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Land suitability evaluation for crops in Warangal district of Telangana under Narsampet division

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Abstract
Six typical Pedon's from central and eastern parts of Warangal district, Telangana were evaluated for their suitability to major crops Viz, rice, maize, cotton, chilly and red gram. The suitability classes ranged from highly suitable to permanently not suitable to these crops. Pedon's 1, 2, 3, 4, 5, 6 were highly suitable for cotton, rice, maize, chilly and red gram. Pedon 1,2,3,6 where Pedon's 4, 5 were moderately suitable for chilly, maize red gram and marginally suitable for Pedon 1, 5, 6 for different growing five crops. All the Pedon's were not involved in temporarily not suitable and permanently not suitable any crop. Pedon 1 was also classified as marginally suitable for red gram and moderately suitable for rice, maize, chilly and cotton. Highly suitable for cotton due to alkaline P^H and higher ESP. Soils are deep to very deep wetness, O.C. P^H and $CaCo_3$ content were limitations in all the Pedon's. Texture was limiting factor.

Keywords: Soil, site suitability, Warangal district, soil taxonomy, limitation levels, potential lad suitability

Introduction
Soil is a component of the lithosphere and biosphere system. It is a vital natural resource on whose proper use depends on the supporting life systems and socio- economic development. The per capita cultivable land has been declining from 0.32 ha through 0.14 to less than 0.1 ha by 2020. The ability of the land to produce is limited and the limits to produce are set by soils, climate, landforms conditions and farming situations. Further, the capacity of soil to produce is also limited and constraints are due to intrinsic characteristics, agro-ecological settings, use and management (FAO, 2007-08) [1]. Therefore, comprehensive account of our land resources ascertaining its potential and problems towards optimizing land use on sustainable basis is necessary and in the present context, it is one of the fundamental pathway for sustainable land use In the recent past, productivity of agricultural soils worldwide in general is on the decline, which prompted the per capita availability of food grain to fall from 510 g per day in 1991 to 463 g per day in 2004. These declining trends across the world can be attributed to ever growing population, raising incomes of populous Asian nations and discovery of new uses such as bio-fuels, besides weather based abnormalities owing to climate change (Sidhu and Vatta, 2008) [2]. Soil is the most important natural resource, which is a treasure of any country. But, it is finite, non-renewable and is constantly degrading. India has to support nearly 18 per cent of the world's population from its meager share of 2.5 per cent of world's land area (Katyal, 2012) [3]. The population of India has increased from 456 million in 1961 to 700 million in 1980 to 1053 million in 2000 and is projected to reach 1387 million by 2020 and 1665 million by 2050. The per capita cultivable land in India is also reported to decline from 0.34 ha in 1961 to 0.14 ha in 2010 and is projected to further decline to 0.09 ha by 2050 (Lal, 2013)4. Proper use of this vital natural resource influences the existence of life systems and socio-economic development of any country. Land suitability evaluation is the process of estimating the potential of land for land use planning (Sys *et al*. 1991) [5]. However, each plant species requires specific soil and climatic conditions for its optimum growth. Information on soil site suitability for crops in Warangal district in particular and in Telangana state in general is very much lacking. Hence, an attempt has been made to evaluate the soil suitability for five major crops viz., rice, cotton, maize, chilli and redgram on alfisols, Ientisols, nceptisols and

Vertisols in central and eastern parts of Warangal district of Telangana state. Satish Kumar and Naidu (2012b) [6] reported that Typic Ustorthents were marginally suitable for growing rice crop in Vadamalapeta mandal of Chittoor district in Andhra Pradesh. Drainage, texture, soil depth Each plant species requires definite soil and site conditions for its optimum growth. Although some plants may be found to grow under different soils and extreme agro-ecological conditions, all plants cannot grow on the same soil and under the same environment. Since, the availability of both water and plant nutrients was largely controlled by the physico-chemical and micro-environment of soils, the success and failure of any plant species was largely determined by these factors in any particular area. The optimum requirements of a crop are always region specific. Climatic and soil parameters play a significant role to maximize crop yields. The depth wise soil characteristics used to arrive at site-soil characteristics for assessing crop suitability. The site-soil properties from the study area were matched with the soil-site suitability criteria for rice, maize, cotton, chilly and redgram that are grown in Warangal district, Telangana. The kind and degree of limitations were evaluated and the suitability of soils of study area for growing these crops is given below. The performance of any crop was largely dependent on soil parameters (depth, texture, drainage *etc.*) as conditioned by climate and topography. The study of soil-site characterization for predicting the crop performance of an area forms land evaluation. According to Wambeke (1998) [7], land evaluation was the rating of soil for optimum returns per unit area. The yield influencing factors for crops have to be evaluated and the results obtained may be applied for higher production of these crops through proper utilization of similar soils that occur elsewhere in same agro-climatic sub-region under scientific management practices (Khadse and Gaikwad, 1995)8.The soil-site characteristics of the study area were matched with soil-site suitability criteria for a few important crops *viz.*, rice, maize, cotton, chilly and redgram given by Sys *et al.* (1993) [5]. The kind and degree of limitation and suitability class was determined and evaluated. The studied soils vary in their suitability for different crops according to the criteria for the determination of the land suitability classes.

Materials and Methods

Description of the study area

An investigation entitled "Land Suitability evaluation for crops in Warangal district of Telangana Under Narsampet division" was carried out in part of Warangal district of Central Telangana Agro-climatic zone. For this study, horizon-wise soil samples were collected from six profiles. The profiles were opened up to parent material or greater than 1.0 m depth and described for morphological characteristic as per the procedure given in the USDA Soil Survey Manual (Soil Survey Staff, 1998) [9]. The particulars relating to the general description of the area, collection and preparation of soil and plant samples and the analytical methods adopted in the investigation are presented in this chapter. Warangal, Location of the study area Telangana State. The area selected for the present study, Warangal district, lies in central Telangana Zone in Telangana State has a total geographical area of 12846 Km^2 which lies between 17^o 19^1< 18^0 36^1 or latitude and 78^0 49^1& 80^0 43^1 East longitude. The climate is semi – arid monsoon with district summer, winter and rainy seasons. The mean annual rain fall is 803.2 mm of which 90.11% received during south west monsoon, 4.80% during summer season. (May to November) and JAN to Feb respectively. The mean annual Temperature is maximum and minimum temperature of the district are 32.44 ^{0}C and 23.31 ^{o}c respectively. The maximum and minimum mean monthly temperature ranges from 17 ^{0}C to 40.8 ^{0}C. The mean minimum temperature is recorded during December 17.0 ^{0}C and maximum in may 40.8 ^{0}C. The mean annual air temperature of the district is 27.78 ^{0}C. The soil moisture regime is ustic, and soil temperature regime is iso hyper thermic. The natural vegetation comprises of species like fiscus, tamarind, mean prosopis, ber are predominated trees in the study area. *Fiscusbe nglaenesis*, tamarind us Indica, *Azadiracta indica*, *Zizyphus jujube*. (Department of Agriculture, Warangal Dist. of Telangana 1972) [10].

Methodology

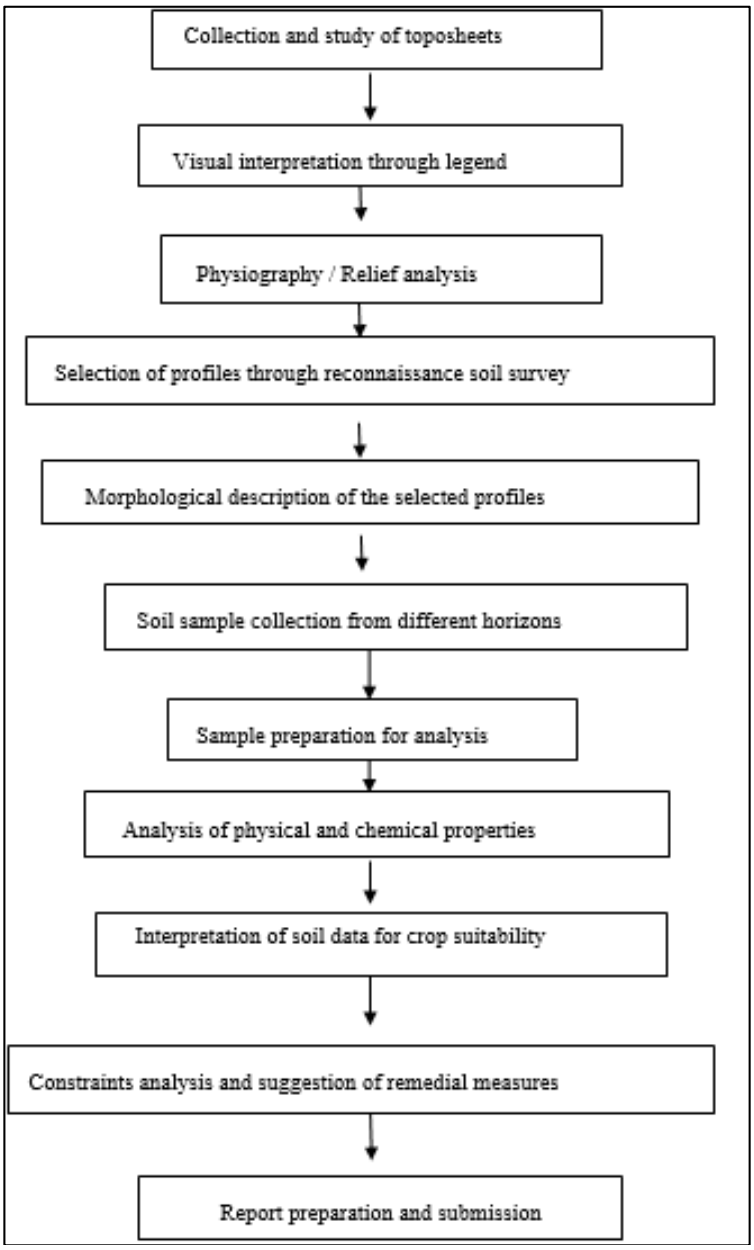
After traversing the Waranagal district, six typical pedons were selected on two land forms (plains and uplands) in central and eastern parts of Warangal district. The morphological characteristics of these typical pedons were described in the field by following the procedure outlined by Soil Survey Staff (2000) [11]. Horizonwise soil samples were collected from these typifying pedons and analyzed for their physical, physico-chemical and chemical properties following the standard procedures and were classified according to Soil Taxonomy (Soil Survey Staff, 1999) [12]. These pedons were evaluated for their suitability using limitation method regarding number and intensity of limitations (Sys *et al*. 1991) [5]. The landscape and soil requirements for the selected crops were matched with generated data at different limitation levels: no (0), slight (1), moderate (2), severe (3) and very severe (4). The number and degree of limitations suggested the suitability class of pedons for a particular crop (Sys *et al*. 1991) [5]. The potential land suitability (table 3) subclasses were determined after considering the improvement measures to correct these limitations (Sys *et al*. 1991) [5].

Soil suitability for major crop growing was evaluated based on FAO (1976) [13] frame work for land evaluation. It involved formulation of climatic and soil requirements of crop and ratings of these parameters viz., highly suitable (S1), moderately suitable (S2), marginally suitable (S3) and unsuitable (N) for agriculture. Soil-site suitability for some of the major crops was evaluated based on the criteria suggested by Sehgal (1996) [14] and Sys *et al.* (1991) [5]. Soil-site suitability characteristics for crops are presented in table 1 to 3.

Criteria for the determination of the land suitability classes

Land Classes	Criteria
S1 : Very suitable	Land units with no, or only 4 slight limitations.
S2: Moderately suitable	Land units with more than 4 slight limitations, and / or not more than 3 moderate limitations.
S3 : Marginally suitable	Land units with more than 3 moderate limitations, and / or one or more severe limitation(s).
N1 : Actually unsuitable and potentially suitable	Land units with very severe limitations which can be corrected.
N2 : Unsuitable	Land units with very severe limitations which cannot be corrected.

Methodology flow chart
Satellite data



Results and Discussion

Details of Pedon's and relevant soil characteristics are given in table 1 and site characteristics and weighted means of soil characteristics are given in table 2. These soils are developed from granite – gneiss, alluvial deposits and sand stones.

Pedon 1, which is grouped under typic haplustarts is highly suitable for cotton, moderately suitable for rice, maize and chilly, marginally suitable for red gram. Temporarily not suitable and permanently not suitable for aby crop. The limitations are include wetness, (drainage), physical soil characteristics soil depth cotton, red gram, $CaCo_3$ content and soil fertility characteristics P^H and organic carbon due to alkaline P^H and high ESP. It can be improved by cultivation crop rotation, mixed cropping growing leguminous crops in rotation or application of organic manuves. Improve the drainage condition but also reduce the run off erosion. Similar observations are also made by Leelavathi *et al*. (2010 b) [15], and Geetha Siresha and Naidu, 2013b) [16] in Yerpedu Mandal of Kadapa district and Banaganapalle Mandal of Karnool district in AP respectively.

Pedon 2 is grouped under typic haplustepts is highly suitable for rice, maize, chilly, cotton, red gram the limitations include wetness (drainage), physical characteristics texture and soil depth $CaCo_3$content and soil fertility characteristics organic carbon and P^H similar findings were reported by Satyavathi and Reddy 2004 in Telangana region.

Pedon 3 is classified under verticeshaplustepts is highly suitable for rice, cotton, chilly and red gram moderately suitable for maize owing to good drainage conditions finer texture of the soil absent of course fragments, very low $CaCo_3$high CEC and high base saturation and no other soil related problems the five texture of these soil, may cause some drainage problems for main especially during the seedling stage. Hence, these soils were categorized as moderately suitable for maize. Alkalinity in the soils can be reduced by addition of gypsum or green magnum with dhaincha not only reduces the alkalinity problems but also increases nutrient availability similar finding and recommendation were also reported likkar and parted (2011) Kuchanwar and Gabhane 2012 [17], Meena *et al*. 2012 [18] and Niranjan *et al*. 2013 [19] in Nagpur district of Maharashtra.

Ridhora watershed in Nagpur district of Maharashtra, Malwa plateau in Banswara district of Rajastan and Pulivendula region of AP respectively.

Pedon 4 is grouped under typic Rhodustalts is moderately suitable for chilly, maize and red gram and marginally suitable for rice, cotton. However slight variations in soil properties. Depth of Pedon among of clay, presence or absence of course fragments, and relative locations of the Pedon on the land scape future the major factors due to the textual drainage related to limitations these soils were shallow depth excessive drainage.

Pedon 5 is grouped under typic haplustepts is highly suitable for maize, moderately suitable for chilly, marginally suitable for rice, cotton and red gram. In view of good drainage and clay loam texture and no other yield limiting constraints.

Pedon 6 is grouped under typic Rhodustalts is moderately suitable for chilly, maize and red gram marginally suitable for rice, cotton course surface, soil texture and medium sub---- soil texture made them classified as moderately suitable for maize, chilly and red gram crops. But due to the textural and drainage related limitation these soils were classified as marginally suitable for rice, cotton. Similar results were findings by Sathish Kumar and Naidu (2012 b)6 reported that typic ustorthants were marginally suitable for growing rice crop in vadamalapeta Mandal of Chittore district in AP. Drin age, texture, soil depth., O.C & P^H.

Limitations are wetness (drainage), physical soil characteristics (soil depth and texture) and soil fertility characteristics (organic carbon and pH). The pedons 2, 3, 5 and 7 are marginally suitable and the pedons 1, 4 and 6 are permanently not suitable for rice. Leelavathi *et al* (2010) [15] and Selvaraj and Naidu (2013) [20] also reported that the soils of Yerpedu and Renigunta mandals in Chittoor district, respectively were marginally suitable for growing rice. The pedons 1 and 3 are moderately suitable while the pedons 2, 4, 5, 6 and 7 are marginally suitable for growing cotton crop. Patil *et al* (2010) [21] and Garhwal *et al* (2013) [22] also reported that soils in Lendi watershed of Chandrapur district in Maharashtra and Sirohi district in Rajasthan, respectively were moderately suitable (S2) for growing cotton. The pedons 1, 2, 3, 5, 6 and 7 are marginally suitable and the pedon 4 is temporarily not suitable for chickpea crop. Garhwal *et al*., (2013) [22] also reported that soils of Sirohi district of Rajasthan were marginally suitable (S3) for chickpea. Pedons 5 and 7 are marginally suitable and pedons 1, 2, 3, 4 and 6 are temporarily not suitable for growing tobacco. The pedon 3 is highly suitable, pedons 1, 5, 6 and 7 are moderately suitable, pedon 2 is marginally suitable whereas the pedon 4 is temporarily not suitable for growing sorghum. Geetha Sireesha and Naidu (2013) [23] reported that the soils of Banaganapalle mandal in Kurnool district of Andhra Pradesh were marginally suitable for growing sorghum. Wetness (drainage), soil depth, organic carbon content and pH are limitation in all the pedons. Poor drainage can be improved by soil conservation measures, growing leguminous crops in rotation and application of organic manures. Shallow depth of soils can be improved by deepening of soil by ridging, deep ploughing / breaking up of soil crust or contour bunding and contour farming or adoption of very careful soil and water management practices. Organic carbon content in these soils can be improved by incorporation of crop residues or application of farm yard manure / compost / press mud or green manuring with legumes or inclusion of legumes in crop rotation. The pH can be reduced by application of organic manures and soil amendments like sulphur / press mud / spent wash. Texture is a limitation in pedons 1, 2, 5, 6 and 7. Heavy textured soils can be improved by cultivation with precautions against permanent damage like bunding / adoption of broad bed and furrow method of irrigation. Following agronomic measures like crop rotation / mixed cropping / growing leguminous crops in rotation or application of organic manures or organic mulches add organic matter to the soil which not only improve the drainage condition but also reduce runoff and erosion. CaCO3 content is also a limiting factor in all the pedons except pedons 5 and 7. High calcium carbonate content leads to greater fixation of P and Zn to limit crop production. Application of organic manures such as FYM or compost or vermicompost or green manuring with legumes reduces the P and Zn fixation by formation of organo-Zn and organo-P complexes. Further, the acids produced during decomposition of organic manures causes solubilisation of CaCO3 and decrease its content in the soil. Alkalinity is a limiting factor in pedon 4. Alkalinity (high ESP) in the soils can be reduced by addition of gypsum or green manuring with dhaincha which not only reduce the alkalinity problem but also increase nutrient availability. The crop suitability of soils in the central and eastern parts of Prakasam district ranged from highly suitable (S1) to permanently not suitable (N2) for the major crops viz., rice, cotton, chickpea, tobacco and sorghum. The limitations observed in these soils were physical characteristics like soil depth, wetness and texture, high CaCO3 content and fertility characteristics like high pH, low organic carbon content and alkalinity. Remedial measures were suggested to achieve potential productivity of these soils without deteriorating the soil quality and to sustain crop yields.

Pedons 14, 17 were classified taxonomically under Typic Haplustepts. Although they were grouped under same classification, they differed in their suitability to different crops. Pedon 14, 17 is classified as highly suitable (S1)for maize, chilly and redgram, moderately suitable (S2) for cotton and marginally suitable for rice owing to the well drained nature of the pedon and medium texture in the control section. Pedon 14 was highly suitable for cultivation of all the five crops in view of good drainage and clay loam texture and no other yield limiting constraints. Pedon 17 was marginally suitable (S3) for the rice, cotton and redgram due to well drained nature of the pedon and excessive Ca CO_3 is not suitable redgram. However, for chilly and maize the pedon was classified as moderately suitable (S2) and Highly suitable (S1), respectively. In case of pedon 15, the soils are marginally suitable for rice and cotton due to coarse texture of surface and medium texture of sub-surface horizons. For the redgram crop, these soils are highly suitable (S1) with very few limitations and for maize and chilly these soils are moderately suitable (S2) owing to higher proportion of coarse fragments and coarse texture of the soil.

Pedons 14,15 and17 were categorized as Vertic Haplustepts according to soil taxonomy. Pedons 14, 15 and17 were classified as highly suitable for all the five crops evaluated (except maize in case of pedons 15 and 17) owing to the good drainage conditions, finer texture of the soil, absence of coarse fragments, very low calcium carbonate, high CEC and high base saturation and no other soil related problems. The fine texture of these soils may cause some drainage problems for maize, especially during the seedling stages. Hence these soils were categorized as moderately suitable for maize (S2). Pedon 14 very high clay content which may cause drainage related problems of the ID crops evaluated in this study. Hence this pedon was classified as moderately suitable (S2)

for maize, cotton, chilly and redgram and as highly suitable for rice (S1). Similar suitability was suggested by Leelavathi *et al.* (2010b) [15], who reported that Typic Haplustepts were marginally suitable (S3) for growing rice crop in Yerpedu mandal of Chittoor district in Andhra Pradesh.

Though pedon13is aclassified under Typic Haplusterts, they differed in their suitability for different crops. Pedons1,3 werately suitable for cultivation of the all the five crops under evaluation. Despite absence of any other crop productivity related constraint, these soils were classified as S2 due to alkaline soil reaction, which may cause several nutrient deficiencies and also limit the availability of P and N.Owing to slightly higher ESP and alkaline soil reaction in the subsoil pedons 11 and 20 were classified as moderately suitable (S2) for maize and redgram and highly suitable (S2) for the rice, cotton crops due to their ability to relatively higher sodicity levels in the soils. Pedon 13 was also classified as marginally suitable for redgram and moderately suitable for rice, maize and cotton due to alkaline pH and higher ESP. Patil *et al.* (2010) [21] reported that Typic Haplusterts in Lendi watershed of Chandrapur district in Maharashtra were moderately suitable (S2) for growing cotton, pigeonpea and soybean.

Pedons 1,6 1,8 were taxonomically classified under Alfisols. However slight variations in soil colour differentiated these profiles into Haplustalfs and Rhodustalfs. Depth of the pedon, amount of clay, presence or absence of coarse fragments, and relative location of the pedon on the landscape were the major factors that determined the crop suitability. on of maize, chilly and redgram due to the good drainage and no other soil related constraints. However, the suitability for cotton and rice is Moderate (S2) due to the medium texture of the soil.

In case of profiles 16, is soil texture and medium sub-soil texture, made them classified as moderately suitable (S2) for maize, chilly and redgrams crops, But, due the textural and drainage related limitations these soils were classified as marginally suitable (S3) for rice and cotton.

Coarse texture, shallow depth, higher slopes resulting excessive drainage rendered the soils of pedon suitable for (N2) for rice and cotton and marginally suitable for maize and chilly. Soils of the pedon are moderately suitable (S2) for cultivation of redgram due to hardy nature of the crop Pedon, organic carbon content and pH.

Management practices suggested based on the constraints

- Heavy texture in soils caused low infiltrartion, poor drainage, leading to runoff and erosion. It can be improved by cultivation with precautions against permanent damage like bunding / adoption of broad bed and furrow method of irrigation. Following agronomic measures like crop rotation / mixed cropping / growing leguminous crops in rotation or application of organic manures or organic mulches add organic matter to the soil which not only improve the drainage condition but also reduce runoff and erosion. Similar observations were also made by Leelavathi *et al.* (2010b) [15] and Geetha Sireesha and Naidu (2013b) [23] in Yerpedu mandal of Chittoor district and Banaganapalle mandal of Kurnool district in Andhra Pradesh, respectively.
- Light textured soils which also had low water holding capacity, can be improved by addition of tank silt (pond mud) along with careful soil and water management practices like mulching or addition of bulky organic manures / green leaf manuring. Similar observations were made and recommendations were suggested by Selvaraj and Naidu (2012) [20] and Niranjana *et al.* (2013) [25] in Renigunta mandal and Pulivendula region of Andhra Pradesh, respectively.
- Shallow depth of soils can be improved by deepening of soil by ridging, deep ploughing / breaking up of soil crust or contour bunding and contour farming or adoption of very careful soil and water management practices. Similar observations and recommendations were earlier made by Geetha Sireesha and Naidu (2013b) [23] and Patil *et al.* (2013) [21] in Banaganapalle mandal of Kurnool district in Andhra Pradesh and in Osmanabad tehsil of Maharashtra, respectively.
- The organic carbon content in these soils can be improved by incorporation of crop residues or application of farm yard manure / compost / press mud or green manuring with legumes or inclusion of legumes in crop rotation. These measures along with judicious water and soil management reduce the adverse affects of high $CaCO_3$ content in soils. Rahate *et al.* (2014) [26] and Garhwal *et al.* (2013) [22] reported similar observations and recommendations in soils of Telangkhedi garden in Nagpur of Maharashtra and in Sirohi district of Rajasthan, respectively.
- The pH can be reduced by application of organic manures and soil amendments like sulphur / press mud / spent wash. Similar findings were noticed by Patil *et al.* (2010) [21] and Niranjana *et al.* (2013) [25] in Chandrapur district of Maharashtra and in Pulivendula region of Andhra Pradesh, respectively.
- Addition of gypsum and green manuring with dhaincha can reduce the alkalinity problem. Similar findings and recommendations were given by Likhar and Prasad (2011) [27] and Nasre *et al.* (2013) [28] in Nagpur district of Maharashtra and in Karanji watershed of Yavatmal district in Maharashtra, respectively.
- Soil test based fertilizer recommendation should be followed to avoid nutrient imbalance and to supply the right nutrients at right time.
- Judicious use of organic manures and biofertilizers in combination with inorganic fertilizers not only improves the supply of major nutrients but also increases the availability of micronutrients for better crop production in these soils.
- Micronutrients can be directly applied to soil or by foliar application for their better management. Soil application of $ZnSO_4$ @ 25 kg ha^{-1} once in two seasons and / or foiliar application of $ZnSO_4$ @ 0.2 per cent for 2-3 times in a week helps in alleviating zinc deficiency. Foliar application of $FeSO_4$ @ 2 per cent for 2-3 times in a week controls iron deficiency.
- The organic carbon in these soils can be improved by incorporation of crop residues or application of farm yard manure / compost / press mud or green manuring with legumes or inclusion of legumes in crop rotation.
- The pH can be reduced by application of organic manures and soil amendments like sulphur / press mud / spent wash thereby increasing the availability of nutrients.
- High calcium carbonate content leads to greater fixation of P and Zn to limit crop production. Application of organic manures such as FYM or compost or vermicompost or green manuring with legumes or application of P and micro-nutrients by mixing with organics reduces the P and Zn fixation by formation of organo-Zn and organo-P complexes. Further, the acids produced during decomposition of organic manures

causes solubilisation of $CaCO_3$ and decrease its content in the soil.

- Alkalinity (high ESP) in the soils can be reduced by addition of gypsum or green manuring with dhaincha not only reduces the alkalinity problem but also increases nutrient availability. Similar findings and recommendations were also reported by Likhar and Prasad (2011) [27], Kuchanwar and Gabhane (2012) [17], Meena *et al.* (2012) [18] and Niranjana *et al.* (2013) [25] in Nagpur district of Maharashtra, Ridhora watershed in Nagpur district of Maharashtra, Malwa plateau in Banswara district of Rajasthan and Pulivendula region of Andhra Pradesh, respectively.

Table 1: Site and soil characteristics of studied profiles for crop suitability classification (Weighted average)

Pedon No	Soil	Drainage	Physical characteristics (s)			$CaCO_3$ (%)	Soil fertility characteristics (f)					Salinity and alkalinity (n)	
			Texture	Coarse fragments Volume (%)	Soil depth (cm)		CEC [cmol (p+) kg^{-1} soil]	Sum of basic cations [cmol (p+) kg^{-1} soil]	BS (%)	pH (1:2.5)	OC (%)	ECE (dSm^{-1})	ESP (%)
13	TypicHaplusterts	Poorly drained	c	6.85	0-195	4.12	50.74	50.74	100	8.62	0.33	1.34	13.51
14	TypicHaplustepts	Moderately well drained	Sl	39.04	0-135	7.08	11.98	11.99	100	7.7	0.3	0.15	1.15
15	VerticHaplustepts	Moderately well drained	c	36.06	0-160	1.71	24.2	24.29	100	7.9	0.34	0.22	2.3
16	TypicRhodustalfs	Well drained	scl	25.45	0-112	--	13.8	8.85	63.34	7.02	0.47	0.61	1.16
17	TypicHaplustepts	Well drained	c	15.22	0-69	12.65	19.7	18.24	92.23	7.87	0.4	0.41	2.38
18	TypicRhodustalfs	Well drained	scl	17.95	0-110	-	13.35	8.77	64.54	6.52	0.53	0.09	2.11

Table 2: Depth wise Soil characteristics used for assessing crop suitability evaluation

Pedon No	Location	Horizons	Depth (cm)	Physical characteristics (s)% of < 2 mm soil			$CaCO_3$ (%)	Physico-Chemical characteristics				Salinity and alkalinity (n)	
				Texture				CEC [cmol (p+) kg^{-1} soil]	BS (%)	pH (1:2.5 H_2O)	OC (%)	EC (dSm^{-1})	ESP
				Sand	Silt	Clay							
13	Warangal	Ap	0-18	18.6	19.8	61.6	-	47.2	100	8.2	0.53	0.35	3.81
		Bw 1	18-42	23.4	21.7	54.9	-	44.8	100	8.5	0.42	0.55	4.69
		Bw 2	42-76	21.7	21.8	65.5	1.9	45.8	100	8.8	0.38	0.65	7.86
		Bss 1	176-105	27.8	19.5	52.7	3.9	40.8	100	8.9	0.26	1.15	11.03
		Bss 2	105-165	25.6	22.9	51.5	4.8	38.9	100	8.8	0.18	1.5	14.4
		Bss 3	165-195	30.9	19.7	49.4	5.8	39.4	100	8.7	0.15	1.65	18.02
14	Kothaguda	Ap	0-18	86.2	6	7.8	2.1	17.5	100	7.3	0.7	1.8	0
		Bw 1	18-46	64.9	9.7	25.4	4.9	15.4	100	7.5	0.35	1.5	0
		Bw 2	46-75	78.8	9.9	21.3	7.8	13.8	100	7.3	0.25	0.09	0
		BC 1	75-103	80.9	9.6	19.5	9.1	7.7	100	7.7	0.2	0.16	1.3
		BC 2	103-135	84.7	10.3	5	9.4	8	100	8.5	0.18	0.18	3.75
		Crk	135+	Weathered Parent Material									
15	Khanapur	Ap	0-18	39.9	22.8	37.3	1.1	24.1	100	7.8	0.72	0.21	3.32
		Bw1	18-36	40.7	19.7	39.6	1.8	23.8	100	7.9	0.48	0.25	2.94
		Bw2	36-68	39.8	21.9	38.3	2.1	22.9	100	7.7	0.32	0.23	2.62
		Bw3	68-97	38.7	19.8	41.5	2	24.5	100	7.6	0.36	0.19	2.04
		Bw4	97-130	39.8	18.9	41.3	1.5	25.9	100	8.1	0.3	0.21	1.93
		Bw5	130-160+	39.9	19.8	40.3	1.6	24.2	100	8.3	0.21	0.29	1.65
16	Narsampet	Ap	0-16	85.3	8.6	6.1	-	2.8	62.5	7.3	0.61	0.26	0
		AB	16-35	76	6.9	17.5	-	8.3	60.36	6.8	0.48	0.14	0
		Bt1	35-65	54.9	8.3	36.8	-	16.4	62.87	6.6	0.52	0.14	0.61
		Bt2	65-98	43.8	8.8	47.4	-	20.8	64.52	6.4	0.5	0.11	0.48
		BC	98-112	65.7	6.9	27.4	1.2	12.4	66.61	6.9	0.22	0.22	1.61
17	Chennaraopet	AP	0-16	58.9	10.7	30.4	9.8	17.5	85.71	7.9	0.55	0.44	1.71
		BW1	16-34	47.9	16.9	35.2	12.4	19.2	92.19	8	0.41	0.37	2.08
		BW2	34-69	44.9	15.9	39.2	14.1	21	95.24	7.8	0.32	0.42	2.86
		C	69+	Weathered Parent Material									
18	Mahabubabad	Ap	0-18	78.1	13.6	8.3	-	3.8	56.58	7.5	0.45	0.15	5.26
		Bt1	18-40	66	11.6	22.4	-	11.8	65.68	6.6	0.57	0.1	1.69
		Bt2	40-92	52.9	8.7	38.4	-	17.5	66.34	6.2	0.6	0.09	1.71
		BC	92-110	65.9	6.5	27.6	-	14.4	66.11	6.3	0.42	0.05	2.08

Table 3: Limitation levels of the land characteristics and land suitability classes for major crops.

Pedon No	Soil	Crop	Wetness (w) drainage	Physical soil characteristics (s)			$CaCO_3$ (%)	Soil fertility characteristics (f)				Alkalinity (n)	Actual land suitability sub-class	Potential land suitability sub-class
				Texture	Coarse fragments (Vol. %)	Soil depth (cm)		CEC	Sum of basic cations	pH 1:2.5	OC (%)	Esp		
13	Typic Haplusterts	Rice	0	0	0	0	0	0	0	2	0	0	S2f	S1
		Maize	2	1	0	0	0	0	0	2	0	2	S2wsfn	S1s
		Cotton	0	0	0	0	0	0	0	1	0	1	S1fn	S1
		Chillies	1	1	0	0	0	0	0	2	0	3	S2wsfn	S1s
		Redgram	1	0	0	0	0	0	0	2	0	3	S3wfn	S1s
14	Typic Haplustepts	Rice	1	1	0	0	0	1	0	0	0	0	S1wsf	S1s
		Maize	0	0	0	0	1	0	0	0	0	0	S1f	S1
		Cotton	0	1	0	0	0	1	0	0	0	0	S1sf	S1s
		Chillies	0	0	0	0	1	1	0	0	0	0	S1sf	S1
		Redgram	0	0	0	0	0	0	0	0	0	0	S1	S1
15	Vertic Haplustepts	Rice	0	0	0	0	0	0	0	0	0	0	S1	S1
		Maize	2	1	0	0	0	0	0	0	0	1	S2wsf	S1s
		Cotton	1	0	0	0	0	0	0	0	0	0	S1w	S1
		Chillies	1	0	0	0	0	0	0	0	0	0	S1w	S1
		Redgram	0	0	0	0	0	0	0	0	0	1	S1n	S1
16	Typic Rhodustalfs	Rice	1	3	3	0	0	3	0	0	1	0	S3sf	S2sf
		Maize	0	1	2	0	0	2	0	0	0	0	S2sf	S2s
		Cotton	1	2	2	0	0	3	0	0	0	0	S3wsf	S2s
		Chillies	1	1	1	0	0	2	0	0	0	0	S2wsf	S1f
		Redgram	0	1	0	0	0	2	0	0	0	0	S2sf	S1f
17	Typic Haplustepts	Rice	2	3	0	0	0	0	0	0	0	0	S3ws	S2ws
		Maize	1	1	0	0	2	0	0	0	0	0	S1ws	S1
		Cotton	2	3	0	0	2	0	0	0	0	0	S3ws	S2ws
		Chillies	1	2	0	0	2	0	0	0	0	0	S2wsf	S2s
		Redgram	1	1	0	0	3	0	0	0	0	0	S3ws	S2s
18	Typic Rhodustalfs	Rice	1	3	3	0	0	3	0	0	1	0	S3sf	S2sf
		Maize	0	1	2	0	0	2	0	0	0	0	S2sf	S2s
		Cotton	1	2	2	0	0	3	0	0	0	0	S3wsf	S2s
		Chillies	1	1	1	0	0	2	0	0	0	0	S2wsf	S1f
		Redgram	0	1	0	0	0	2	0	0	0	0	S2sf	S1f

Limitations: 0- No; 1- Slight; 2- Moderate; 3- Severe; 4- Very severe

Suitability classes: f- soil fertility limitations; s- Physical soil limitations; w- wetness limitations; n- Salinity (and /or alkalinity) limitations

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