Agropedology 2020, 30 (02), 88-111
doi.org/10.47114/j.agroped.2020.dec2

Land Evaluation for Alternate Land Use Planning in Tatrakallu Village of Anantapuramu District, Andhra Pradesh

G. Sashikala[1]*, M.V.S. Naidu[1], K.V. Ramana[2], K.V. Nagamadhuri[3], A. Pratap Kumar Reddy[4] and P. Sudhakar[5]

[1]*Department of Soil Science and Agricultural Chemistry, S.V Agricultural College, Tirupati-517 502*
[2]*Andhra Pradesh Space Applications Centre, Vijayawada-520010*
[3]*Regional Agriculture Research Station, ANGRAU, Tirupati-517 502*
[4]*Acharya N. G. Ranga Agricultural University, Lam, Guntur-522034*
[5]*Department of Crop Physiology, S.V Agricultural College, Tirupati-517502*

Abstract: Twenty-two typical pedons (14 soil series- TTK1 to TTK 14) representing major landforms of Tatrakallu village of Ananatapuramu district of Andhra Pradesh were evaluated by using qualitative and quantitative methods.Three major land capability classes (III, IV and VI) were identified with two sub classes (erosion and wetness). Crop suitability analysis revealed that the village falls under marginally suitable (S3) with limitations of soil fertility, wetness and sodicity and not suitable (N) with limitations of slope, texture, shallow rooting depth, sodicity and poor nutrient status. Riquier's parametric approach was found to be good indicator for identification of production potential. The land evaluation revealed that, suitability and productivity of these soils were highly variable, and hence their management must be site-specific.The suggestion including the crop residue retention, nutrient recycling, minimum tillage, crop rotation, cover crops and intercropping not only helps to conserve soil and water more effectively in soils but also increase organic matter content and improve fertilizer use efficiency. Farmers continued to grow groundnut, pigeonpea, chickpea and castor for many years on marginally suitable as they are not aware of suitable soils for a particular crop. Adoption of suggested ameliorative measures and land use not only improve the yield but also sustain the soil productivity.

Key words : *Land evaluation, castor, chickpea, groundnut,pigeonpea, soils*

Introduction

Land evaluation is a tool for strategic land use planning and it predicts land performance, in terms of the expected benefits and constraints in production as well as the expected environmental degradation due to these uses. In the recent past, the ill-effects of land use on the environment and environmental sustainability of agricultural production systems have become an issue of concern. The problems of declining soil fertility, stagnant yield level and unfettered soil erosion are associated with intensive agriculture in industrialized countries, while over-exploitation of natural resources and scarcity of inputs like chemical fertilizers denote intensive agriculture in the developing areas (Fresco 1991).

*Corresponding author:(Email:sashikala08@gmail.com)

Several workers have worked out the suitability of soils for various crops such as wheat, cotton (Mandal *et al.* 2002) and sorghum (Pakhan *et al.* 2010). Many researchers in India evaluated potential and actual productivity of soils in diverse agro-ecological regions for various soils as excellent, good, average, poor, extremely poor to nil (Chinchmalatpure *et al.* 2001; Sharma and Kumar 2003; Gabhane *et al.* 2006).

Anantapuramu is the largest district of Andhra Pradesh and second driest part of the country after Jaisalmer in Rajasthan (APSAC 2018). The soil and land resource inventories made so far in Anantapuramu district had limited scope of scale of mapping. Farmers still grow groundnut, castor and chickpea on unsuitable soils which needs site-specific information in terms of soil characteristics, their productivity potentials and limitations so that site-specific land use could be suggested for Tatrakallu village, Anantapuramu district, Andhra Pradesh.

Materials and Methods

Tatrakallu village (14° 58′ to 15° 00′ N; 77°19′ to 77°25′ E) with a spatial extent of 2469.29 ha (Fig. 1). The climatic data of area (2009-2018) indicated that the area is confined to semi-arid monsoon type of climate with distinct summer (April to June), rainy (July to November) and winter (December to March) seasons. The mean annual rainfall of the area is 528.40 mm of which 92 per cent was received during May to November.

A land form map prepared from the merged data of Cartosat-1 (2.5 m resolution) and Resourcesat-2 (LISS-IV 5.8 m resolution) in the form of digital and geo-coded false colour composites (FCC) in the scale of 1: 10000 and toposheet of survey of India (SOI) on 1:50000 scale served as base map for ground truthing, compilation of soil data for generating soil map. The boundaries of land units were verified and modified by field traversing. The morphological properties of 22 pedons were recorded as per Soil Survey Staff (1995) and Soil Survey Staff (2014). Horizon-wise soil samples were collected, processed and analysed. Fourteen soil series were tentatively identified. The weighted mean of each property was calculated and soil-site characteristics of different soil units were obtained as shown in table 3. These weighted mean data have been used for the qualitative (USDA land capability classification and suitability for different crops) as per the guidelines of FAO framework (FAO 1976) modified by Sys (1985) and the soil requirement NBSS&LUP (1994) and quantitative evaluation methods (Riquier's parametric method). The Riquier *et al.* (1970) system suggests the calculation of a productivity index considering nine factors for determining soil productivity *viz.*, moisture (H), drainage (D), effective depth (P), texture / structure (T), base saturation (N), soluble salt concentration (S), organic matter (O), mineral exchange capacity / nature of clay (A) and mineral reserve (M).

Productivity index

$$= H \times D \times P \times T \times N \text{ or } S \times O \times A \times M$$

Each factor was rated on a scale from 0 to 100, the actual percentages multiplied by each other. The resultant index of productivity, also lies between 0 to 100 is set against a scale placing the soil in one or other of following five productivity classes.

Productivity	Classes	Rating
1	Excellent	100 – 65
2	Good	64 – 35
3	Average	34 – 20
4	Poor	19 – 8
5	Extremely poor to nil	7 – 0

In actual productivity index, the value of the ratings refers to the present day situation and in potential productivity index, the ratings will be given according to the situations after management. It is thus, the future potentiality of that soil taking into account physical and chemical characteristics which are modified by conservation practices or improvements and also those characteristics which are not modified by present day technology (Riquier *et al.* 1970).

Results and Discussion

Physico-chemical characteristics

The soils of Tatrakallu had varied texture *viz.*, loamy sand, sandy loam, sandy clay loam, sandy clay, clay, clay loam and silty clay loam (Table 1). The pH of the soils ranged from 6.5 to 9.0 (Table 2) owing their formation from granite gneiss (uplands) and limestone (plains), leaching, presence of calcium carbonate and exchangeable sodium (Reddy and Naidu 2016). The electrical conductivity (EC) in soils ranged from 0.01 to 1.90 dS m^{-1}, indicating non-saline soils. The organic carbon (OC) content was low to medium (1.0 to 6.7 g kg^{-1}). The CEC varied from 6.4 to 50.6 cmol(p+)kg^{-1} soil and the exchangeable bases were in the order of Ca^{2+}> Mg^{2+}> Na^{+}> K^{+}. The base saturation varied from 55 and 99 %. The variation in base saturation of the soils might be due to variation in nature and / or content of soil colloids. Relatively high base saturation in surface layer could be attributed to the recycling of basic cations through vegetation (Devi *et al.* 2015).

Site characteristics

The site characteristics (elevation, slope, erosion and drainage) varied with topographic position of soils. The slope of Tatrakallu village ranged from 0 to 35% in uplands and 0 to 3 % in plains. The pedons of uplands were moderately well to well drained while that of plains (P16 to P20) was somewhat poorly to poorly drained.

Land evaluation

Fourteen soil series namely, TTK1 (P1, P2, P5 and P9), TTK2 (P3, P8, P10 and P21), TTK3 (P11), TTK4 (P4), TTK5 (P14), TTK6 (P7), TTK7 (P13), TTK8 (P6), TTK9 (P12), TTK10 (P15), TTK11 (P16 and P18), TTK12 (P17), TTK13 (P19) and TTK14 (P20) were tentatively identified.

Qualitative evaluation

The soil series namely TTK9 and TTK14, TTK11 and TTK13 and TTK12 fall under land capability sub-class IIIs, IIIw and IIIwes spectively, with slight limitations of poor drainage (poor), low organic carbon, alkalinity, poor nutrient status and slow to moderately slow permeability.

The soil series *viz.*, TTK7, TTK5, TTK10 and TTK3, TTK4, TTK6 and TTK8 were placed under land capability sub-classes IVs and IVes respectively owing to severe limitations of texture, slope, drainage, shallow depth, gravelliness, low organic carbon, and poor nutrient status. Soil series *viz.*, (TTK1 and TTK2) were classified into land capability sub-class VIes with severe limitations of erosion, texture, slope, soil depth, drainage and organic carbon.

The important soil-site characteristics (Table 3) were evaluated suitability of groundnut, pigeonpea, chickpea and castor crops and results indicated that overall suitability of area falls under two categories *i.e.*, marginally suitable (S3) and not suitable (N).

Groundnut

Groundnut crop requires an annual rainfall of 400 - 750 mm, drainage, well drained, deep soil (80 cm) with fine sandy to loamy texture and pH 6.5 to 9.2. Based on the criteria and degree of limitation, the overall suitability class for groundnut showed that the soil series *viz.*, TTK4, TTK6, TTK8 and TTK10 were marginally suitable (S3) with limitations of soil texture, slope, poor drainage and low organic carbon whereas the soil series of TTK1, TTK2, TTK3, TTK5, TTK6, TTK7, TTK9,

Table 1. Physical characteristics of the soils of studied profiles

Pedon No. & Horizon	Depth (m)	Sand	Silt	Clay	Bulk density (Mg m^{-3})	Water holding capacity (%)	COLE
			(%)				
Pedon 1	**Lithic Ustorthents(Upland)**						
Ap	0.00-0.20	57.7	10.7	31.6	1.49	49.0	-
R	0.20	Hard granite-gneiss					
Pedon 2	**Lithic Ustorthents (Upland)**						
Ap	0.00-0.20	69.5	7.4	23.1	1.46	48.4	-
AC	0.20-0.30	55.3	24.0	20.7	1.54	43.2	-
R	0.30	Hard granite-gneiss					
Pedon 3	**Lithic Ustorthents (Upland)**						
Ap	0.00-0.21	75.0	4.1	20.9	1.52	49.6	-
AC	0.21-0.41	69.3	8.7	22.0	1.57	45.0	-
R	0.41	Hard granite-gneiss					
Pedon 4	**Typic Haplustepts (Upland)**						
Ap	0.00-0.20	57.0	10.7	32.3	1.34	51.4	-
Bw	0.20-0.41	58.4	9.3	32.3	1.46	48.9	-
BC	0.41-0.81	78.4	11.8	9.8	1.54	45.3	-
Cr	0.81	Weathered gneiss mixed with lime accretions					
Pedon 5	**Lithic Ustorthents (Upland)**						
Ap	0.00-0.20	56.3	7.9	35.8	1.26	55.3	-
R	0.20	Hard granite-gneiss					
Pedon 6	**Typic Haplustalfs (Upland)**						
Ap	0.00-0.20	80.2	6.6	13.2	1.40	53.2	-
Bt	0.20-0.40	65.6	5.6	28.8	1.78	30.2	-
Cr	0.40	Weathered gneiss					
Pedon 7	**Lithic Haplustepts (Upland)**						
Ap	0.00-0.20	72.0	6.1	21.9	1.45	45.3	-
Bw	0.20-0.45	77.9	4.0	18.1	1.61	36.2	-
R	0.45	Hard granite-gneiss					

Pedon 8	**Lithic Ustorthents (Upland)**						
Ap	0.00-0.19	79.0	7.0	14.0	1.4	44.8	-
AC	0.19-0.41	80.2	6.6	13.2	1.4	50.4	-
R	0.41	Granite					
Pedon 9	**Lithic Ustorthents (Upland)**						
Ap	0.00-0.15	69.4	7.0	23.6	1.40	48.1	-
R	0.15	Hard granite-gneiss					
Pedon 10	**Lithic Ustorthents (Upland)**						
Ap	0.00-0.07	56.8	7.9	35.3	1.17	58.0	-
AC1	0.07-0.20	78.1	7.5	14.4	1.30	50.3	-
AC2	0.20-0.44	81.3	4.1	14.6	1.42	45.3	-
R	0.44	Hard granite gneiss					
Pedon 11	**Typic Ustifluvents (Upland)**						
Ap	0.00-0.20	55.0	24.1	20.9	1.32	50.1	-
C1	0.20-0.40	64.0	24.8	11.2	1.44	49.7	-
2C1	0.40-0.70	87.6	2.0	10.4	1.52	46.2	-
2C2c	0.70-1.20	83.9	4.6	11.5	1.37	45.1	-
Ck	1.20	Soil mixed with lime					
Pedon 12	**Typic Haplustalfs (Upland)**						
Ap	0.00-0.20	64.0	24.8	11.2	1.38	48.6	-
AB	0.20-0.40	62.5	25.8	11.7	1.58	45.0	-
Bt1	0.40-0.70	69.4	7.0	23.6	1.49	44.9	-
Bt2	0.70-0.91	68.3	9.0	22.7	1.49	42.6	-
Ck	0.91	Weathered gneiss mixed with lime					
Pedon 13	**Fluventic Haplustepts (Upland)**						
Ap	0.00-0.21	71.5	8.1	20.4	1.42	49.5	-
1C1	0.21-0.51	74.2	14.1	11.7	1.39	44.8	-
2Bw1	0.51-0.81	74.1	4.3	21.6	1.35	46.6	-
3C2	0.81-1.10+	79.5	6.1	14.4	1.53	40.7	-

Pedon 14	**Fluventic Haplustepts (Upland)**						
Ap	0.00-0.22	19.3	49.7	31.0	1.34	53.9	-
Bw	0.22-0.40	65.3	12.2	22.5	1.50	46.9	-
BC	0.40	Gravel bed					
Pedon 15	**Lithic Haplustalfs (Upland)**						
Ap	0.00-0.19	78.4	11.8	9.8	2.56	34.5	-
Bt	0.19-0.40	71.5	8.1	20.4	2.45	40.7	-
R	0.40	Hard granite-gneiss					
Pedon 16	**Sodic Haplusterts (Plains)**						
Ap	0.00-0.22	21.2	23.0	55.8	1.29	56.0	0.18
Bss1	0.22-0.48	17.6	23.7	58.7	1.31	59.3	0.19
Bss2	0.48-0.84	32.0	10.0	58.0	1.38	56.3	0.20
Bss3	0.84-1.17	37.2	5.2	57.6	1.39	47.8	0.22
Bss4	1.17-1.51+	39.2	7.2	53.6	1.48	47.9	0.23
Pedon 17	**Sodic Calciustert (Plains)**						
Ap	0.00-0.26	14.8	37.6	47.6	1.28	59.8	0.18
Bss1	0.26-0.58	21.8	34.0	44.2	1.31	57.0	0.20
Bss2	0.58-0.90	33.2	15.4	51.4	1.31	52.4	0.23
Bss3k	0.90-1.10	44.0	4.4	51.6	1.49	48.6	0.16
R	1.10	Limestone					
Pedon 18	**Sodic Haplusterts (Plains)**						
Ap	0.00-0.24	38.3	27.4	34.3	1.21	59.2	0.17
Bss1	0.24-0.50	33.0	26.8	40.2	1.22	52.9	0.17
Bss2	0.50-0.85	22.9	37.2	39.9	1.28	54.7	0.23
Bss3	0.85-1.19	19.9	43.7	36.4	1.36	59.2	0.22
Bss4	1.19-1.60+	22.1	43.7	34.2	1.37	49.2	0.19
Pedon 19	**Fine, smectitic, Typic Haplusterts (Plains)**						
Ap	0.00-0.22	28.0	41.1	30.9	1.21	58.9	0.20
Bss1	0.22-0.46	24.4	42.2	33.4	1.28	54.8	0.19
Bss2	0.46-0.74	28.8	34.4	36.8	1.30	53.1	0.22
Bss3	0.74-1.10	19.3	49.7	31.0	1.33	51.1	0.23

Pedon 20	**LepticHaplusterts (Plains)**						
Ap	0.00-0.27	13.8	37.6	48.6	1.22	51.9	0.15
Bw	0.27-0.55	27.9	33.4	38.7	1.27	50.9	0.18
Bss	0.55-0.75	31.5	40.3	28.2	1.47	44.3	0.19
R	0.75+	Limestone					
Pedon 21	**Lithic Ustorthents (Upland)**						
Ap	0.00-0.20	85.9	4.0	10.1	1.51	43.4	-
AC	0.21-0.45	81.4	10.3	8.3	1.66	38.4	-
Cr	0.45	Weathered gneiss					
Pedon 22	**Lithic Ustorthents (Upland)**						
A	0.00-0.20	63.5	18.4	18.1	1.50	20.0	-
R	0.20	Hard granite gneiss					

TTK11, TTK12, TTK13 and TTK14 were not suitable (N) for growing groundnut crop because of very severe limitation of slope, shallow rooting depth, erosion, wetness, texture, alkalinity, gravelliness, pH and low organic carbon. Similar results were also reported by Meena *et al.* (2017).

Pigeonpea

Pigeonpea requires annual rainfall of 550-1200 mm, well drained, deep soil (120 - 125 cm) with sandy to fine clay texture and pH 7.0 to 8.5. The overall suitability class for pigeonpea revealed that the soil series (TTK2, TTK4, TTK6, TTK8, TTK10 and TTK14)were marginally suitable (S3) with severe limitations of soil texture, slope, drainage and low organic carbon while soil series of TTK1, TTK3, TTK5, TTK7, TTK9, TTK11, TTK12 and TTK13 were not suitable (N) for growing pigeonpea crop because of very severe limitation of slope, erosion, shallow rooting zone, texture, poor drainage, alkalinity, pH and low organic carbon.

Chickpea

Chickpea requires annual rainfall of 800-1000 mm, well drained deep soil (100 cm) with sandy clay loam to clay loam texture and pH 6.0 to 7.5. The overall suitability class for chickpea showed that the soil series (TTK2, TTK4, TTK6, TTK8, TTK10 and TTK14) were marginally suitable (S3) with severe limitations of soil texture, slope, drainage, permeability rate and low organic carbon. However, soil series *viz.*,TTK1, TTK3, TTK5, TTK7, TTK9, TTK11, TTK12 and TTK13 were not suitable (N) for growing chickpea crop because of very severe limitation of slope, erosion, wetness, shallow rooting zone, texture, poor drainage, soil alkalinity, gravelliness, pH and low organic carbon.

Castor

In general, castor requires annual rainfall of 500 to 1200 mm, well drained, deep soil (150 cm) with loam to clay texture and pH 5.5 to 7.2. The overall suitability class for castor indicated that all the soil series except TTK4 were not suitable (N) because of very severe

Table 2. Chemical properties of the soils of studied profiles

Pedon No. & Horizon	Depth (m)	pH (1:2.5 H_2O)	EC (dS m^{-1})	Organic carbon (g kg^{-1})	$CaCO_3$ (%)	CEC (cmol (p^+) kg^{-1})	Exchangeable bases (c mol (p^+) kg^{-1})				Base saturation (%)	ESP
							Ca^{2+}	Mg^{2+}	Na^+	K^+		
Pedon 1	**Lithic Ustorthents (Upland)**											
Ap	0.00-0.20	7.1	0.19	3.8	5.8	15.5	6.9	3.0	0.10	0.06	65	0.64
R	0.20	Hard granite-gneiss										
Pedon 2	**Lithic Ustorthents (Upland)**											
Ap	0.00-0.20	7.0	0.09	4.0	6.3	13.8	6.7	1.9	0.07	0.06	63	0.50
AC	0.20-0.30	7.8	0.07	2.0	7.3	14.6	9.0	2.0	0.11	0.04	76	0.75
R	0.30	Hard granite-gneiss										
Pedon 3	**Lithic Ustorthents (Upland)**											
Ap	0.00-0.21	6.7	0.09	3.6	4.9	11.8	9.4	2.0	0.08	0.05	98	0.67
AC	0.21-0.41	6.6	0.06	2.2	6.0	12.3	8.3	1.7	0.1	0.08	83	0.80
R	0.41	Hard granite-gneiss										
Pedon 4	**Typic Haplustepts (Upland)**											
Ap	0.00-0.20	7.3	0.08	4.8	4.3	18.6	8.2	4.3	0.14	0.08	68	0.74
Bw	0.20-0.41	6.8	0.04	4.0	7.2	15.4	7.9	2.4	0.08	0.05	68	0.51
BC	0.41-0.81	7.1	0.06	2.0	4.2	9.2	6.3	2.2	0.12	0.01	94	1.29
Cr	0.81	Weathered gneiss mixed with lime										
Pedon 5	**Lithic Ustorthents (Upland)**											
Ap	0.00-0.20	6.6	0.08	4.4	8.3	21.1	8.90	5.10	0.15	0.05	67	0.70
R	0.20	Hard granite-gneiss										

Pedon 6	**Typic Haplustalfs (Upland)**											
Ap	0.00-0.20	6.9	0.10	4.8	4.4	7.6	3.2	2.7	0.10	0.07	80	1.31
Bt	0.20-0.40	7.2	0.28	2.5	5.3	15.6	8.3	1.7	0.11	0.09	65	0.70
Cr	0.40	Weathered gneiss										
Pedon 7	**Lithic Haplustepts (Upland)**											
Ap	0.00-0.20	6.8	0.06	4.4	0.5	12.2	4.7	2.0	0.11	0.14	57	0.89
Bw	0.20-0.45	6.5	0.05	1.6	2.1	7.5	2.2	2.0	0.10	0.24	61	1.33
R	0.45	Hard granite-gneiss										
Pedon 8	**Lithic Ustorthents (Upland)**											
Ap	0.00-0.19	8.4	0.14	4.8	7.3	17.7	10.8	3.9	0.28	0.11	85	1.57
AC	0.19-0.41	8.2	0.16	2.5	10.	6.4	4.0	2.1	0.11	0.08	98	1.69
R	0.41	Granite										
Pedon 9	**Lithic Ustorthents (Upland)**											
Ap	0.00-0.15	7.0	0.08	3.9	3.7	11.4	6.00	1.50	0.16	0.05	68	1.39
R	0.15	Hard granite –gneiss										
Pedon 10	**Lithic Ustorthents (Upland)**											
Ap	0.00-0.07	6.9	0.11	5.0	0.5	15.1	5.2	4.0	0.31	0.06	63	2.04
AC1	0.07-0.20	6.7	0.05	3.9	0.5	9.8	4.2	2.3	0.46	0.09	72	4.67
AC2	0.20-0.44	6.8	0.06	2.5	0.5	9.1	3.3	2.6	0.24	0.22	70	2.63
R	0.44	Hard granite-gneiss										

Pedon 11	**Typic Ustifluvent (Upland)**											
Ap	0.00-0.20	8.2	0.26	6.0	13.1	15.8	8.7	3.3	0.46	0.26	81	2.90
C1	0.20-0.40	8.4	0.14	5.5	11.5	9.5	6.1	2.6	0.31	0.12	96	3.26
2C1	0.40-0.70	8.5	0.12	2.0	9.4	7.0	4.0	1.9	0.2	0.07	88	2.84
2C2c	0.70-1.20	8.4	0.16	3.1	7.9	8.9	4.5	3.2	0.33	0.11	91	3.68
Ck	1.20	Soil mixed with lime										
Pedon 12	**Typic Haplustalf (Upland)**											
Ap	0.00-0.20	8.2	0.10	4.4	6.3	9.4	5.3	1.3	0.21	0.18	74	2.22
AB	0.20-0.40	8.3	0.05	3.3	0.5	7.3	5.2	1.5	0.14	0.08	95	1.89
Bt1	0.40-0.70	8.5	0.11	4.1	1.0	16.3	9.9	2.6	0.71	0.09	82	4.34
Bt2	0.70-0.91	8.9	0.19	2.6	1.6	15.5	8.8	5.1	1.45	0.05	99	9.30
Ck	0.91	Weathered gneiss mixed with lime										
Pedon 13	**Fluventic Haplustept (Upland)**											
Ap	0.00-0.21	8.3	0.31	5.8	7.3	18.9	8.2	3.9	0.80	0.15	69	4.23
1C1	0.21-0.51	8.5	0.13	4.9	4.7	8.5	5.1	2.8	0.43	0.11	99	5.05
2Bw1	0.51-0.81	8.2	0.01	2.2	2.6	19.5	8.2	7.2	0.70	0.08	83	3.58
3C2	0.81-1.10+	8.0	0.11	2.0	0.5	9.3	4.8	3.3	0.33	0.09	92	3.54
Pedon 14	**Typic Haplustept (Upland)**											
Ap	0.00-0.22	8.2	0.06	5.5	17.3	14.7	7.2	4.7	0.52	0.21	86	3.53
Bw	0.22-0.40	8.3	0.20	2.0	15.5	13.3	8.8	2.8	0.48	0.36	94	3.59

Pedon 15	**Lithic Haplustalf (Upland)**											
Ap	0.00-0.19	7.9	0.16	4.8	1.0	11.0	4.2	3.0	0.4	0.20	71	3.61
Bt	0.19-0.40	7.5	0.02	1.8	2.6	19.1	6.6	3.1	0.77	0.10	55	4.03
R	0.40	Hard granitegneiss										
Pedon 16	**Sodic Haplusterts (Plains)**											
Ap	0.00-0.22	8.4	0.77	4.2	1.6	38.0	26.5	6.10	4.38	0.31	98	11.50
Bss1	0.22-0.48	8.5	1.83	5.3	11.5	39.6	19.5	5.70	6.37	0.14	80	16.04
Bss2	0.48-0.84	8.6	1.83	3.5	7.3	45.3	14.8	10.6	11.56	0.12	82	25.49
Bss3	0.84-1.17	8.7	1.90	2.2	8.9	42.4	14.7	11.5	10.99	0.10	88	25.90
Bss4	1.17-1.51+	8.5	1.80	2.0	5.8	47.3	15.5	11.0	12.52	0.13	83	26.43
Pedon 17	**Sodic Calciusterts (Plains)**											
Ap	0.00-0.26	8.4	0.11	6.7	7.3	46.6	29.3	5.20	1.68	0.20	78	3.60
Bss1	0.26-0.58	8.8	0.21	4.6	7.3	43.5	28.2	8.10	1.75	0.13	88	4.02
Bss2	0.58-0.90	8.8	0.01	4.2	11.5	45.4	25.0	10.0	4.77	0.12	88	10.49
Bss3k	0.90-1.10	8.7	0.20	2.5	25.2	37.1	17.6	6.70	8.22	0.09	88	22.15
R	1.10	Limestone										
Pedon 18	**Sodic Haplusterts (Plains)**											
Ap	0.00-0.24	8.9	0.22	6.5	11.5	40.5	21.9	6.1	6.09	0.17	85	15.02
Bss1	0.24-0.50	9.0	0.29	5.2	6.3	43.4	20.4	8.5	7.02	0.16	83	16.15
Bss2	0.50-0.85	8.9	1.11	5.0	7.3	42.0	21.0	9.3	9.97	0.13	96	23.72
Bss3	0.85-1.19	8.6	1.67	2.5	12.1	41.1	21.4	8.2	10.99	0.16	99	26.73
Bss4	1.19-1.60+	8.3	0.09	2.0	15.5	42.1	21.0	6.1	14.15	0.15	98	33.57

Pedon 19	**Typic Haplusterts (Plains)**											
Ap	0.00-0.22	8.2	0.21	4.8	11.0	36.5	31.2	4.0	0.87	0.16	99	2.37
Bss1	0.22-0.46	8.2	0.14	3.5	11.5	40.9	32.4	6.8	1.10	0.13	99	2.68
Bss2	0.46-0.74	8.5	0.11	2.8	11.5	45.7	33.9	8.6	2.75	0.12	99	6.00
Bss3	0.74-1.10	8.5	0.12	2.0	7.90	45.0	28.2	9.3	4.08	0.12	93	9.06
Bss4	1.10-1.50+	8.4	0.20	2.0	8.95	48.1	32.5	8.0	4.01	0.13	93	8.33
Pedon 20	**LepticHaplusterts (Plains)**											
Ap	0.00-0.27	8.0	0.15	5.2	5.8	50.6	28.0	16.5	0.69	0.14	90	1.36
Bw	0.27-0.55	8.1	0.08	3.3	7.9	43.2	30.3	5.7	0.42	0.13	85	0.97
Bss	0.55-0.75	8.2	0.12	2.7	8.9	40.1	32.3	5.8	0.69	0.13	97	1.71
R	0.75+	Limestone										
Pedon 21	**Lithic Ustorthents (Upland)**											
Ap	0.00-0.20	6.7	0.03	4.6	1.6	11.8	6.2	3.5	0.25	0.13	85	2.11
AC	0.21-0.45	6.6	0.03	1.0	0.5	9.5	5.3	1.1	0.22	0.13	71	2.30
Cr	0.45	Weathered gneiss										
Pedon 22	**Lithic Ustorthents (Upland)**											
A	0.00-0.20	7.1	0.15	4.6	2.4	7.6	4.26	2.1	0.50	0.40	96	6.52
R	0.20	Hard granite-gneiss										

limitations of shallow soil depth, texture, erosion, wetness, $CaCO_3$ content, alkalinity, gravelliness, pH and low organic carbon.

Quantitative evaluation

The productivity index data (Table 4 and 5) revealed that actual productivity index of the soils varied between 9.09 to 59.85 and potential productivity index ranged between 14.62 to 85.50. The lowest productivity was observed in TTK1 soil series and the highest productivity was associated with TTK3 soil series. In general most of the soil series were categorized into good, average and poor productivity classes with limitations of low organic carbon, shallow depth and texture. Gabhane *et al.* (2006) observed that the productivity index of soils of Belura micro-watershed of Vidarbha region of Maharashtra varied between 8.64 and 43.20.

The overall results indicated that soils of marginally suitable (S3) category fall under the land capability classes IVes, IVs and VIes (Table 6) while not suitable (N) category fall under VIes, IIIw, IIIs, IVes, VIs land capability sub-classes. The marginally suitable (S3) category had the productivity classes of average and good productivity whereas the soils of not suitable (N) category had productivity class of poor, average and good.

The marginally suitable (TTK4, TTK6, TTK8 and TTK10 soil series) is under the cultivation with groundnut and pigeonpea. After improving the soil by managing the constraints like low organic matter content, texture, CEC, soluble salts and drainage through the addition of amendments like gypsum, tank silt, green manuring with legumes / organic mulches, FYM / compost and soil and water conservation measures, these soils can be upgraded to moderately suitable (S2) and highly suitable (S1) or actual productivity can be improved from average and good to good and excellent potential productivity class.

The soils under not suitable category (TTK1, TTK3, TTK5, TTK7, TTK9, TTK11, TTK12, TTK13 soil series) are cultivated for groundnut, pigeon pea, chickpea and castor crops. These not suitable soils can be elevated to marginally suitable (S3), moderately suitable (S2) and highly suitable (S1) for different crops by adopting the management practices. The main limitations in these soils were gravelliness, slope, texture, soil depth, poor drainage, erosion, organic carbon and sodicity. These limitations can be managed by the application of sulphur / gypsum, adoption of broad bed or furrow method of irrigation, contour bunding / contour farming, addition of tank silt to improve the soil texture, crop rotation with legumes, green manuring and FYM / compost addition to increase the organic carbon content. Slope could be managed through terrace-based-hill-slope farming. Soil conservation measures like mulching, rough seed bed ridge furrow system and tied ridges are to be followed to prevent the soil from further degradation.

The actual productivity of these soils varied from poor productivity (TTK1 and TTK2), average productivity (TTK5) and good productivity (TTK3, TTK7, TTK9, TTK11, TTK12, TTK13 and TTK14) can be improved from average to good and good to excellent potential productivity class by following management practices such as mulch farming, rough seed bed, contour farming or contour bunding to control the erosion and deepening the soil by ridging and deep ploughing in shallow depth soils can be taken up. It is suggested to go for alternate crops like sorghum, pearl millet, minor millets, coriander and chickpea.

Implications for land use planning

The soil suitability evaluation showed that the prevailing crops in the area are mostly marginally suitable. The soil suitability evaluation indicated a strong mismatch between scientific rationale and farmer's outlook. These results are in agreement with the reports of Patangray *et al.* (2016). Tatrakallu village receives most of the water through rainfall, monsoon variability will be the most significant factor deciding choice of crops as well as their yields. Another reason for reluctance of the farmers to cultivate other vegetable and horticultural crops is due to wild animals attack. During field interactions, farmers opined that the crop choice is strongly influenced by water availability and the only

Table 3. Site and soil characteristics of studied profiles (Weighted average)

Tentative soil series	Pedon No.	Land form	Parent material	Wetness (W) drainage	Physical soil characteristics (s)				Soil fertility characteristics (f)					Salinity and alkalinity (n)	
					Texture	Coarse fragments volume (%)	Soil depth (m)	$CaCO_3$ (%)	Apparent CEC [c mol (p+) kg^{-1} soil]	Sum of basic cations [c mol (p+) kg^{-1} soil]	BS	pH 1:2.5	OC (g kg^{-1})	EC (dSm^{-1})	ESP
TTK 1	1,2, 5,9,22	Upland	Granite-gneiss	Well drained	gscl	15 -40 %	0.15 – 0.20	0.20	8.30	21.16	14.20	67.18	6.65	0.44	0.08
TTK 2	3,8,10, 21	Upland	Granite-gneiss	Well drained	gsl	15 -40 %	0.40 – 0.45	0.41	8.78	6.48	12.97	91.49	8.40	0.42	0.15
TTK 3	11	Upland	Granite-gneiss	Well drained	sl	None	1.20	9.76	11.54	12.00	89.22	8.29	5.9	0.16	3.37
TTK4	4	Upland	Granite-gneiss	Well drained	gscl	15 -40 %	0.81	5.01	15.61	12.26	57.55	7.25	4.6	0.05	0.95
TTK5	14	Upland	Granite-gneiss	Well drained	gsl	15 -40 %	0.41	16.54	13.35	12.60	89.14	8.21	5.0	0.12	3.55
TTK6	7	Upland	Granite-gneiss	Well drained	gsl	15 -40 %	0.45	1.41	7.50	6.56	59.52	6.76	3.8	0.05	1.13
TTK7	13	Upland	Granite-gneiss	Well drained	sl	None	1.10	3.57	12.86	12.31	88.13	8.38	5.6	0.12	4.12
TTK 8	6	Upland	Granite-gneiss	Well drained	gscl	15 – 40%	0.40	4.85	15.66	6.97	72.99	6.99	0.43	0.19	1.00
TTK 9	12	Upland	Granite-gneiss	Well drained	sl	15 – 40%	0.91	7.26	10.00	8.51	87.84	8.26	4.1	0.11	4.48
TTK 10	15	Upland	Granite-gneiss	Well drained	gsl	15 – 40%	0.40	1.90	19.10	8.46	62.55	7.87	4.0	0.08	3.83
TTK 11	16, 18	Plains	Limestone	Poorly drained	c	None	1.51	7.25	39.20	36.62	85.33	8.42	4.3	1.90	22.29
TTK12	17	Plains	Limestone	Poorly drained	c	None	1.10	11.83	45.50	36.38	85.46	8.45	6.7	0.12	9.09
TTK 13	19	Plains	Limestone	Some what poorly drained	cl	None	1.50	9.90	39.41	36.73	95.80	8.26	4.6	0.15	6.29

Table 4. Actual productivity index and productivity class for soil series in Tatrakallu village

Tentative soil series	Pedon No.	Moisture (H)	Drainage (D)	Effective depth (P)	Texture/ structure (T)	Base saturation (N)	Soluble salts (S)	Organic matter content (O)	Mineral exchange capacity (A)	Mineral reserve (M)	Actual productivity index (PI)	Actual productivity class
TTK1	1,2,5,9,22	H4b (90)	D4 (100)	P2 (20)	T7 (100)	N4 (80)	S1(100)	O1(70)	A2(95)	M2b(95)	9.09	Poor
TTK2	3,8,10,21	H4b(90)	D4 (100)	P2(20)	T6 (90)	N5(100)	S1(100)	O1(70)	A2(95)	M2b(95)	10.23	Poor
TTK3	11	H4b(90)	D4(100)	P5 (100)	T7 (100)	N5(100)	S1(100)	O1(70)	A3(100)	M2b(95)	59.85	Good
TTK4	4	H4b(90)	D4(100)	P4(80)	T7 (100)	N4 (80)	S1(100)	O1(70)	A2(95)	M2b(95)	36.38	Good
TTK5	14	H4b(90)	D4(100)	P3 (50)	T6 (90)	N5 (100)	S1(100)	O1(70)	A3(100)	M2b(95)	21.54	Average
TTK6	7	H4b(90)	D4(100)	P3(50)	T7 (100)	N4 (80)	S1(100)	O1(70)	A2(95)	M2b(95)	22.74	Average
TTK7	13	H4b(90)	D4(100)	P5 (100)	T7 (100)	N4 (80)	S1(100)	O1(70)	A3(100)	M2b(95)	47.88	Good
TTK8	6	H4b(90)	D4(100)	P3 (50)	T6 (90)	N5 (100)	S1(100)	O1(70)	A2(95)	M2b(95)	25.58	Average
TTK9	12	H4b(90)	D4(100)	P5 (100)	T6 (90)	N4 (80)	S1(100)	O1(70)	A2(95)	M2b(95)	40.93	Good
TTK10	15	H4b(90)	D4(100)	P3 (50)	T6(90)	N4 (80)	S1(100)	O1(70)	A2(95)	M2b(95)	20.46	Average
TTK11	16,18	H4b(90)	D3b (80)	P6 (100)	T5b (80)	N5 (100)	S6(15)	O1(70)	A3(100)	M2c(100)	40.32	Good
TTK12	17	H4b(90)	D3b (80)	P5(100)	T6b (90)	N5 (100)	S1(100)	O1(70)	A3(100)	M2c(100)	51.03	Good
TTK13	19	H4b(90)	D3b (80)	P6 (100)	T5b (80)	N5 (100)	S1(100)	O1(70)	A3(100)	M2c(100)	45.36	Good
TTK14	20	H4b(90)	D3b (80)	P4 (80)	T5b (80)	N5 (100)	S1(100)	O1(70)	A3(100)	M2c(100)	36.28	Good

Table 5. Potential productivity index and productivity class for soil series in Tatrakallu village

Tentative soil series	Pedon No.	Moisture (H)	Drainage (D)	Effective depth (P)	Texture/ structure (T)	Base saturation (N)	Soluble salts (S)	Organic matter content (O)	Mineral exchange capacity (A)	Mineral reserve (M)	Potential productivity index (PI)	Potential productivity class
TTK1	1,2,5,9,22	H4b(90)	D4(100)	P2(20)	T7(100)	N5(100)	S1(100)	O4(100)	A2(95)	M2b(95)	16.24	Poor
TTK2	3,8,10,21	H4b(90)	D4(100)	P2(20)	T6(90)	N5(100)	S1(100)	O4(100)	A2(95)	M2b(95)	14.62	Poor
TTK3	11	H4b(90)	D4(100)	P5(100)	T7(100)	N5(100)	S1(100)	O4(100)	A3(100)	M2b(95)	85.50	Excellent
TTK4	4	H4b(90)	D4(100)	P4(80)	T7(100)	N5(100)	S1(100)	O4(100)	A2(95)	M2b(95)	64.98	Good
TTK5	14	H4b(90)	D4(100)	P3(80)	T6(90)	N5(100)	S1(100)	O4(100)	A2(95)	M2b(95)	58.48	Good
TTK6	7	H4b(90)	D4(100)	P3(80)	T7(100)	N5(100)	S1(100)	O4(100)	A2(95)	M2b(95)	64.98	Excellent
TTK7	13	H4b(90)	D4(100)	P5(100)	T7(100)	N5(100)	S1(100)	O4(100)	A3(100)	M2b(95)	85.50	Excellent
TTK8	6	H4b(90)	D4(100)	P3(80)	T6(90)	N5(100)	S1(100)	O4(100)	A2(95)	M2b(95)	58.48	Good
TTK9	12	H4b(90)	D4(100)	P5(100)	T6(90)	N5(100)	S1(100)	O4(100)	A2(95)	M2b(95)	73.10	Excellent
TTK10	15	H4b(90)	D4(100)	P3(80)	T6(90)	N5(100)	S1(100)	O4(100)	A2(95)	M2b(95)	58.48	Good
TTK11	16,18	H4b(90)	D4(100)	P6(100)	T5b(80)	N5(100)	S1(100)	O4(100)	A3(100)	M2c(100)	72.00	Excellent
TTK12	17	H4b(90)	D4(100)	P5(100)	T6b(90)	N5(100)	S1(100)	O4(100)	A3(100)	M2c(100)	81.00	Excellent
TTK13	19	H4b(90)	D4(100)	P6(100)	T5b(80)	N5(100)	S1(100)	O4(100)	A3(100)	M2c(100)	72.00	Excellent
TTK14	20	H4b(90)	D4(100)	P4(80)	T5b(80)	N5(100)	S1(100)	O4(100)	A3(100)	M2c(100)	57.60	Good

Table 6. Comparative evaluation of capability, suitability and productivity of soil series of Tatrakallu village

Soil Series	Present land use	Land capability classification		Soil site suitability		Production potential		Management practices	Suggested land use after adopting management practices
		Class	Constraint	Class	Constraint	Class	Constraint		
TTK1	Groundnut	VIes	Slope, erosion, shallow depth, organic carbon, texture, gravelliness	Not suitable(N)	pH, organiccarbon,texture,shallow depth, gravelliness	Poor	Organic matter, shallow depth,texture, mineral exchange capacity, mineral reserve	Amendments like gypsum ,agronomic measures like crop rotation/organic mulches, and compost, gypsum and FYM/ compost/green manuring with legumes, contour bunding	Suitable for growing pasture crops and multi purposeforest trees
TTK2	Groundnut	VIes	Slope, erosion, shallow depth, organic carbon, texture, gravelliness	Not suitable(N)	pH, organiccarbon, texture,shallow depth, gravelliness	Poor	Organic matter, shallow depth,mineral exchange capacity, mineral reserve,	Agronomic measures like crop rotation/organic mulches, and compost, gypsum and FYM/ compost/green manuring with legumes, contour farming, amendments like sulphur	Suitable for growing pasture crops and forest trees
TTK3	Groundnut	IVes	Slope, erosion, shallow depth, organic carbon, texture, gravelliness	Not suitable(N)	pH, organiccarbon, texture,shallow depth, gravelliness	Good	Organic matter, shallow depth, texture, mineral exchange capacity, mineral reserve,	Addition of tank silt and soil water conservation measures, agronomic measures like crop rotation with legumes/organic mulches, and compost, gypsum and FYM/ compost/green manuring with legumes, ridging and deep ploughing.	Suitable for growingfield crops like groundnut, finger millet, pearl millet, sorghum and pasture crops

TTK4	Groundnut	VIes	Slope, erosion, shallow depth, organic carbon, texture, gravelliness	Not suitable(N)	pH, organiccarbon, texture,shallow depth, gravelliness	Good	Organic matter, shallow depth, texture, mineral exchange capacity, mineral reserve,	Agronomic measures like crop rotation/organicmulches, and compost, gypsum and FYM/ compostgreen manuring with legumes, contour farming , Amendments like sulphur	Suitable for growing pasture crops and forest trees
TTK5	Groundnut	IVs	Slope, erosion, shallow depth, organic carbon, texture, gravelliness	Not suitable(N)	pH, organiccarbon, texture,shallow depth, gravelliness	Average	Organic matter, shallow depth, mineral exchange capacity, mineral reserve	Addition of tank silt and soil water conservationmeasures, agronomic measures like crop rotation with legumes/organic mulches, and compost, gypsum and FYM/ compost/green manuring with legumes, ridging and deep ploughing.	Suitable for growingfield crops like groundnut, finger millet, pearl millet, sorghum and pature crops
TTK6	Groundnut	IVes	Slope, erosion, shallow depth, organic carbon, texture, gravelliness	Marginally suitable (S3)	pH, organiccarbon, texture,shallowdepth, gravelliness	Average	Organic matter, shallow depth, texture, mineral exchange capacity, mineral reserve,	Addition of tank silt and soil water conservationmeasures, agronomic measures like crop rotation with legumes/organic mulches, and compost, gypsum and FYM/ compost/green manuring with legumes, ridging and deep ploughing.	Suitable for growingfield crops like groundnut, finger millet, pearl millet, sorghum and pature crops

TTK7	Groundnut	IVs	Slope, erosion, shallow depth, organic carbon, texture, gravelliness	Not suitable(N)	pH, organiccarbon, texture,shallow depth, gravelliness	Good	Organic matter, shallow depth, texture, mineral exchange capacity, mineral reserve,	Deepening of soil by ridging and deep ploghing addition of tank silt, agronomic measures like crop rotation/organic mulches, and compost, gypsum and FYM/ compostgreen manuring withlegumes, contour farming, amendments like sulphur	Suitable for growing pasture crops and forest trees
TTK8	Groundnut	IVes	Slope, erosion, shallow depth, organic carbon, texture, gravelliness	Marginally suitable (S3)	pH, organiccarbon, texture,shallow depth, gravelliness	Average	Organic matter, texture, mineral exchange capacity, mineral reserve, soluble salts, drainage	Amendments like gypsum,compost, and FYM/ compost/green manuring with legumes, adoption of broad bedand furrow method o f irrigation and agronomic measures like crop rotation/organic mulches, addition of tank silt	Suitablefor minor millets and field crops like pearl millet, sorghum, finger millet,
TTK9	Groundnut	IIIs	Slope, erosion, shallow depth, organic carbon, texture, gravelliness	Not suitable(N)	pH, organiccarbon, texture,shallow depth, gravelliness	Good	Organic matter, texture, mineral exchange capacity, mineral reserve, soluble salts, drainage	Amendments like spentwash / pressmud compost, gypsum and FYM/ compost/gr een manuring with legumes, adoption of broad bed and furrow method of irrigation and agronomic measures like crop rotation/organic mulches	Suitablefor minor millets and field cropslike pearl millet, sorghum, finger millet,

TTK10	Groundnut	IVs	Slope, erosion, shallow depth, organic carbon, texture, gravelliness	Marginally suitable (S3)	pH, organiccarbon, texture,shallow depth, gravelliness, sodicity	Average	Organic matter, shallow depth, texture, mineral exchange capacity, mineral reserve.	Addition of tan k silt and soil water conservationmeasures, agronomic measures like crop rotation with legumes/organic mulches, and compost, gypsum and FYM/ compost/green manuring with legumes, ridging and deep ploughing.	Suitable for growingfield crops like groundnut, finger millet, pearl millet, sorghum and pasture crops
TTK11	Chickpea	IIIw	Wetness, sodicity, organic carbon,$CaCO_3$	Not suitable(N)	Wetness, texture, pH, organic carbon, sodicity, $CaCO_3$	Good	Organic matter, texture, mineral exchange capacity, mineral reserve, soluble salts, drainage	Amendments like gypsum,compost, and FYM/ compost/green manuring with legumes, adoption of broad bedand furrow method of irrigation and agronomic measures like crop rotation/organic mulches, addition of tank silt	Suitablefor minor millets and field crops like pearl millet, sorghum, finger millet, coriander and Bengal gram
TTK12	Chickpea	IIIws	Wetness, sodicity, organic carbon,	Not suitable(N)	Wetness, texture, pH, organic carbon, sodicity	Good	Organic matter, texture, mineral exchange capacity, mineral reserve, soluble salts, drainage	Amendments like sulphur/ spentwash / press-mud compost, gypsum and FYM/ compost/green manuring with legumes, adoption of broad bed and furrow method of irrigation and agronomic measures like crop rotation/organic mulches	Suitablefor minor millets and field cropslike pearl millet, sorghum, finger millet, coriander and Bengal gram

TTK13	Chickpea	IIIw	Wetness, sodicity, organic carbon,	Not suitable(N)	Wetness, texture, pH, organic carbon, sodicity	Good	Organic matter, texture, mineral exchange capacity, mineral reserve, soluble salts, drainage	Amendments like sulphur/ spentwash / press-mud compost, gypsum and FYM/ compost/green manuring with legumes, adoption of broad bed and furrow method of irrigation and agronomic measures like crop rotation/organic mulches	Suitablefor minor millets and field crops like pearl millet, sorghum, finger millet, coriander and Bengal gram
TTK14	Castor	IIIs	Wetness, sodicity, organic carbon,	Not suitable(N)	Wetness, texture, pH, organic carbon, sodicity	Good	Organic matter, texture, mineral exchange capacity, mineral reserve, soluble salts, drainage	Amendments like spentwash / press-mud gypsum and FYM/ compost/green manuring with legumes, adoption of broad bed and furrow method of irrigation and agronomic measures like crop rotation/organic mulches	Suitablefor minor millets and field crops like pearl millet, sorghum, finger millet, coriander and Bengal gram

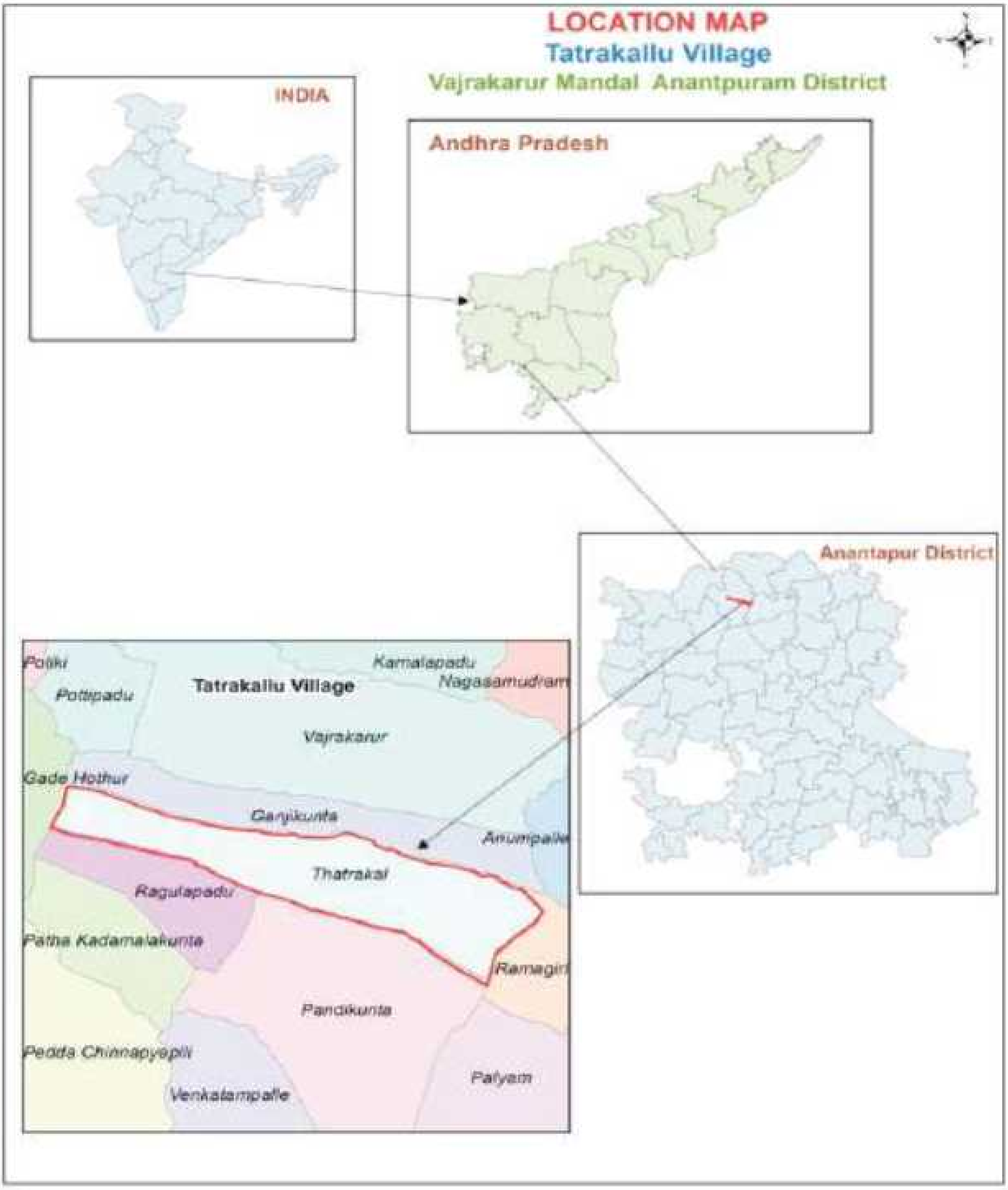

Fig. 1. Location map of Tatrakallu village

source of water is through rainfall in the area. Besides this, other socio-economic conditions (investment, seed availability, Government subsidy and belief of good productivity by these crops during a good monsoon year *etc.*) made the farmers continued to grow groundnut, pigeonpea, chickpea and castor though unsuitable.

Conclusion

It is concluded that characteristics and suitability of soils in area were highly variable, and hence their management must be site-specific. The identified major limitations in Tatrakallu village for crop production / suitability were slope, erosion, alkalinity, shallow rooting depth, pH, gravelliness, organic carbon and poor nutrient status. Slope and erosion can be managed by adopting soil conservation measures while soil sodicity and alkalinity were controlled through reclamation measures. The fertility problem can be corrected / managed by crop rotation with legumes, incorporation of FYM / compost / pressmud to increase the organic carbon status and increase the microbial activity so as to enhance the mineralization process. Green manuring with dhaincha, trash mulching and vertical mulching, contour bunding would be other options to upgrade these soils to highly and moderately suitable for different crops.

Acknowledgements

The senior author is highly grateful to the Acharya N.G. Ranga Agricultural University, Guntur, Andhra Pradesh for providing financial assistance in the form of stipend during course of investigation.

References

APSAC.(2018). District Survey report- Anantapuramu district. ITE & C Department, Government of Andhra Pradesh. Andhra Pradesh Space Application Centre, Vijayawada.

Chinchmalatpure, Anil, R., Nayak, A.K. and Rao, G.G. (2001). Suitability assessment of some crops on salt-affected soils of Gujarat. *Indian Journal of Soil Conservation* **29,** 138-142.

Deng, D. and Yong, A. (1981). 'Soil Survey and Land evaluation', Allen & Unwin, London.

Devi, P.A.V., Naidu, M.V.S. and Ramakrishnarao, A. (2015). Characterization and classification of sugarcane growing soils in southern agro-climatic zone: A case study in eastern mandals of Chittoor District in Andhra Pradesh. *Journal of Indian Society of Soil Science* **63**, 245-258.

FAO. (1976). A framework for land evaluation. FAO Soils Bulletin 32. Food and Agriculture Organization of the United Nations, Rome, Italy.

Fresco, L.O. (1991). Using land evaluation and farming systems methods for planning sustainable land use – an example from Costa Rica., Land use planning applications. In Proceedings FAO Expert Consultation, Rome, World Soil Resources – Reports, No. 68, pp. 153–157.

Gabhane, V.V., Jadhao, V.O. and Nagdeve, M.B. (2006). Land evaluation for land use planning of a micro-watershed in Vidarbha region of Maharashtra. *Journal of the Indian Society of Soil Science* **54,** 307-315.

Mandal, D.K., Kandare, N.C., Mandal, C. and Challa, O. (2002). Assessment of quantitative land evaluation methods and suitability mapping for cotton growing soils of Nagpur district. *Journal of the Indian Society of Soil Science* **50,** 74-80.

Meena, R.L., Verma, T.P., Singh, R.S, Tailor, B.L. and Singh, S.K. (2017). Soil-site suitability evaluation for groundnut (*Arachis hypogea* L.) in western Saurashtra region of Gujarat, India. *International Journal of Current Microbiology and Applied Science* **6,** 3074-3083.

NBSS & LUP (National Bureau of Soil Science and Land Use Planning) (1994). Proceedings of National Meeting on Soil-site Suitability Criteria for Different Crops. Feb. 7-8, Nagpur, India. 20.

Pakhan A.D., Chatterji, S., Sen, T.K., Venugopalan, M.V., Patil, S. and Challa, O. (2010). Use of different techniques in evaluation of suitability of shrink-swell soils of Nagpur district, Maharashtra for rainfed Sorghum. *Journal of the Indian Society of Soil Science* **58**, 117-124.

Patangray, A.J., Patil, N.G., Singh. S.K.. Tiwari, P., Mishra, V.N., Pagdhune, A.R. and Patil, B.A. (2016). Soil suitability evaluation of major crops for sustainable land use planning in Kupti watershed, Yavatmal district, Maharashtra. *Agropedology* **26,**117-131.

Riquier, J.. Bramo. D.L. and Cornet, J.P. (1970). A New System of Soil Appraisal in Terms of Actual and Potential Productivity. FAO, Soil Resource, Development and Conservation Service, Land and Water Development Division, FAO. Rome. pp. 88-99.

Reddy, K.S. and Naidu, M.V.S. (2016). Characterization and classification of soils in semi-arid region of Chennurmandal in Kadapa district, Andhra Pradesh. *Journal of the Indian Society of Soil Science* **64,** 207-217.

Sharma, V.K. and Kumar, A. (2003). Characterisation and classification of the soil of upper Maul Khad catchment in wet temperate zone of Himachal Pradesh. *Agropedology* **13,** 39-49.

Soil Survey Staff. (1995). Soil Survey Manual. U.S, Department Agriculture Handbook 18. Oxford and I.B.H. Publishing Co., New Delhi.

Soil Survey Staff. (2014). Keys to Soil Taxonomy (Twelfth edition). USDA Natural Resource Conservation Service, Washington, DC.

Sys, C. (1985). Land evaluation. Part I. II and III. Pub. Agricole 7, ITC University. Ghent. Publication No. 7 Brussels, Belgium.

Received: July, 2020 *Accepted: November, 2020*