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SOIL TYPES, SOIL FORMING ENVIRONMENT AND SOIL MANAGEMENT IN THE SEMI-ARID ZONE OF ANANTAPUR DISTRICT, ANDHRA PRADESH

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ABSTRACT: Soil is the Natural wealth to the farming community but it differs from place to place due to varied environmental conditions. Since the soil is the basic foundation of farming as well as the important constituent of eco-system, it is imperative to safeguard the soil resources, it is necessary to understand the soil forming environment of a region. This paper attempts to discuss the soil types, soil forming environment and soil conservation in the semi-arid tract of Anantapur district. The description of soils in the present study is made at 'taluk' level and the study is based on the field observation, the soil analysis data collected from the soil Testing Laboratory and Agricultural Research Station, Anantapur.

Edaphically, soil is defined as a natural body engendered from a variable mixture of broken and weathered minerals and decaying organic matter which covers the earth in a thin layer and which may supply, when containing the proper amounts of air and water, mechanical support and in part sustenance for plants (Lyon, 1949, p.4). From the genetic point of view, soils are the function of parent materials, relief soil biota, climate and time. Agriculture, which literally means, the cultivation of the field "epitomises the critical role of the soil in agriculture". Carefully husbanded and worked, soil is the asset that can be passed to countless generations almost intact forming the most precious and all important legacy.

STUDY AREA

Anantapur district is located in the south-western most part of the Andhra Pradesh. It is situated in the rainshadow region of the Western Ghats and it is one of the most driest parts in this country. Agriculture is the predominant economy of the region. But the frequent occurrence of drought, prolonged dry spells and crop failures have had a devastating effect on agricultural economy of the district.

TYPE AND DISTRIBUTION OF SOILS

The soils of the district are predominantly of the red and black types. It is estimated that red soils account for 82 per cent and black soils for 18 per cent of the total classified area.

With respect to the distribution of soils, the different areas in the district can be grouped in three natural divisions, viz., (i) Gooty, Tadipatri and Uravakonda zone in the north with large areas of black cotton soils, (2) Anantapur, Kalyandurg, Rayadurg, Dharmavaram, Kadiri and Penukonda zone in the centre with their arid treeless expanses of poor mostly red sandy and (3) Hindupur and Madakasira zone in the south with their comparatively fertile red loamy soils.

The soils in the southern part, continues to be red, but are superior to that found in the central taluks and have more cultivation and vegetation. The central parts which constitute the major area is made up of barren, undulating

wastes, clothed with thin grass and dotted with scattered scrub growth. Most of the soils are so poor that they can not withstand continuous cultivation and the land has to be left fallow for long periods.

THE SOIL FORMING ENVIRON - MENT IN ANANTAPUR DISTRICT

In any region, the properties of the soils is detemined by the soil-forming enviroment. Pedologists often compare soil with an organism. According to them, soil is a natural phenomenon with its own independent organisation, and is formed by the interaction of other natural elements. Modern pedologists express soil as a function of various factors as follows :

$S = f(c, v, o, p, r)\ t$

Where S = Soil,
C = Climate,
V = Vegetation,
O = Other organisms,
P = Parent material,
r = Relief and
t = Time.

For proper management of the soil-resources, it is necessary to understand the soil forming environment of a region.

PARENT MATERIAL

Most of the soils in the district are formed in situ from the regolith derived on weathering of the underlying rocks. Soils derived from the transported parent materials are confined only to narrow belts of low lying stream courses. The parent materials of the region are derived mostly from the old group and archaean rocks which cover about 85 per cent of the area and the younger group of precambrian sedimentary rocks. The older group of rocks include granites, granitic gneisses, phyllites and schists. Granites are mostly confined to the southern and south-western parts of the district. The Dharwar super group, mainly consisting of schists, extend north-south in a narrow band 2 to 10 km from Gooty in the north through Anantapur and Penukonda to Dharmavaram in the south. the rest of the area is mainly covered with gneissic rocks. The younger group of the rocks are entirely confined to the north-eastern part of the district. They comprise quartzites, limestones, dolomites and shales. Granites and gneisses are acidic rocks with the dominance of silicate minerals and on weathering give rise to red soils in semi-arid climates. Schists and dolomites are basic rocks with the dominance of dark coloured ferromagnesium minerals and along with shales give rise to black soils.

Climate : The district has a semi-arid to arid type of climate with a Thronthwaite's moisture index of -71.3. It receives very low rainfall (544 mm) which ranges from as low as 512 mm in north-western part (Rayadurg taluk) to 630 mm in the southern part (Kadiri taluk). The prevailing climate promotes fairly quick chemical weathering and decay of organic matter. The short rainy period also causes intensive normal erosion in the form of gullying and dry period witnesses wind erosion to some extent.

Relief: A major portion of the district is a pediplain ranging in elevation from 300 to 600 mts with hill ranges and hillocks of relatively low relief scattered all over especially in the eastern, southern and south-western parts of the district. The pediplain is characterised by gently stoping concave interstream areas, usually with rocky flat outcrops in the middle. Nearly 85 per cent of the area of the district has less than 2° of slope. This has led to the formation of a distinct relief associated soil catena in the order of clayey, loamy, sandy, and rock soils occurring in that order from valley flats to the interstream areas.

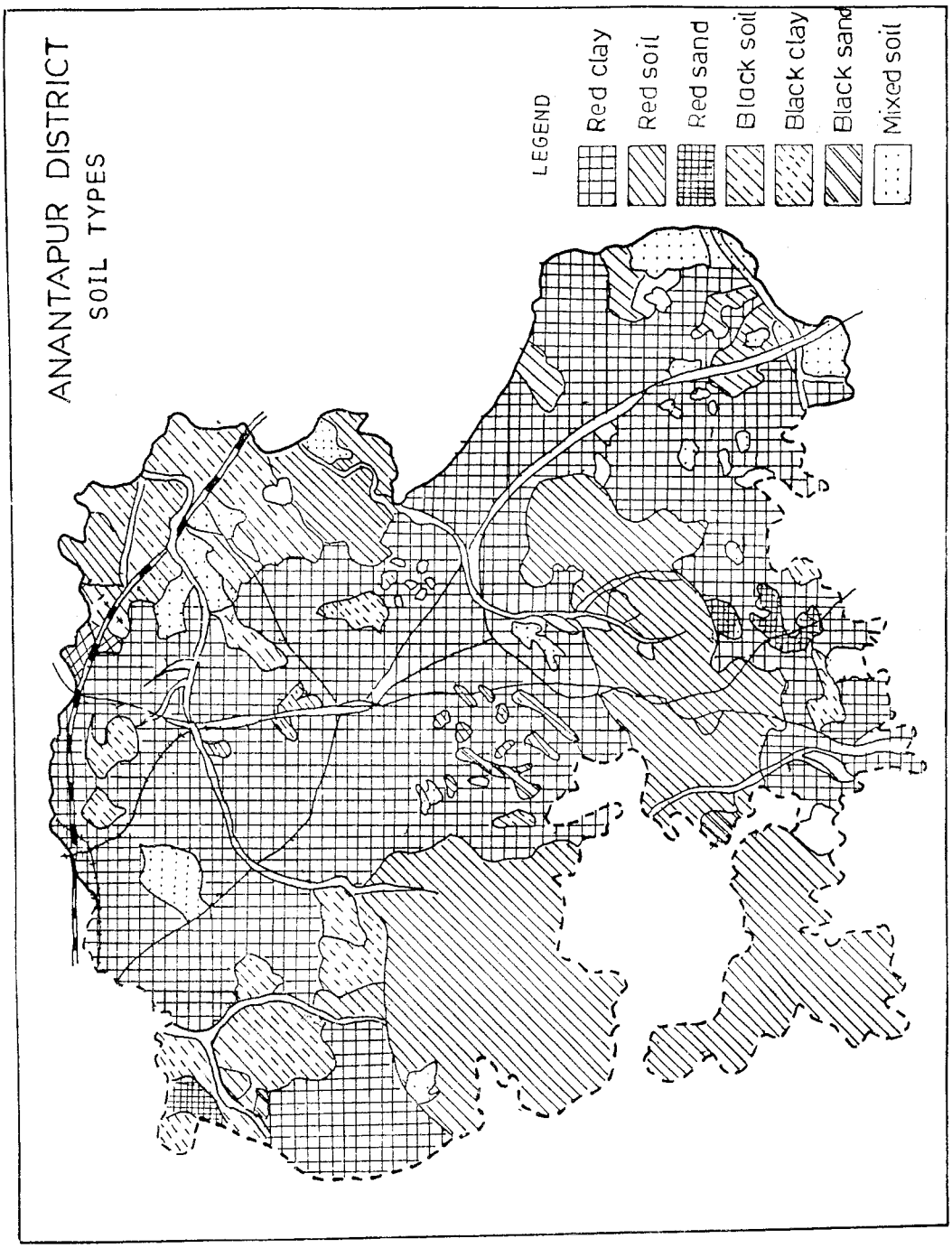

Fig. 1: Anantapur District - Soil Types

Vegetation : Vegetation is the main source of soil organic matter which is a vital soil ingredient controlling a host of activities in the soil and also properties. Most of the hill ranges are barren or have thin veneer of vegetative cover of shrubs and coarse grasses. Only in the southern region, the hilly areas have better vegetative cover.

Soil Biota : The population and activities of the soil biota is at the minimum in the upland tracts due to low moisture and organic matter required for their sustenance and multiplication.

Time : Most of the soils in the uplands show rocky soils or soils with (A) C-profiles or AC-profiles indicating lack of stability and time in their development. But most of the soils, in the low lying areas, show the standard ABC-profiles.

NUTRITIONAL STATUS OF THE SOILS

Though a host of elements are taken by plants as nutrients, yet three elements which are described as 'the big three' namely phosphorus, potassium and nitrogen are the most important. They play a crucial role in plant growth and plant productivity.

Phosphorus: The phosphorus content is generally low in the soils of the Anantapur district. Except in three taluks viz., Hinduper, Kadiri and Penukonda nearly 80 per cent of the soils in other taluks have low phosphorous content. Phosphorus rich soils are found in Penukonda (37 per cent in high category), Hindupur taluk (30 per cent in high category) and in Kadiri taluks (35 per cent in medium and high category). Phosphorus deficiency in the soils of this region is mainly due to the nature of parent materials namely igneous rocks which contain few phosphorus containing minerals.

Potassium : Hard igneous rocks such as granites and granite gneisses contain potassium. It is released in the form of soluble salts when the rock is weathered. It is found that the soils of Anantapur district are farily rich in potassium

Table 1 : Phosphorus, Potassium and Organic Matter content in the soils of Anantapur District

Taluk	Area in percentage of the total classified area								
	Phosphorus			Potassium			Organic matter		
	low 20 kg/ ha	medium 20-50 kg/ ha	high 50 kg/ ha	low 125 kg/ ha	medium 125-250 kg ha	high 250kg/ ha	low 0.5%	medium 1-2%	high 2%
Anantapur	75.5	14.0	10.5	20.0	65.0	15.0	89.0	8.5	2.5
Tadipatri	87.0	7.0	6.0	11.0	40.0	49.0	77.0	19.0	4.0
Gooty	75.0	11.0	13.0	12.0	72.0	16.0	79.0	13.0	8.0
Uravakonda	87.0	7.0	6.0	19.0	68.0	13.0	83.0	12.0	5.0
Dharmavaram	78.5	12.5	9.0	16.0	74.5	9.5	90.5	9.5	-
Kalyandurg	85.0	10.0	4.5	14.0	78.5	9.5	87.5	9.5	2.0
Rayadurg	92.0	2.5	5.5	9.0	74.5	16.5	83.0	8.0	9.0
Penukonda	55.0	8.0	37.0	7.0	59.0	34.0	86.0	13.0	1.0
Kadiri	67.5	18.5	14.0	13.0	64.0	20.0	68.0	29.5	2.5
Hindupur	59.0	11.0	30.0	46.0	51.0	3.0	8.0	14.0	4.0
Madakasira	85.0	12.0	3.0	33.0	64.0	3.0	91.0	4.0	5.0

content. In most of the taluks, 60 to 70 per cent of the soils contain moderate amounts of (125-250 Kg/hec.) potassium. Potassium content is fairly high in the two taluks viz., Tadiparti in which nearly 50 per cent of the soils are having high potassium content and in Penukonda in which nearly 35 per cent of the soils are having high potassium content. The two significant taluks with low content of potassium are Hindupur with 40 per cent of the soils falling in the low category and Madakasira with 33 per cent of the soils in the low category. The moderate to high potassium content of the soils is predictable as 85 per cent of the area is underlain by igneous rocks like granites and granitic gneisses which contain potassium in a significant quantity.

Organic Matter : The proportion of organic matter in the soils indirectly indicates nitrogen content. In almost all the taluks except Kadiri, nearly 80 to 90 per cent of the soils contain low organic matter. About 30 per cent of the soils in Kadiri contain medium amounts of organic matter. In general, red soils contain low organic matter. In a semi-arid region like Anantapur, where the forest cover is thin with about 10 per cent of the area, addition of organic matter to the soils is naturally very low.

AGRICULTURAL SUITABILITY OF THE SOILS

The soils with high acidity, alkalinity and salinity are not suitable for plant growth. Acidity and alkalinity are related to hydrogen-ion concentration and salinity is related to the proportion of the total soluble salts in the soils. In fact, there can be soils which are both saline as well as alkaline.

Hydrogen-Ion Concentration (pH) : Soil acidity depends upon theH ion concentration (pH) of the soil solution. In most of the semi-arid and arid regions the soils tend to be alkaline. In these regions, due to low rainfall and high temperatures, there is a tendency for the accumulation of soluble salts at the surface. Though the direct effect of the pH on the plant growth is small, it plays a vital role in agriculture by controlling the quantities of nutrient chemicals which are made available to the plant. The solubility and availability of many important nutrients are greatly influenced by the pH of the soil. In Anantapur district the soils are not affected by acidity except a mere 0.3 per cent of the soils in Hindupur taluk. Talukwise extent of normal soils varies from as low as 6.5 per cent in Tadipatri to as high as 83.0 per cent in Madakasira. In general about 20 to 50 per cent are normal soils and 30 to 80 per cent are weakly alkaline soils. The highest extent of alkaline soils is found in Gooty taluk where 28.0 per cent are alkaline. The alkalinity of the region is mainly due to the semi-arid climate that prevails in the region.

SALINITY OF THE SOILS

Table 2: pH in the soils of Anantpur District

Taluk	Percentage extent of soils in each category			
	Acidic 6.5	Normal 6.5-7.5	Weakly Alkaline 7.5-8.5	Alkaline 8.5
Anantapur	-	40.5	51.5	8.0
Tadipatri	-	6.5	88.0	5.5
Gooty	-	30.0	42.0	28.0
Uravakonda	-	22.0	77.0	1.0
Dharmavaram	-	28.5	64.5	7.0
Kalyandurg	-	58.0	39.0	3.0
Rayadurg	-	50.0	41.5	8.5
Penukonda	-	50.0	43.0	1.0
Kadiri	-	64.5	32.5	3.0
Hindupur	0.3	48.0	44.0	7.7
Madakasira	-	83.0	12.0	5.0

The excess of salts that the soils contain is termed as the salinity of the soils which are mostly chlorides, sulphates and carbonates of calcium, magnesium and sodium. Salinity of the soils is determined by electrical conductivity method and the E.C. is experssed in mmhos/cm (milli mhos). Virtually the entire district has normal soils. In most of the taluks 95 to 97 per cent of the soils are normal. The only taluk where significant salinity problems are encountered, is in Uravakonda where 20.0 per cent of the soils are slightly saline and 4.0 per cent are saline and injurious to crops. The other taluks are Rayadurg and Hindupur where about 10 per cent of the soils are slightly saline. Salinity problem is encountered mainly in canal irrigated areas, near the water bodies like tanks and along large river courses where ground water table is at shallow depth.

PROBLEM OF SOIL EROSION IN ANANTAPUR DISTRICT

The general aridity of the region, sparse vegetation cover, the ever-increasing population pressure on land and forest areas and livestock pressure on grazing areas have lead to severe soil erosion in this region. The soil forming sytem of a semi-arid region with high temperatures, low rainfall, an year round water deficiency and the resultant sparse vegetation are least suited for the development of a fertile soil. More over a slight interference of man in this system in the form of removing the already sparse vegetation cover aggravates the problem at the rapid rate. These areas are affected both by wind and fluvial erosion. Though the average annual rainfall is low, it comes, sometimes, as cloud-bursts and causes severe soil erosion. The all important fine soil is depleted both by the wind and normal erosion process.

At present, some soil conservation schemes are under implementation both in black soil zone and red soil zone. The Agricultural Research Station, at Rekulakunta near Anantapur town, is experimenting and demonstrating both engineering and agronomic measures for controlling soil erosion and reclamation of erosion affected areas. What is needed is implementation of these measures in combination.

Soil Management : The soil management programme in semiarid region should be comprehensive and integrated one encompassing three different objectives-namely, (i) improvement of the soil forming environment and thereby fertility of the soil, (ii) improvement of the suitability of the soil with proper measures to prevent soil alkalinity and salinity and also reclamation of soils already affected, and (iii) prevention of soil erosion and reclamation of erosion-affected areas.

In the soil conservation programmes, stress should be laid on extension programmes for creating awareness in the farming community about the dangers of continued soil erosion and motivating them for implementation of the soil conservation measures. The soil conservation measures consisting of agronomic and engineering measures should be implemented in complementary manner to achieve better results. Agronomic practices of soil and water conservation help to reduce the splash effect on soil, promote better intake of water rate by the soil by improving the content of the organic matter and soil structure, help to retard and reduce the overland runoff through the use of contour cultivation, ploughing against the slope, mulches, dense growing crops, strip cropping, mixed cropping and crop rotation.

Mechanical measures play a vital role in

controlling erosion. These measures include basin-listing, subsoiling, contour bunding, graded bunding and bench terracing on steep slopes.

Rising rows of trees along the bunds act as windbreaks; thus reducing severity of wind erosion. They also help to add organic matter to the soil.

The soil forming environment could be improved by management of the stream catchments at microlevel. Construction of check-dams on small catchments serves as a multipurpose scheme in this direction. The stored water is useful for short term irrigation, groundwater replenishment and improving the vegetative cover. The dams act as silt traps which can be respread over the catchment thus restoring the fine material to the soil. This scheme should be implemented in the piedmont areas of the district where sheet and gully erosion is most severe.

The alkalinity and salinity problems of the soils have to be solved with suitable measures like gypsum application and leaching of the excessive salts with suitable dosage of irrigation respectively.

Evaluation of quality of irrigation water and the suitability of the soil for heavy irrigation is to be done to prevent adverse effects like salinity and alkalinity problems in the soils.

Proper care should also be taken to minimise water seepage from the irrigation canals which will lead to the problems of salinity and alkalinity in the semi-arid areas. What is needed is an integrated approach for management of soil and water resources.

CONCLUSION

The district is covered with red soils over 82 per cent of the area and black soils over the rest of the area. The black soils are comparatively more fertile and better suited for cultivation in this drought-district. The soil-forming environment of the region with its low rainfall, high temperatures, sparse vegetation and the undulating relief promoting soil erosion, is not congenial for development of good fertile soils. The soils of the region are generally poor in phosphorus and organic matter content but contains moderate amounts of potash. Most of the soils are neutral or weakly alkaline and only a few small pockets are having severe salinity or alkaline problems. But if the soils are not properly manged, the soils are prone to become saline as well as alkaline in some micro-environments. The conditions in the region are causing both wind and river erosion of the soil and suitable integrated engineering and agronomic measures are to be implemented to prevent the soil erosion to reclaim the erosion affected areas and to improve the soil conditions.

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