	Extremely high	>16

Available Macro nutrient classes				
S. no.	**Nutrients**	**Low**	**Medium**	**High**
1	Organic carbon (%)	<0.5	0.5-0.75	>0.75
2	Nitrogen (kg ha^{-1})	<280	280-560	>560
3	Phosphorus (kg ha^{-1})	<23	23-57	>57
4	Potassium (kg ha^{-1})	<145	145-337	>337

Available Micro nutrient classes			
S. no	**Micronutrients**	**Sufficient**	**Deficient**
1	Iron (ppm)	<4.5	>4.5
2	Manganese (ppm)	<0.1	>0.1
3	Copper (ppm)	<0.2	>0.2
4	Zinc (ppm)	<0.6	>0.6

soils were low in salt content with a mean EC of 0.47 dS m^{-1} (Table 2). The higher pH of soils could be attributed to low intensity of leaching and accumulation of bases. The results were in agreement with those reported for northern dry zone soils by Ravikumar *et al.* (2007) and Prabhavati *et al.* (2015).

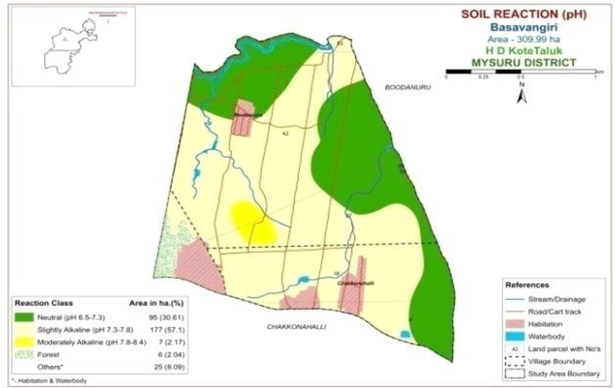

Fig. 2 : Soil reaction.

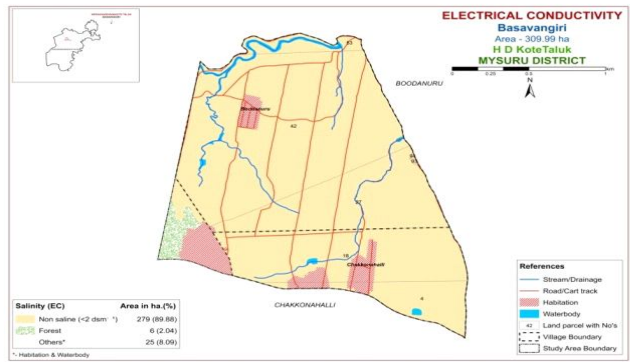

Fig. 3 : Electrical conductivity.

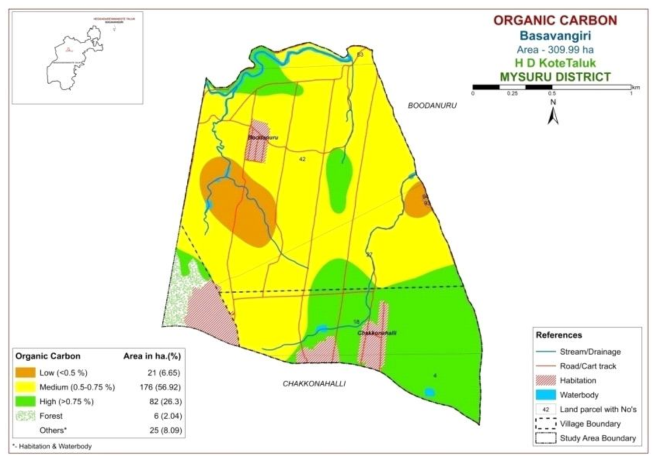

Fig. 4 : Organic carbon.

Organic carbon

The OC (g kg^{-1}) content in study area varied considerably with the mean value of 0.72 (g kg^{-1}) (Table 2). Soils with medium OC status occupied 56.92% of total watershed area (TWA) followed by high status which occupied an area of 26.30 % of TWA (Table 3 and Fig. 4). The medium OC content status might be due to marginal addition of crop residues. Higher OC at the surface was mainly due to accumulation of organic materials through crop residue and external applications in the surface soils.

Available macronutrients

The available N status (Table 3 and Fig. 5) in soil

Table 2 : Mean value of different soil fertility parameters of Basavangiri village.

Parameters	Mean	SD±
pH (1:2.5) soil : water ratio	7.50	0.40
EC (dS m^{-1})	0.47	0.30
OC (g kg^{-1})	0.72	0.40
Available N (kg ha^{-1})	381.70	68.80
Available P_2O_5 (kg ha^{-1})	53.90	26.60
Available K_2O (kg ha^{-1})	340.50	143.10
DTPA extractable Fe (ppm)	12.20	6.20
DTPA extractable Mn (ppm)	9.00	1.48
DTPA extractable Zn (ppm)	1.04	0.72
DTPA extractable Cu (ppm)	3.00	0.99

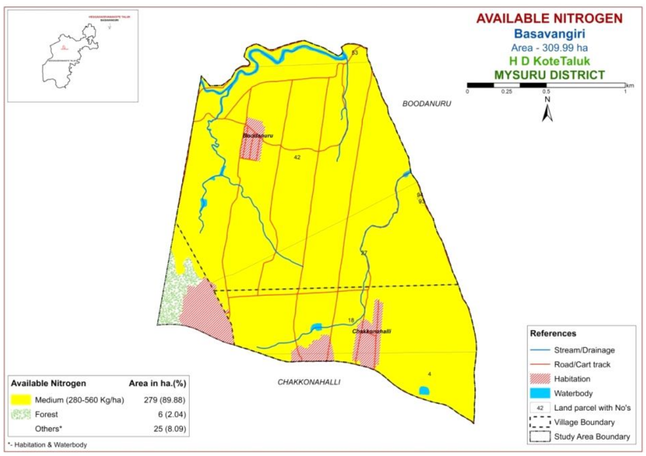

Fig. 5 : Available Nitrogen.

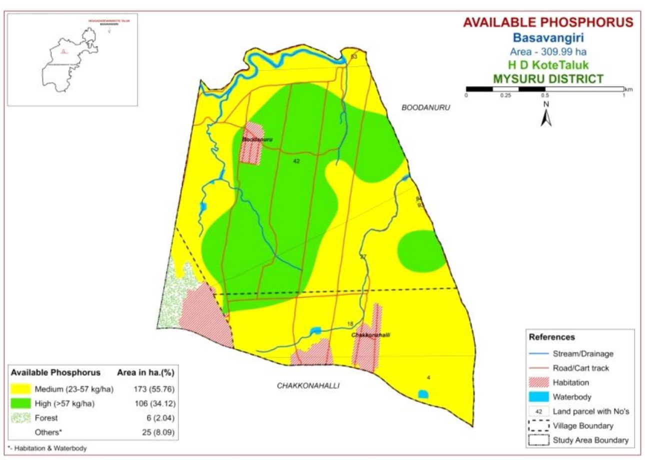

Fig. 6 : Available Phosphorus.

was medium (mean value of 381.70 kg ha^{-1}) in the entire micro-watershed area. The medium nitrogen status might be due to application of N fertilizer recommended for the crops (Pulakeshi *et al.*, 2012). The variation in N content related to soil management, varied application of FYM and application of maximum amount of N fertilizer.

The available P_2O_5 content was medium to high with a mean value of 53.90 kg ha^{-1} (Table 3 and Fig. 6). Among

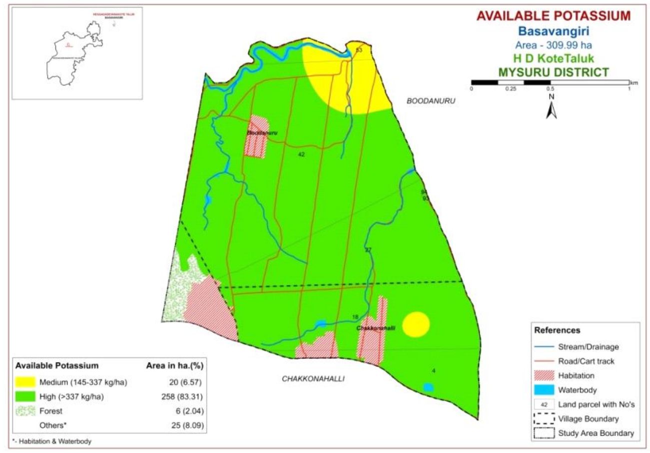

Fig. 7 : Available Potassium.

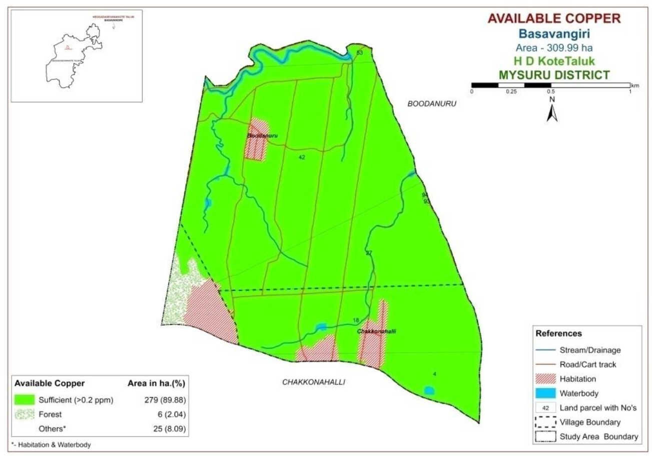

Fig. 8 : Available Copper.

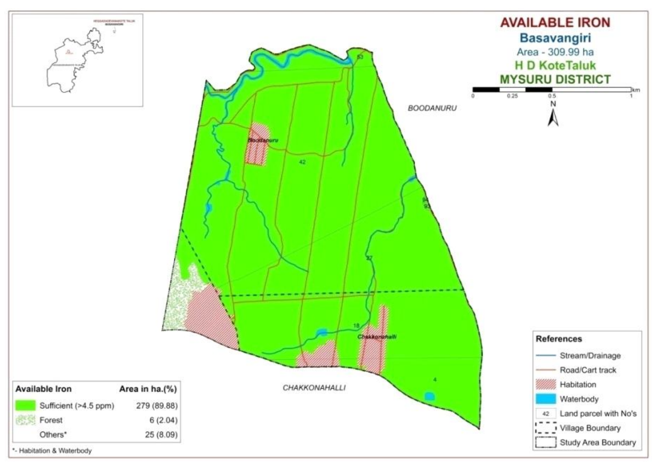

Fig. 9 : Available Iron.

these, available P_2O_5 was medium in an area of 55.76 % of TWA (309.99 ha) followed by high available P_2O_5 in an area of 34.12% (106 ha). This medium status could be also due to the tendency of farmers to apply more DAP fertilizer as source of nitrogen and phosphorus (Motsara, 2002). The soils recording higher P_2O_5 attributed to the confinement of crop cultivation to the rhizosphere and supplementing the depleted phosphorus through external fertilizer sources and fixation of more

Table 3 : Area distribution among different categories in the study area.

Soil parameter	Category	Area (ha)	% of TWA
pH	Neutral	95	30.61
	Slightly alkaline	177	57.11
	Moderately alkaline	7	2.17
EC (dS m^{-1})	Non saline	279	89.88
Organic carbon (g kg^{-1})	Low	21	6.65
	Medium	176	56.92
	High	82	26.3
Nitrogen (kg ha^{-1})	Medium	279	89.88
Phosphorus (kg P_2O_5 ha^{-1})	Medium	173	55.76
	High	106	34.12
Potassium (kg K_2O ha^{-1})	Medium	20	6.57
	High	258	83.31
Copper (ppm)	Sufficient	279	89.88
Iron (ppm)	Sufficient	279	89.88
Manganese (ppm)	Sufficient	279	89.88
Zinc (ppm)	Sufficient	226	73.02
	Deficient	52	16.86

TWA = Total Watershed Area.

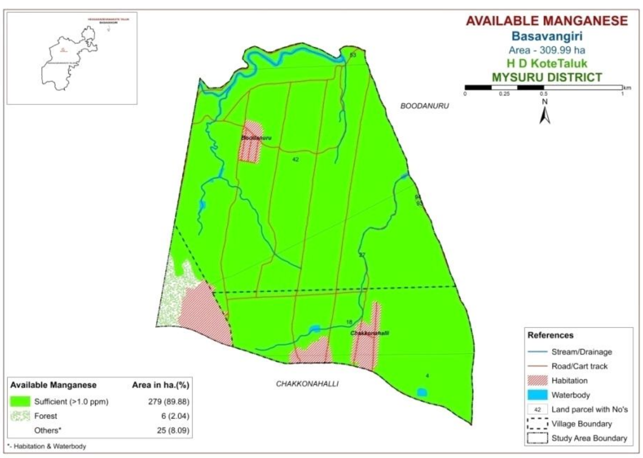

Fig. 10 : Available Manganese.

phosphorus in sub-surface layers. The variation could be due to different crops grown and different management practices followed by farmers in the study area.

The available K_2O (Table 3 and Fig. 7) was medium to high in soil with the mean value of 340.50 kg ha^{-1}. This attributed to weathering, application of K_2O fertilizers to different crops grown in study area and upward translocation of potassium from lower depth along with capillary raise due to low rainfall and higher temperature. Similar results were reported by Ravikumar *et al.* (2007) and Vara Prasad Rao *et al*. (2008).

DTPA-extractable micronutrients

The DTPA extractable micronutrients *viz.*, Cu and Mn were found sufficient with the mean values of 3.00 and 1.04 ppm, respectively, while Fe and Zn were sufficient with the mean values of 12.20 and 9.00 ppm, respectively (Table 2, Figs. 8 to 11). The Zn status in 73.02% of TWA (309.99 ha) was sufficient and about 16.86 ha area (Table 3, Fig. 8) was deficient in zinc. While Fe, Cu and Zn were sufficient in 89.88% of TWA (309.99 ha). The alkaline condition of soil might be the reason behind the deficiency of zinc in the study area. Sufficiency of Cu, Fe content it might be due to granite gneiss parent material, Mn content was sufficient in study area it might be due to high organic carbon content and immense biological activity in the surface horizons (Murthy *et al.*, 1977).

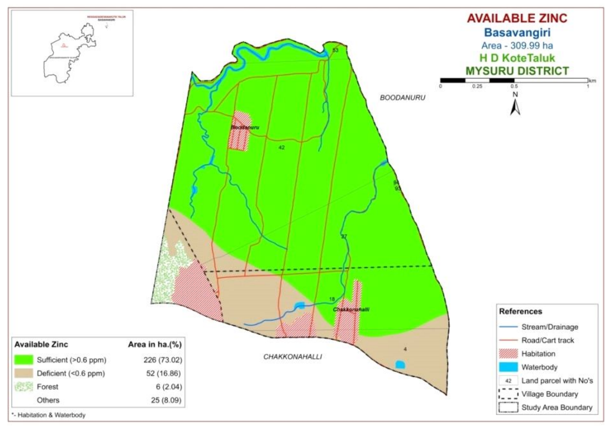

Fig. 11 : Available Zinc.

Conclusion

Soil fertility and nutrient management influence agricultural productivity and hence food security and livelihood. Nutrient mining (extracting more nutrients than are returned) is a key factor in impoverishing the soil. The deteriorating soil fertility cannot be ameliorated only by green manuring and use of legumes. Using them in conjunction with mineral fertilizers can have a greater sustainable impact. Soils and their management options are site and situation-specific. The prepared spatial distribution and fertility maps will aid farmers and planners in understanding the existing soil conditions and making judicious decisions to better manage the soil for sustainability and productivity. The thematic maps generated using the survey data provide information regarding the aerial extent of different nutrient category soils. Using this information, a sound and scientific nutrient management practices can be suggested to each parcel of land which would help in enhancing nutrient use efficiency, reducing input cost and improving the productivity of crops.

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