Original Research Article

Production Potential Appraisal: A Case Study in Jammalamadugu-Proddutur Tract of Pennar River Basin in YSR Kadapa District, Andhra Pradesh, India

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ABSTRACT

Eleven typical pedons representing major landforms in semiarid ecosystems of Jammalamadugu - Proddutur tract of Pennar river basin in YSR Kadapa district *viz.,* summits, backslopes and foot slopes developed from lower Gandikota formation with Quartzite (conglomerate, quartzite and rippled siltstone) and upper Tadipatri formation with purple shale, (siltstone and carbonate complex) under varying land uses were evaluated for actual and potential productivity. The actual productivity of P1 (21.54) and P2 (20.41) situated on summits was average and the potential productivity was good. Similarly, the actual productivity of P3 to P11 located on back slopes and foot slopes was poor and the potential productivity was good. However, actual and potential productivity are increased from summits to foot slopes. The coefficient of improvement ranged from (Ci) from 1.78 (Pedons1 and2) to 4.57 (Pedons 3, 7, 8, 10 and 11). The study revealed that, implementation of judicious soil management practices such as application of green manure/ FYM/crop residues/, contour farming and contour bunding and mixing of soil with tank silt helps not only to achieve sustainable yields but also sustains the soil productivity.

Introduction

Soil is a critical natural resource and maintaining soils in the state of high productivity on sustainable basis needs periodical evaluation. The knowledge of soils with respect to their extent, distribution, characteristics and potential use is important for optimizing land use. Nature provides soil and climate for farming but fertility of soil differs from place to place for which availability of nutritional elements is responsible. Soil fertility specialists need well characterized sites with similar soil and other ecological conditions in order to carry out meaningful fertilizer trails.

Indiscriminate use of finite soil resources coupled with lack of proper management has led to degradation echoing the concern of

planners, researchers and farmers (Sharma, 2006). Management of finite soil resources in agro –ecological regions is highly essential for not only to increase the yields of different crops but also to sustain soil productivity. Jammalamadugu – Proddutur tract of Pennar river basin in YSR Kadapa district falls under semiarid agro- ecological region having variety of soils. Evaluation of soils for different land uses is the first milestone to develop sustainable and eco-friendly land use models. Though sporadic information is available for the soils of Pulivendula region in Kadapa district (Niranjana *et al*., 2011), but no information is available especially on soil potential productivity pertaining to Jammalamadugu – Proddutur tract of Kadapa district in Andhra Pradesh. Evaluation of soils for potential productivity plays a pivotal role not only to sustain soil fertility but alsoto improve soil productivity. Hence, present study was taken up to study the Jammalamadugu – Proddutur of tract of Pennar river basin in YSR Kadapa district in Andhra Pradesh.

Materials and Methods

The study area liesin between14^o 45' and 14^o53' North latitudes and 78^o21' to 78^o36' East longitudes (Fig. 1 and 2) at an elevation of ranging from 160-330m (msl) The area qualified for semi – arid monsoonic climate with a distinct summer, winter and rainy seasons with a mean annual rainfall of 943 mm (2011-2020). The mean annual temperature is 25.9^oCwith a mean annual summer temperature of 28.01^oC and mean annual winter temperature of 23.3^oC. The maximum temperature for the last 10 years is 42.6^oC, recorded in the month of May whereas the minimum temperature is 12^oC, noticed in the month of December. The study area qualifies for ustic soil moisture regime and as iso-hyperthermic soil temperature regime. The natural vegetation in the study area comprises of *Azadirachta indica,*

Parthenium hysterophorus, Cynodon dactylon, Calotropis gigantia, Acacia nilotica, Tephrosia perpurea, Amaranthus viridis, Cypurus rotundus, Pongamia pinneta, etc.

Field survey

A reconnaissance soil survey was conducted in Jammalamadugu – Proddutur tract of Pennar river basin in YSR Kadapa district using toposheet of 1:50,000 scale as per the procedure outlined by AIS & LUS (1970). After traversing the area, based on the visual observations and based on the variations in soil site characteristics (Table 1), twenty sites were selected by following the procedure outlined by soil survey division staff (2000). Soil correlation exercise yielded eleven typical pedons *i.e.*, four pedons in summits, four pedons in back slopes and three in foots slopes in the study area. Horizon-wise soil samples were collected forlaboratory analysis. Processed soil samples (< 2 mm) were analyzed for various physic- chemical properties such as organic carbon, texture and cation exchange capacity by adopting standard analytical procedures (Bower *et al.,* 1952; Jackson 1973; Piper, 1966). The soils were classified up to the sub-groups levels by following USDA soil taxonomy (Soil Survey Staff 2014).

The Riquier's parametric approach (1970) suggests nine factors for the calculation of productivity index, *viz.*, P – productivity index, H - soil moisture content, D - drainage, P -effective soil depth, T - texture/structure, N - base saturation, S - soluble salts, O - organic matter, A – mineral exchange capacity and M – mineral reserves.

P = H X D X P X T X N/S X O X A X M (1)

Each factor is rated on a scale from 0 to 100, the actual percentage being multiplied by each other. The resultant index of productivity

also lying between 0 and 100 is set against a scale placing the soil in one or other of five productivity classes. After employing all the possible improvement factors, the potential productivity rating was worked out by assigning different grades. The coefficient of improvement (Ci) was worked out based on the actual productivity and potential productivity ratings.

Coefficient of improvement (Ci) = Potential productivity rating/Actual productivity rating

Results and Discussion

Actual and potential productivity

In the present study, actual and potential productivity of soils / pedons are determined by following parametric approach of Riquier et al (1970), who suggested that productivity index for evaluating soils for the commonly growing crops of the area. Accordingly, the productivity index for soils under the study was calculated by considering nine factors which were related to soil productivity.

Table.1 Landscape characteristics of Pedons

Pedons / Villages	Location	Elevation above MSL (m)	Physio-graphy	Slope (%)	Drainage
P1 Kottala	N 14^0 $45^{'}$ $55.1^{"}$ E 078^0 $21^{'}$ $51.6^{"}$	330	Summits	5-10	Well drained
P2 Mallambhavi	N 14° $46^{'}$ $53.1^{"}$ E 078^0 $22^{'}$ $41.1^{"}$	260	Summits	5-10	Well drained
P3 Kondapuram	N 14^0 $48^{'}$ $47.1^{"}$ E 078^0 $22^{'}$ $38.8^{"}$	200	Backslope	3-5	Somewhat poorly drained
P4 Kanneluru	N 14^0 $50^{'}$ $37.8^{"}$ E 078^0 $24^{'}$ $29.9^{"}$	188	Backslope	1-3	Somewhat poorly drained
P5 Seshareddipalli	N 14° $50^{'}$ $30.1^{"}$ E 078° $36^{'}$ $25.1^{"}$	183	Footslope	3-5	Somewhat poorly drained
P6 Peddapasupula	N 14^0 $53^{'}$ $07.9^{"}$ E 078^0 $26^{'}$ $50.6^{"}$	174	Footslope	1-3	Somewhat poorly drained
P7 Sumanchipalli	N 14^0 $53^{'}$ 07.9 E 078^0 $26^{'}$ $50.6^{"}$	230	Summits	0-1	Somewhat poorly drained
P8 Chinnadandluru	N 14^0 $46^{'}$ $26.3^{"}$ E 078^0 $28^{'}$ $52.1^{"}$	200	Summits	0-1	Somewhat poorly drained
P9 Chouduru	N 14^0 $46^{'}$ $55.5^{"}$ E 078^0 $32^{'}$ $48.4^{"}$	180	Backslope	1-3	Somewhat poorly drained
P10 Kakirenipalle	N 14^0 $47^{'}$ 16.6 E 078^0 $28^{'}$ $51.0^{"}$	175	Backslope	1-3	Somewhat poorly drained
P11 Pottipadu	**N 14^0 $49^{'}$ $17.5^{"}$ E 078^0 $32^{'}$ $12.7^{"}$**	**160**	**Footslope**	**1-3**	**Somewhat poorly drained**

Table.2 Actual productivity index and Actual productivity class of Jammalamadugu –Proddutur tract of Pennar river basin in YSRKadapa district

| 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	Actual productivity class
1	H4b(90)	D4(100)	P3(50)	T6b(90)	N5(100)	S3(80)	O1(70)	A2(95)	M2c(100)	21.54	Average
2	H4b(90)	D4(100)	P3(50)	T6b(90)	N5(100)	S3(80)	O1(70)	A1(90)	M2c(100)	20.41	Average
3	H4b(90)	D3b(80)	P5(100)	T5b(80)	N5(100)	S5(25)	O1(70)	A1(90)	M2c(100)	9.072	Poor
4	H4b(90)	D3b(80)	P5(100)	T6a(80)	N5(100)	S4(40)	O1(70)	A2(95)	M2c(100)	15.32	Poor
5	H4b(90)	D3b(80)	P5(100)	T6b(90)	N5(100)	S5(25)	O1(70)	A3(100)	M2c(100)	11.34	Poor
6	H4b(90)	D3b(80)	P5(100)	T6b(90)	N5(100)	S4(40)	O1(70)	A3(100)	M2c(100)	18.14	Poor
7	H4b(90)	D3b(80)	P5(100)	T6b(90)	N5(100)	S5(25)	O1(70)	A3(100)	M2c(100)	11.34	Poor
8	H4b(90)	D3b(80)	P5(100)	T5b(80)	N5(100)	S5(25)	O1(70)	A1(90)	M2c(100)	9.072	Poor
9	H4b(90)	D3b(80)	P5(100)	T6b(90)	N5(100)	S4(40)	O1(70)	A2(95)	M2c(100)	17.24	Poor
10	H4b(90)	D3b(80)	P5(100)	T6b(90)	N5(100)	S5(25)	O1(70)	A3(100)	M2c(100)	11.34	Poor
11	H4b(90)	D3b(80)	P5(100)	T6b(90)	N5(100)	S5(25)	O1(70)	A3(100)	M2c(100)	11.34	Poor

Table.3 Potential productivity index and Potential productivity class of Jammalamadugu –Prodduturtract of Pennar river basin in YSRK Adapa district

| 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	Potential productivity class
1	H4b(90)	D4(100)	P3(50)	T6b(90)	N5(100)	S1(100)	O4(100)	A2(95)	M2c(100)	38.46	Good
2	H4b(90)	D4(100)	P3(50)	T6b(90)	N5(100)	S1(100)	O4(100)	A1(90)	M2c(100)	36.45	Good
3	H4b(90)	D3b(80)	P5(100)	T5b(80)	N5(100)	S1(100)	O2(80)	A1(90)	M2c(100)	41.47	Good
4	H4b(90)	D3b(80)	P5(100)	T6a(80)	N5(100)	S1(100)	O2(80)	A2(95)	M2c(100)	43.77	Good
5	H4b(90)	D3b(80)	P5(100)	T6b(90)	N5(100)	S1(100)	O2(80)	A3(100)	M2c(100)	51.84	Good
6	H4b(90)	D3b(80)	P5(100)	T6b(90)	N5(100)	S1(100)	O2(80)	A3(100)	M2c(100)	51.84	Good
7	H4b(90)	D3b(80)	P5(100)	T6b(90)	N5(100)	S1(100)	O2(80)	A3(100)	M2c(100)	51.84	Good
8	H4b(90)	D3b(80)	P5(100)	T5b(80)	N5(100)	S1(100)	O2(80)	A1(90)	M2c(100)	41.47	Good
9	H4b(90)	D3b(80)	P5(100)	T6b(90)	N5(100)	S1(100)	O2(80)	A2(95)	M2c(100)	49.25	Good
10	H4b(90)	D3b(80)	P5(100)	T6b(90)	N5(100)	S1(100)	O2(80)	A3(100)	M2c(100)	51.84	Good
11	H4b(90)	D3b(80)	P5(100)	T6b(90)	N5(100)	S1(100)	O2(80)	A3(100)	M2c(100)	51.84	Good

Table.4 Soil productivity index and capability classes

Pedon No	Actual productivity(P)		Potential Productivity(P')		Crop improvement factor(Ci)
	Rating	Classes	Rating	Classes	
1	21.54	Average	38.46	Good	1.78
2	20.41	Average	36.45	Good	1.78
3	9.072	Poor	41.47	Good	4.57
4	15.32	Poor	43.77	Good	2.86
5	11.34	Poor	51.84	Good	4.57
6	18.14	Poor	51.84	Good	2.86
7	11.34	Poor	51.84	Good	4.57
8	9.072	Poor	41.47	Good	4.57
9	17.24	Poor	49.25	Good	2.86
10	11.34	Poor	51.84	Good	4.57
11	11.34	Poor	51.84	Good	4.57

Fig.1 Landscape diagrams of Gandikota formation in Jammalamadugu – Proddutur tract of Pennarriver basin in YSR Kadapa district

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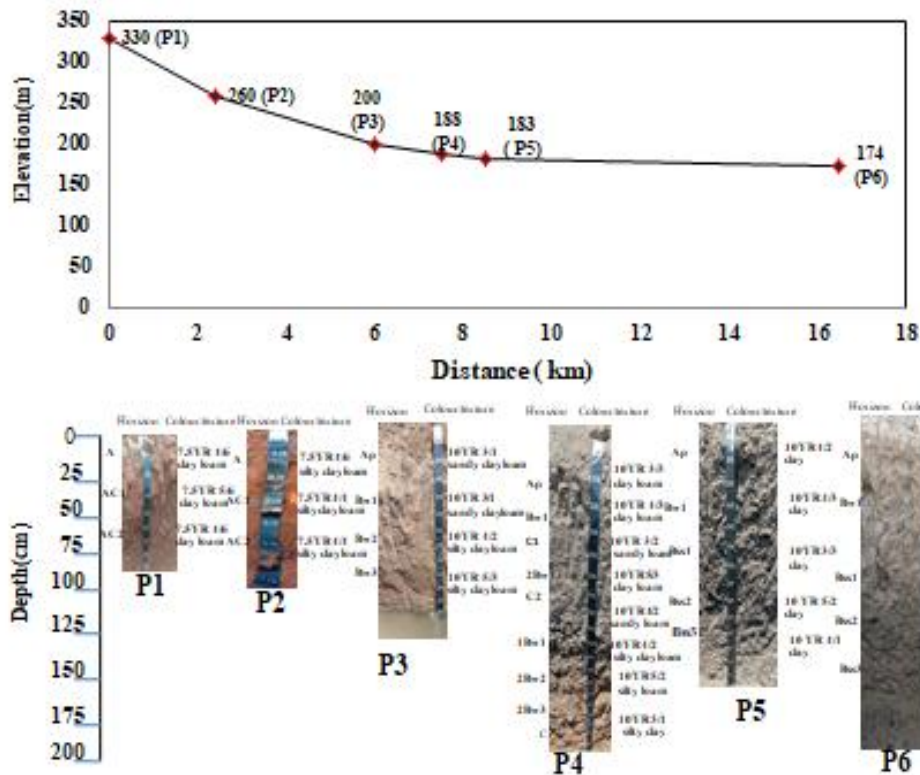
Fig.2 Land scape diagrams of Tadipatriformation in Jammalamadugu – Proddutur tract of Pennar river basin in YSR Kadapa district
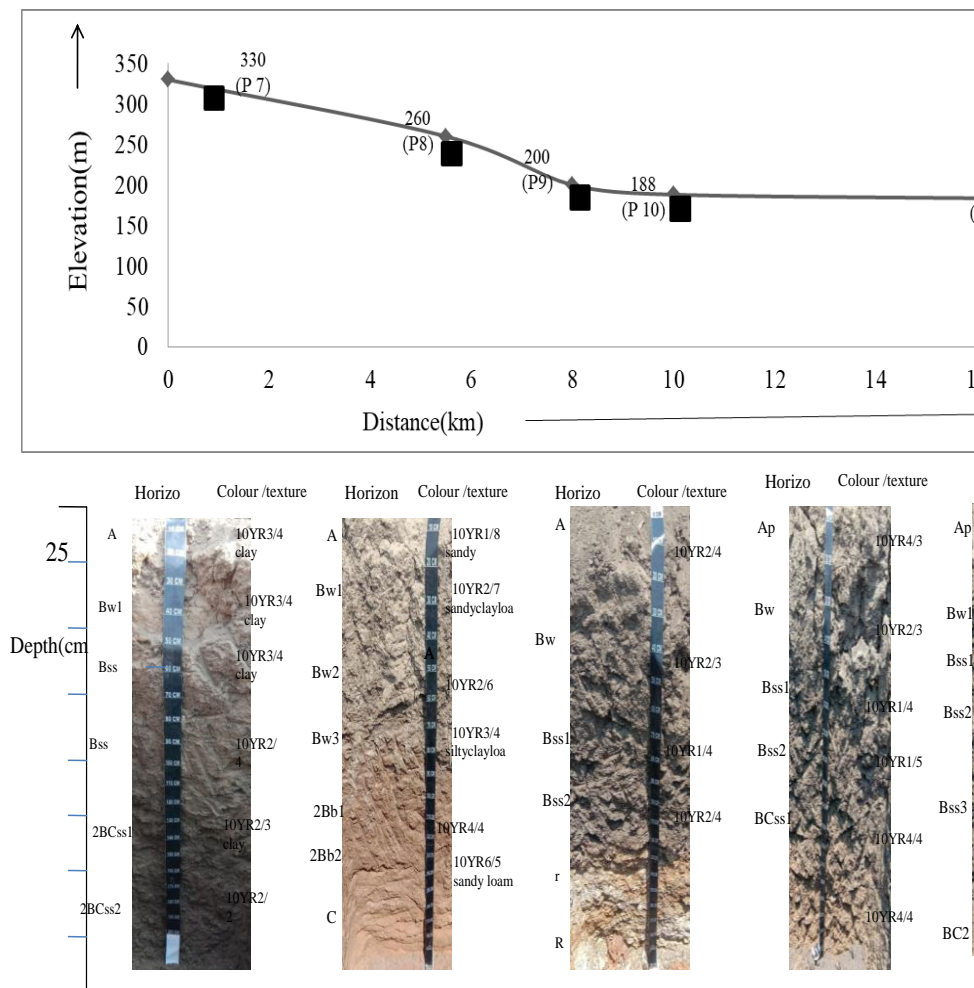
The actual productivity of the studied soils/ pedons varied from 9.07 to 21.54 whereas potential productivity varied between 36.45 and 51.84 (Tables 2 and 3). The lowest potential productivity was observed in pedon 2 (36.45) while the highest potential productivity was observed in pedons6, 7, 10 and 11 (51.84). In general the potential productivity of most of the pedons was categorized under the good productivity class. Quantitatively, the coefficient of improvement in the present study ranged from 1.78 to 4.57. Based on the Riquier's parametric approach, the soils of Jammalamadugu – Proddutur tract of Pennar river basin in YSR Kadapa district had one category *i.e*. good (Table 4).

The actual productivity of pedons 1 (21.54) and 2 (20.41) was average whereas the actual productivity of pedons 3 to 11was poor. The main constraints attributed for average productivity of pedons 1 and 2 are low organic carbon, slope, shallow depth and erosion. The low organic carbon can be improved by application of FYM /compost, adopting green manuring and incorporation of crop residues (Shireesha *et al*., 2020).

Furthermore, practice of contour farming or contour bunding to restrict the erosion hazards and deepening the soil by ridging and deep ploughing in shallow soils can be taken up. Therefore, it is also suggested to take up alternate crops like vegetables, pulses, oil seeds and ground nut crops which suits better for shallow soils with loamy sand structure in pedons having poor or average productivity (Gangopadhyay *et al.,* 2012). By adopting above management practices the potential productivity of the pedons 1 and 2 can be upgraded from average to good.

Similarly, the actual productivity of pedons 3 to 11was poor. The main constraints attributed for poor productivity of pedons 3 to 11 are slope, low organic carbon, shallow depth, erosion, drainage and texture. The low organic carbon, erosion and shallow depth improved by adopting the above management practices. However, texture and drainage in pedons 3 to 11 can be improved by mixing of soil with tank (Girish *et al.,* 2010.) Due to adoption of above management practices the potential productivity of the pedons 3 to 11 can be upgraded from poor to good.

In conclusion, the actual productivity can be upgraded from average to good (P1 and P2) and poor to good (P3 to P11) by adopting improved management practices such as application of compost/ FYM or adopting green manuring, incorporation of crop residues, trash mulching and vertical mulching with filter cake, mixing of soil with tank silt and contour bunding and contour farming.

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