Indian Farmer
Volume 13, Issue 05, 2026, Pp. 234-245
Available online at: www.indianfarmer.net
ISSN: 2394-1227 (Online)

Original Article

Soil micronutrient status and mapping for site-specific fertiliser recommendation using GPS and GIS in Rayalaseema region, India

[1]*Chandrakala M.

[1]*National Bureau of Soil Survey and Land Use Planning, Regional Centre, Bangalore-560024, Karnataka*

**Corresponding author: chandra.ssac@gmail.com*

Received: 14/05/2026 *Published:17/05/2026*

ABSTRACT

The objective of the study was to determine the soil's available micronutrient status and to map it for site-specific fertiliser recommendations; thus, 87 surface soil (0-20 cm) samples were collected randomly from different farmlands using GPS in the Rayachoty mandal, Rayalseema region, Andhra Pradesh, representing all the major landforms. Soil samples were analysed for micronutrients using standard procedures and mapped using kriging and interpolation in ArcGIS. Results revealed that available iron content varied from deficient to sufficient (1.06 - 74.10 ppm), with about 57.88 per cent of the area under sufficient. Available manganese content varied from 0.34 to 28.38 ppm, with about 65.57 per cent area under sufficient. The zinc content varied from deficient to sufficient (0.04 - 5.94 ppm). The copper varied from 0.12 to 2.32 ppm, with about 64.75 per cent area under adequate. The available boron in soils varied from 0.04 to 1.07 ppm, with about 51.06 per cent area under low. Mapping of soil micronutrients has implications for site-specific and optimum micro nutrient fertiliser recommendations to maintain soil nutrient balance to achieve elevated yield and income, thereby improving the livelihood status of small and marginal farmers in the Rayalseema region, besides achieving nutritional security.

Keywords: Mapping, Available micronutrients, Rayalseema region, Soil test-based fertiliser recommendation, GPS and ArcGIS

1. INTRODUCTION

Soil fertility is one of the important factors controlling the crop yields in hot semi-arid regions like Rayachoty Mandal, Rayalseema region, Andhra Pradesh, as it receives low rainfall of 638 mm and has a tropical wet and dry climate characterised by year-round high temperatures. It has a record of reaching more than 50 degrees Celsius. Sustainable soil management with a proper understanding of soil fertility levels helps in maintaining or improving the level of soil available nutrients status, and avoiding soil nutrient imbalances. Balanced fertilizer recommendations rely on soil available nutrient status, which varies spatially due to the combined impact of physical, chemical and biological processes operating in soil along with human/animal activities. A proper understanding of the spatial variability and distribution of soil micronutrients and their mapping is the key to site-specific soil management for sustainable crop production by variable-rate application of micronutrients. Intensive agriculture without adequate and balanced use of micro nutrient fertilizers and with little or no use of organic manure caused severe micro nutrient deterioration in agricultural soils, resulting in stagnating or even declining crop productivity and soil health. Evaluation of soil micronutrient status and its mapping serves as one of the most important tools for soil test-based fertiliser recommendation for precision agriculture to achieve elevated crop production and productivity per unit of land, cost, labour, and inputs, which helps to achieve nutritional security through better crop uptake of all the essential nutrients. With the above views, the present study has been undertaken at Rayachoty mandal, YSR Kadapa district, Rayalseema region, Andhra Pradesh, with the objective of knowing the soil available micro-nutrient status and mapping to recommend site-specific soil test-based fertiliser for crop production.

2. Status of soil available micro-nutrients and mapping in Rayachoty Mandal, Rayalseema region, India

2.1. Available iron (Fe)

The available iron content in the soils of Rayachoty Mandal ranged from 1.06 to 74.10 ppm (Table 1 and Fig. 1). About 57.88 per cent of the area had sufficient iron levels, while 14.27 per cent of the area was deficient in available iron. The sufficient iron content was attributed to the granite gneiss parent material, which was known to possess higher iron content. Similar results reported by Ravikumar *et al*. (2009). In iron deficient areas, iron supplementation of 20–30 kg ha^{-1} ferrous sulfate ($FeSO_4$) should be applied to the soil. Iron chelates can also be used as a foliar spray or applied to soil to prevent chlorosis and ensure healthy crop growth. Whereas, the region with sufficient iron content there is no need of additional iron supplementation.

Table 1: Available iron status of Rayachoty mandal

Available iron classes	**Rayachoty mandal**	
	Area (ha)	**Per cent area**
Deficient (<4.5 ppm)	3316.24	14.27
Sufficient (>4.5 ppm)	13452.3	57.88
Soil total	**16768.55**	**72.15**
Rock outcrops	2840.9	12.22
Forest	1978.98	8.52
Habitation	911.61	3.92
Water body	740.66	3.19
Total geographical area	23240.7	100.00

2.2. Available manganese (Mn)

The available manganese content in the soils of Rayachoty Mandal ranged from 0.34 to 28.38 ppm (Table 2 and Fig. 2). About 65.57 per cent of the area had sufficient manganese levels, while 6.58 per cent of the area was deficient in available manganese. The major area of the micro-watershed was sufficient in available manganese. The higher DTPA extractable manganese content in the study area was attributed to its higher content in granite gneiss parent material (Rajashekar, 2018). The sufficient content of manganese due to high organic matter content was observed in the Upper Krishna of command area by Yeresheemi (1996). The higher Mn status in the soils might be attributed to the lower oxidation under optimum soil reaction of the soils and also due to the release of chelated Mn from the organic compounds (Arokiyaraj *et al*., 2011).

For manganese deficient areas, need to apply manganese sulfate at 10–20 kg ha^{-1} or foliar spray of manganese chelates (0.10–0.20 %) to correct deficiencies of manganese. For sufficient manganese areas there is no additional manganese fertilizer is required.

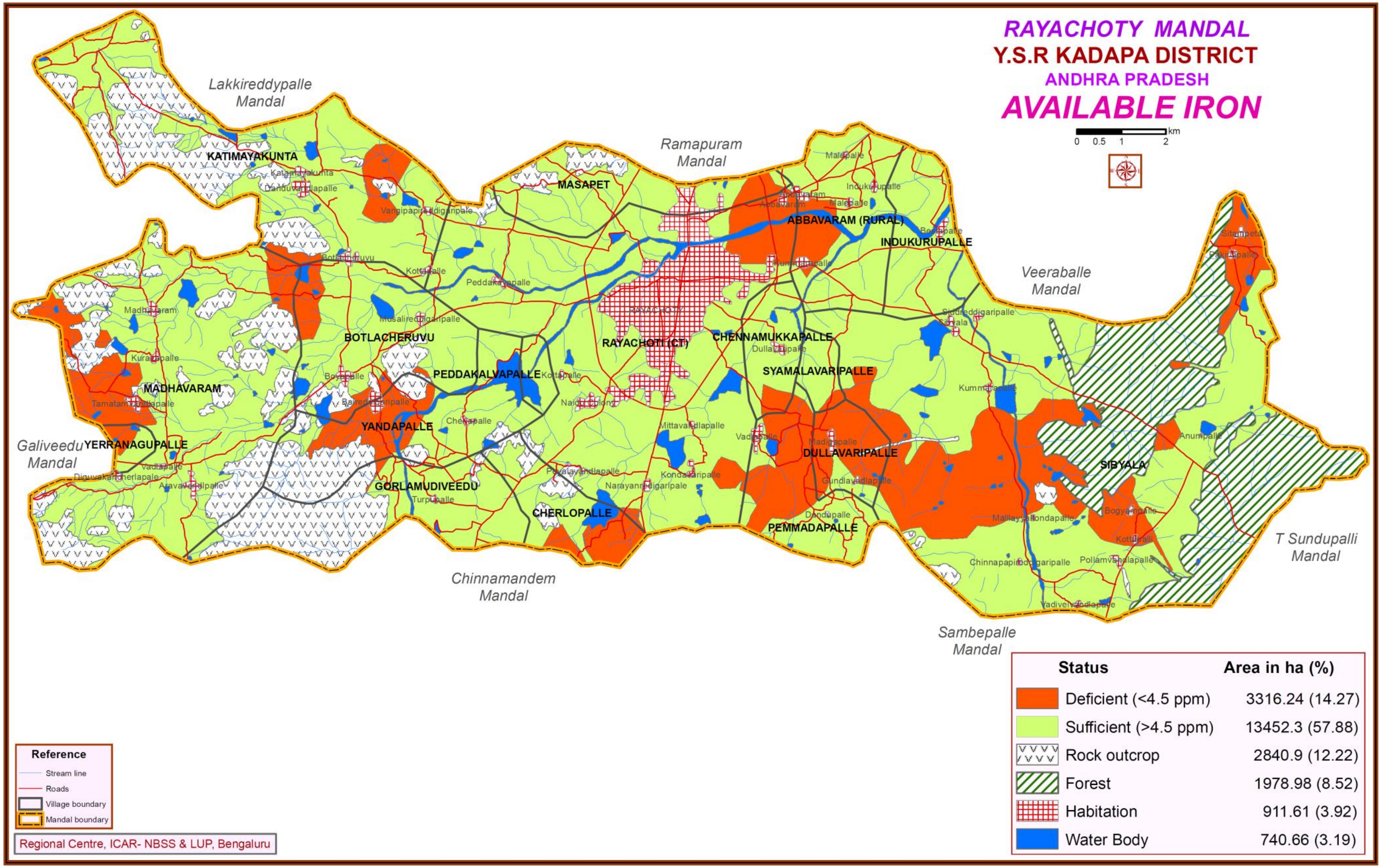

Fig. 1: Soil available iron status in Rayachoty mandal, Rayalseema region, India

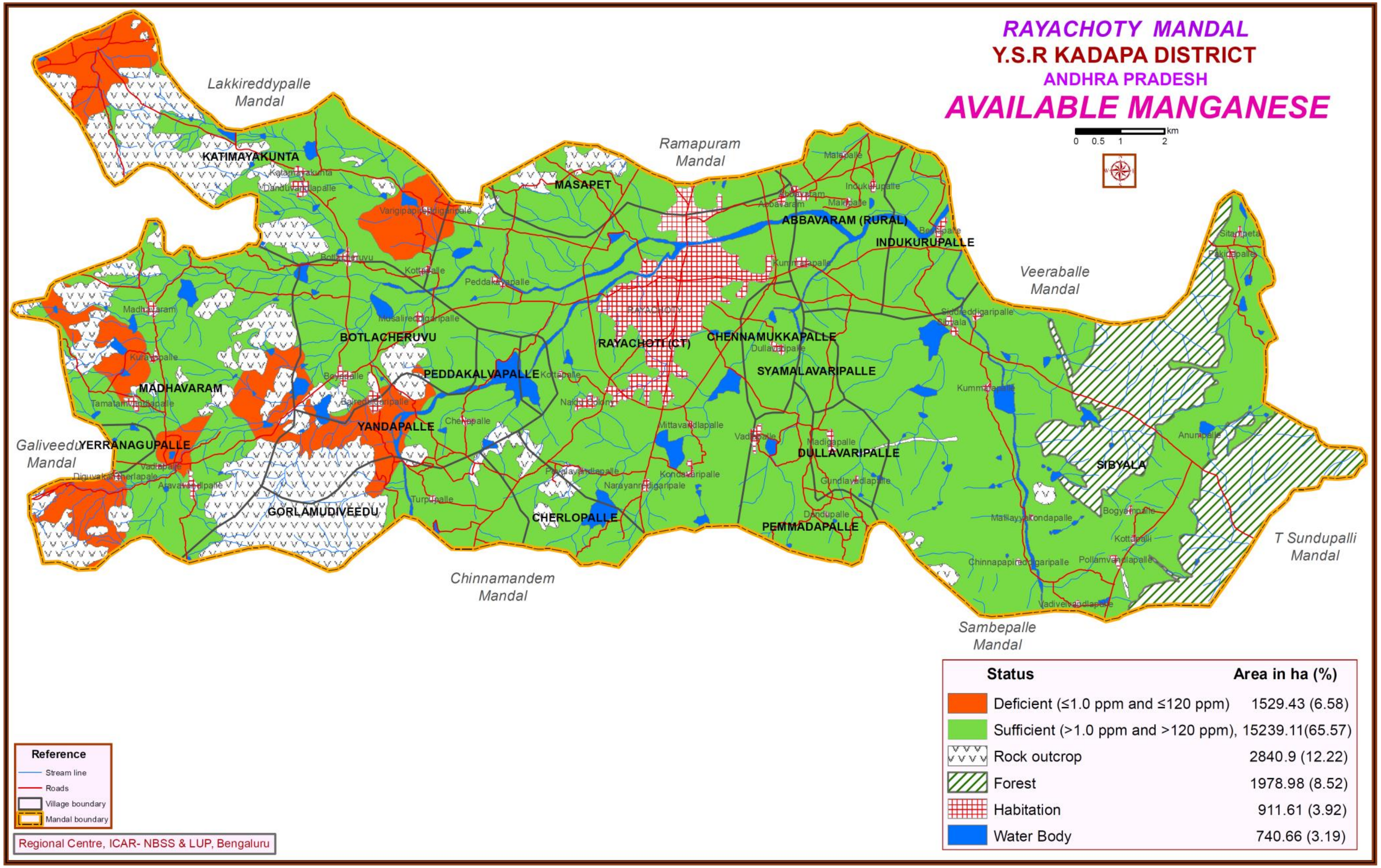

Fig. 2: Soil available manganese status in Rayachoty mandal, Rayalseema region, India

Table 2: Available manganese status of Rayachoty Mandal

Available manganese classes	Rayachoty Mandal	
	Area (ha)	Per cent area
Deficient (≤1.0 ppm and ≤120 ppm)	1529.43	6.58
Sufficient (>1 ppm and > 120 ppm)	15239.11	65.57
Soil total	**16768.55**	**72.15**
Rock outcrops	2840.9	12.22
Forest	1978.98	8.52
Habitation	911.61	3.92
Water body	740.66	3.19
Total geographical area	23240.7	100.00

2.3. Available zinc (Zn)

The zinc content in the soils of Rayachoty Mandal ranged from 0.04 to 5.94 ppm (Table 3 and Fig. 3). About 39.93 per cent of the area recorded adequate zinc levels, while 32.23 per cent of the area was deficient in available zinc. The granite-gneiss parent material in Rayachoty Mandal might naturally contain higher levels of zinc, contributing to the increased availability of Zn micronutrient in the soils. When the soil is derived from this parent material, it is likely to have an inherent zinc content that is released slowly over time through weathering processes. Zinc availability is also influenced by soil pH. Zinc tends to be more available in slightly acidic to neutral soils. Since 23.92 percent of Rayachoty Mandal's area was neutral and 15.92 percent had slightly acidic soils, the availability of zinc may be higher in these regions due to optimal conditions for zinc solubility. The deficiency of the Zn was found in red soils, which may be due to low organic carbon values. In alkaline condition of soil, conversion of zinc cations to their oxides or hydroxides at higher pH, which is known to have lower solubility, might be the reason for low zinc status in the study area (Thangasamy *et al*., 2005). The available zinc was deficient in the soils samples might be due to the soils were having lower organic carbon values.

To address low zinc content in soils, 25-50 kg ha^{-1} zinc sulphate ($ZnSO_4$) was recommended as the primary source of zinc. It can be applied either as a basal fertilizer or foliar spray to correct zinc deficiencies in the soil.

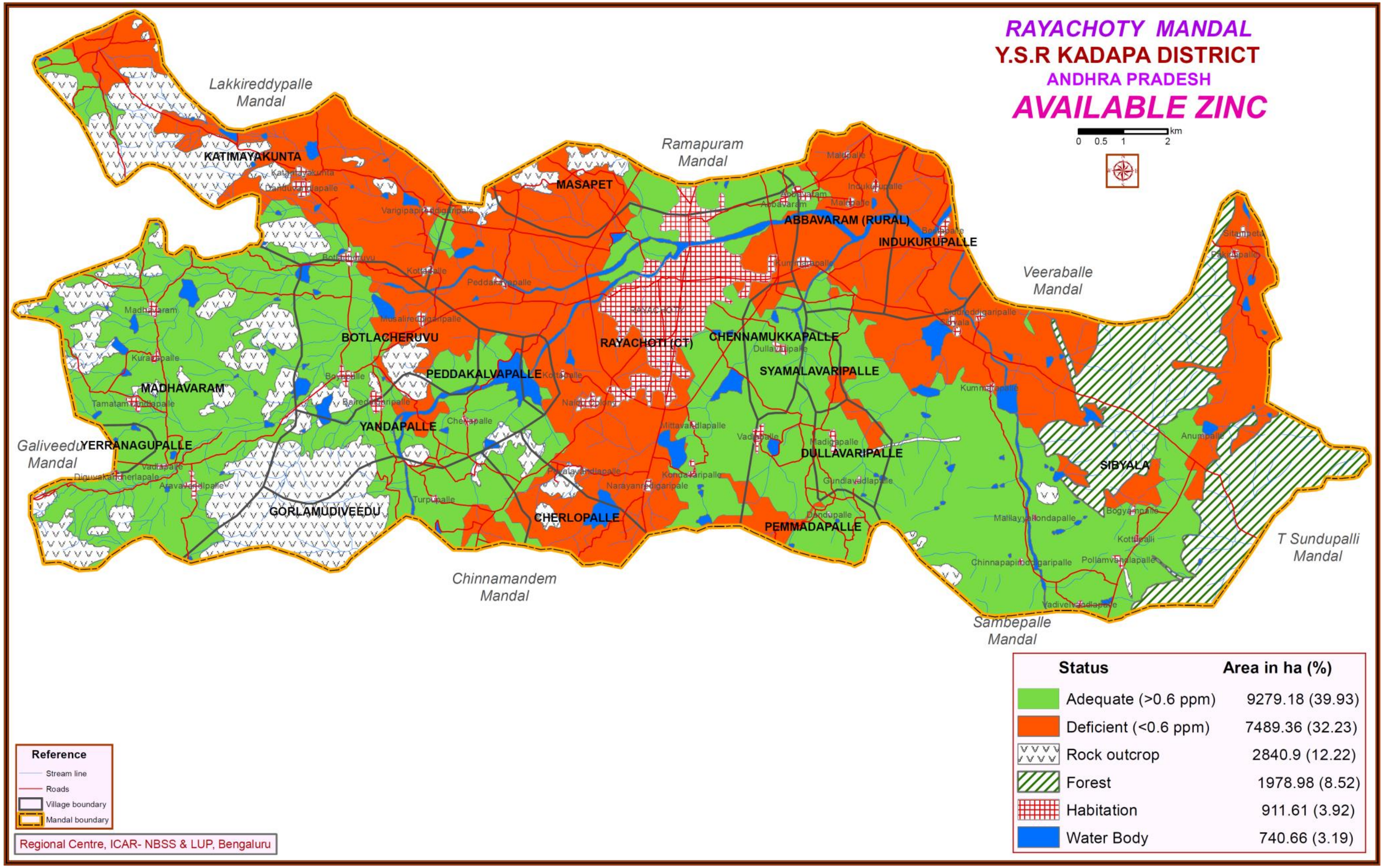

Fig. 3: Available zinc status of Rayachoty mandal, Rayalseema region, India

Table 3: Available zinc status of Rayachoty Mandal

Available zinc classes	Rayachoty mandal	
	Area (ha)	**Per cent area**
Deficient (<0.6 ppm)	7489.36	32.23
Adequate (>0.6 ppm)	9279.18	39.93
Soil total	**16768.55**	**72.15**
Rock outcrops	2840.9	12.22
Forest	1978.98	8.52
Habitation	911.61	3.92
Water body	740.66	3.19
Total geographical area	23240.7	100.00

2.4. Available copper (Cu)

The copper content in the soils of Rayachoty Mandal ranged from 0.12 to 2.32 ppm (Table 4 and Fig. 4). About 64.75 per cent of the area had adequate copper levels, while 7.4 per cent of the area was deficient in available copper. The sufficiency of copper in the study area might also be related to its parent material *i.e.,* granite gneiss containing higher copper content (Jujin *et al*., 2022). It might be due to agricultural practices could add copper to soils through the application of manures, inorganic fertilizers and fungicides (Novoa-Munoz *et al*., 2007). The adequate availability of copper in soil might be due to, it being an ingredient in common fungicide and their frequent application either to soil or in crops might increase its level and also copper has a strong negative correlation with pH but positively correlated with organic carbon (Kavitha and Sujatha, 2015).

In copper deficient soils, it's important to correct the deficiency for optimal plant growth. Copper sulphate ($CuSO_4$) was the most commonly used as fertilizer to address copper shortage in soil. It can be applied either as a basal fertilizer or a foliar spray. The typical application rate was 2-5 kg ha^{-1}, depending upon the extent of the copper deficiency.

Table 4: Available copper status of Rayachoty mandal

Available copper classes	Rayachoty mandal	
	Area (ha)	**Per cent area**
Deficient (<0.2 ppm)	1720.24	7.4
Adequate (>0.2 ppm)	15048.31	64.75
Soil total	**16768.55**	**72.15**
Rock outcrops	2840.9	12.22
Forest	1978.98	8.52

Habitation	911.61	3.92
Water body	740.66	3.19
Total geographical area	23240.7	100.00

3.5. Available boron (B)

The available boron content in the soils of Rayachoty Mandal ranged from 0.04 to 1.07 ppm (Table 5 and Fig. 5). About 51.06 per cent of the area had low boron content, followed by 19.63 per cent of the area with medium content and 1.46 per cent of the area with high boron content. The presence of low organic carbon content in the study area led to low boron content.

In boron deficient areas, apply boric acid at a rate of 0.5 to 1.0 kg ha^{-1} as the basal application and 0.25 to 0.5 kg ha^{-1} as foliar spray or sodium borate at the rate of 0.5 to 1.00 kg ha^{-1} to correct the deficiency in the low boron content areas. Micronutrient mix which includes the boron can also be applied. Adding organic matter, such as compost or farmyard manure helps in improving nutrient retention and availability, especially in soils with low boron levels.

Table 5: Available boron status of Rayachoty Mandal

Available boron classes	Rayachoty mandal	
	Area (ha)	**Per cent area**
Low (< 0.5 ppm)	11867.40	51.06
Medium(0.5-1.0 ppm)	4562.54	19.63
High (>1.0 ppm)	338.61	1.46
Soil total	**16768.55**	**72.15**
Rock outcrops	2840.90	12.22
Forest	1978.98	8.52
Habitation	911.61	3.92
Water body	740.66	3.19
Total geographical area	23240.70	100.00

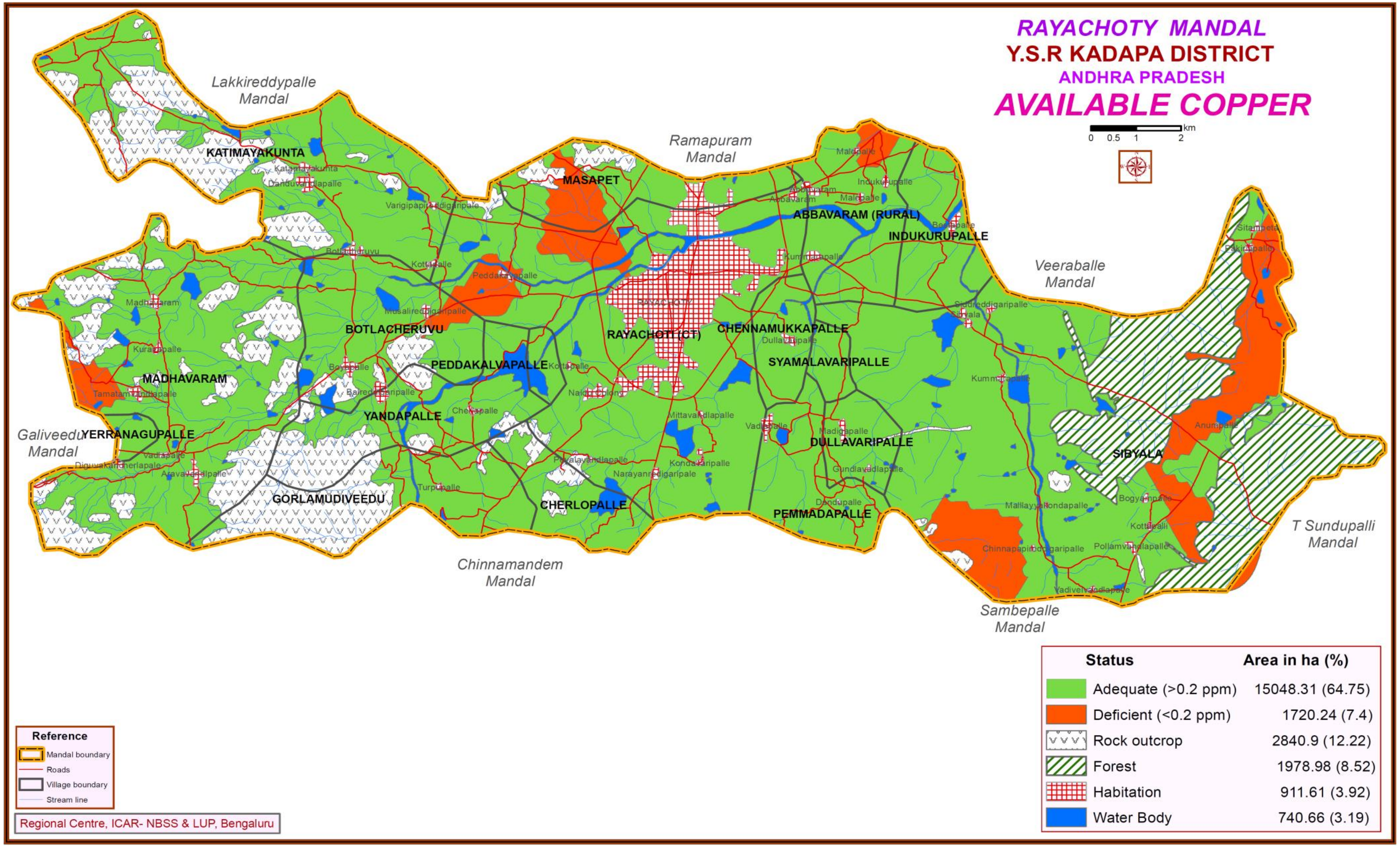

Fig. 4: Available copper status of Rayachoty mandal, Rayalseema region, India

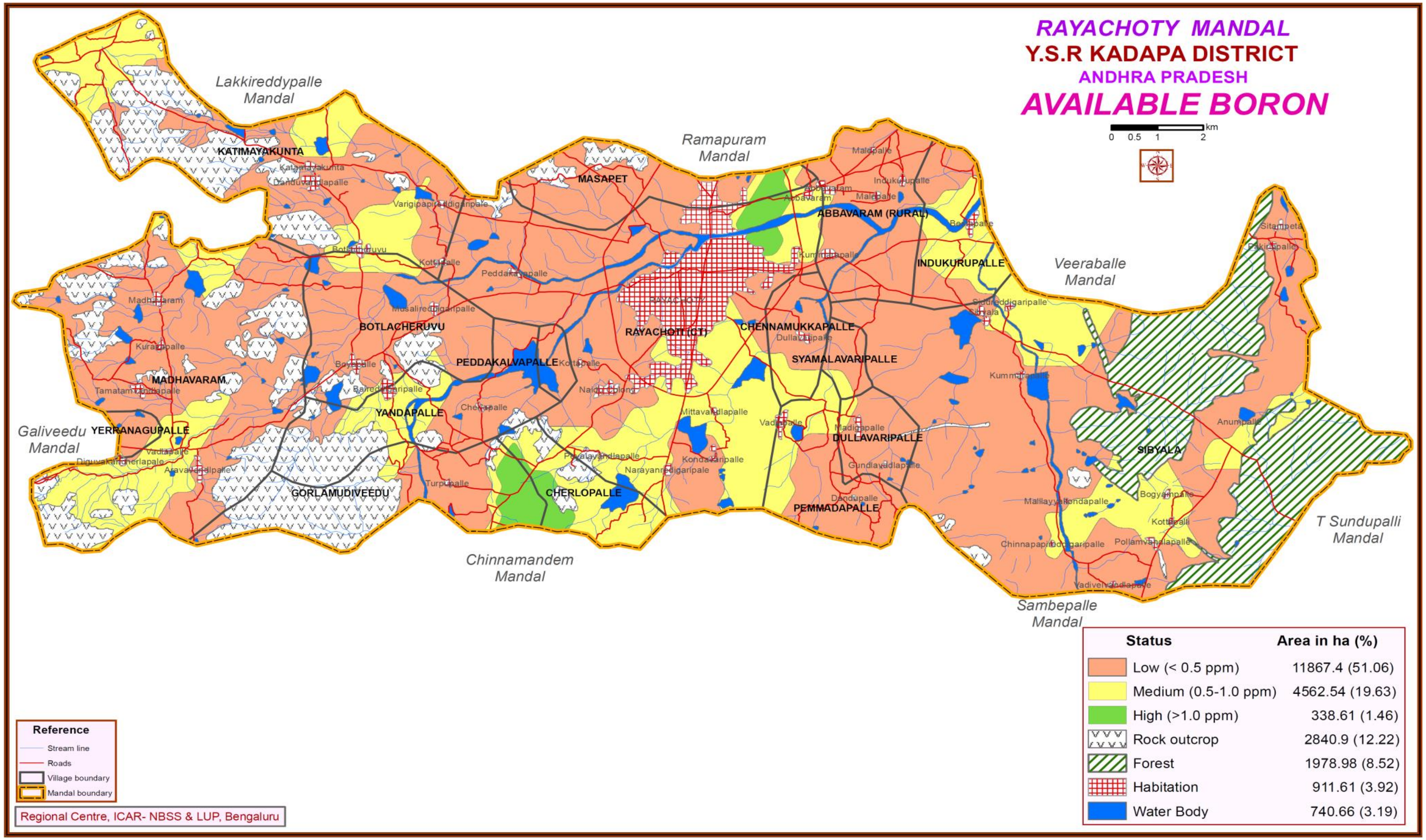

Fig. 5: Available boron status of Rayachoty mandal, Rayalseema region, India

4. CONCLUSION

The soil analysis of Rayachoty Mandal in the Rayalseema region of Andhra Pradesh revealed a wide range of soil micronutrients status. Iron and manganese levels were predominantly sufficient, covering 57.88 per cent and 65.57 per cent of the area, respectively. Zinc, copper and boron contents exhibited deficiencies in some areas, with about 51.06 per cent of the land showing low boron content. Mapping of soil available micronutrients has implications on knowing and understanding the status and distribution of specific micronutrient in a specific land unit which further helps to soil test based, site-specific, optimum fertilizer recommendations to maintain soil nutrient balance to achieve elevated yield and income, thereby improving the livelihood status of small and marginal farmers in the Rayalseema region besides achieving nutritional security.

5. REFERENCES

Arokiyaraj, A., Vijayakumar, R. and Devaprasath, P.M., (2011). Assessment of the status of micronutrients in Nagapattinam district, Tamilnadu. *Journal of Chemical and Pharmaceutical Research*, 3(4), pp. 10- 16.

Jujin, S.A., Gurumurthy, K.T., Thippeshappa, G.N., Ravikumar, D., Mavarkar, N.S. and Halingali, B.I., (2022). Fertility assessment of soils of Duglapura-1 micro watershed under Chikkamagaluru district, Karnataka. *The Pharma Innovation Journal*, 11(11), pp. 1886-1892.

Kavitha, C. and Sujatha, M.P., (2015). Evaluation of soil fertility status in various agro ecosystems of Thrissur District, Kerala, India. *International Journal of Agricultural Crop Sciences*, pp. 328-338.

Nóvoa-Muñoz, J.C., Queijeiro, J.M.G., Blanco-Ward, D., Álvarez-Olleros, C., Martínez-Cortizas, A. and García-Rodeja, E., (2007). Total copper content and its distribution in acid vineyards soils developed from granitic rocks. *Science of the Total Environment*, *378*(1-2), pp.23-27.

Rajashekhar, L., (2018). Soil resources characterization, classification and productivity assessment of sigehadlu micro watershed of Chikkamagaluru district, PhD thesis, Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga.

Ravikumar, M.A., Patil, P.L. and Dasog, G.S., (2010). Characterization, classification and mapping of soil resources of 48A distributary of Malaprabha right bank command, Karnataka for land use planning. *Karnataka Journal of Agricultural Sciences*, 22(1).

Thangasamy, A., Naidu, M.V.S., Ramavatharam, N. and Reddy, C.R., (2005). Characterisation, classification and evaluation of soil resources in Sivagiri micro-watershed of Chittoor District in Andhra Pradesh for sustainable land use planning. *Journal of the Indian Society of Soil Science*, 53(1), pp. 11-21.

Yeresheemi, A.M., (1996). Studies on salt affected soils of Upper Krishna project command area. M. Sc. (Agri.) Thesis, University of Agricultural Sciences. Dharwad, Karnataka, India.