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Climate and Land Resource Appraisal for Robusta Banana (*Musa acuminate*) Suitability in Pulivendala Tehsil of YSR Kadapa District, Andhra Pradesh

Bhaskar B.P.[1], Sunil Maske[2], Ramesh Kumar S.C.[3], Ramamurty V.[4], Srinivas S.[5], Rajendrahegde[6]

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Abstract

The land suitability evaluation for banana production (Musa acuminate) and its irrigation management in drought prone Pulivendula tehsil (133315 hectares) of Cuddapah district requires systematic land resource information to apply FAO-SYS guidelines to analyze and generate maps under Geographical information system. The climate is semiarid with length of growing period of 95 to 135 days and aridity index of 11.29 to 14.25. The angot pluvimetric analysis shows that August to October receives high intensity rainfall (>20mm) with probability more than 50 per cent. A soil resource inventory on 1:25000 scale using IRS-P6-LISS-IV satellite imagery was carried out to derive soil map having 43 soil mapping units. The soil map shows that 69 per cent of area is non-gravelly with deep, moderately well drained, moderately to strongly calcareous alkaline clay soils occurring on nearly flat to very gently sloping lands. The land suitability map shows that fifty one thousand hectares of land is moderately suitable for banana with limitations of subsoil gravelliness, rooting depth and texture under erratic rainfall pattern. The irrigability analysis for drip irrigation shows that 38.33 per cent of area (56091ha) is suitable with high soil erosion risk that needs construction of bench terraces with rock bunding.

Keywords: Aridity Index; Angot Pluvimetric Analysis; Land Evaluation; Soil Map; Banana; Drip Irrigation, Soil Erosion Risk.

Author's Affiliation: [1,3-6]No Scientists Grade, [2]Senior Scientist, ICAR-National Bureau of Soil Survey & Land Use Planning, Bangalore 560024, India.

Corresponding Author: B.P. Bhaskar, No Scientists Grade, ICAR-National Bureau of Soil Survey & Land Use Planning, Bangalore 560024, India.

E-mail: bhaskar_phaneendra@yahoo.co.in

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INTRODUCTION

Banana is a major crop in Y.S.R. Kadapa district growing in 16371 ha with productivity of 65 metric tons/hectare (t/ha) during 2016-17 (Mehazabeen and Srinivasan, 2019). The regional productivity trends are matching with the reports of Sys et al. (1993) with productivity of 30 to 35 Mg ha^{-1} yr^{-1} under rainfed but not enough for small areas with specific characteristics (Ronja Herzberg et al., 2019) and off 40 to 60 Mg ha^{-1} yr^{-1}, under irrigated conditions. It was reported that banana generally grows well in well drained, neutral to slightly alkaline with coarse gravel content less than 10% and soil depth more than 125 cm (Raj kishore Kumar et al., 2017). The climatic parameters suitable for optimal banana growth includes: temperature of 26-300C, rainfall of 1200 to 1500mm (Djaenudin et al., 2003), and a wind speed less than 20 kmph (Naidu et al., 2006). However, banana is a water sensitive plant that demands adequate amounts of water in all stages of its growth and development (FAO, 2012). Changes to rainfall distribution and temperatures may affect the suitability of certain regions for banana production and cause a decrease in yields.

The experimental land evaluation studies were carried out for banana in Way Kambas East Lampung, Indonesia under drip and sprinkler systems of irrigation (Ansyori et al., 2010, Ranjitkar, et al., 2016). He reported that the yield is almost doubled under drip (45.86 Mgha-^{1} yr-^{1}) over sprinkler system. In another study, banana development in hills based on the land conservation was proposed to construct bench terrace in Jenawi District, Indonesia (Pusponegoro et al., 2018). The appraisal of climate and land resources studies for banana suitability in semiarid tracts of south India is scanty. Hence, the present study aims at evaluating land resource data base for banana suitability in pulivendula tehsil of Kadapa district was selected to provide more productive, profitable and sustainable options in the region.

MATERIALS AND METHODS

Details of Study area

Pulivendula lies between 14°16′to 14°44′ N and 77°56′ to 78°31′E covering 1,46,235 hectares in YSR Kadapa district. The study area comes under hot arid eco-region (K6E2) with a length of growing period of 60 to 90 days (Mandal, et al., 1999). The area has Papaghni and Chitravati group of rocks of Cuddapah Super Group of rocks (Basu et al., 2009).

Methodology of study

The outline of methodology applied in land evaluation exercise for banana cultivation is presented in Fig.1. In the first stage, the climate data of monthly rainfall, maximum, minimum and mean temperature of Kadapa district for the period of 1901 to 2002 was obtained from Indian Water Portal.org. of IMD data (Indian Meteorological Department) to workout aridity index of De Martonne (1926) and Angot index (Dragot˘a et al., 2008). In the second step, the semi detailed soil survey was initiated with visual interpretation of P6-LISS-IV imagery on 1:25,000 scale as per the guidelines of Soil Survey Division Staff (2017). The morphological properties of 330 soil profiles were recorded (Schoeneberger et al., 2012) and classified as per keys to soil taxonomy (Soil Survey Staff, 2014). Twenty five soil series were defined and used for setting series class limits (Reddy et al. , 2006).

In the third step, the twenty five soil series were collected and horizon wise soil samples were used for determination of particle size distribution, pH in 1:2.5soil water, Organic carbon by wet digestion, CaCO3 content (acid neutralization method), distillation of ammonium for CEC and bulk density (clod method) as per procedures described in Dewis and Freitas (1970). In fourth step, the soil map with 43 units were used for land evaluation for banana (Table 1) and parametric approach for irrigation suitability in GIS environment (Arc info. version 10.3, Sys et al., 1991, 1993). The land requirements for banana were used to determine suitability classes as given under.

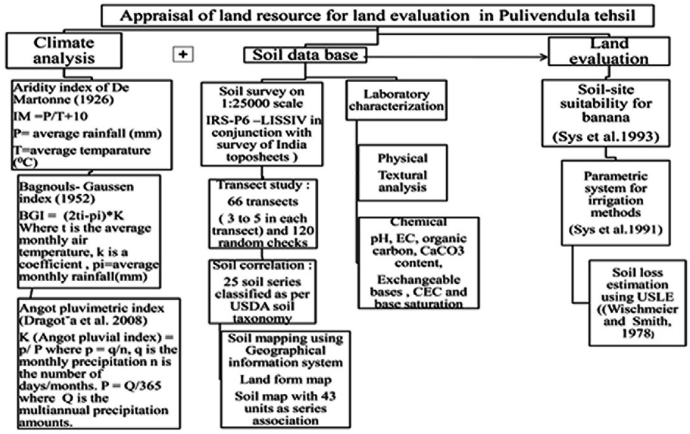

Fig. 1: Flow chart of methodology used in land evaluation for banana

Table 1: Criteria for land suitability evaluation for Banana

Land Climate suitability	Suitability Class			
	S1	S2	S3	N1
Climatic parameters				
Altitude (meters above mean sea level)	<1200	1200-1500	1500-2000	>2000
Rainfall (mm/year)	1500-2500	1250-1500	1000-1250	<1000
Period of dry month (month)	0-3	3-4	4-6	>6
Slope (%)	<8	8-16	16-40	>40
Soil Parameters				
Total N (%)	>0.4	0.1-0.4	0.05-0.1	<0.05
Olsen's P (mg/kg)	>20	15-20	8-15	<8
Exchangeable K (cmol/kg)	>0.8	0.4-0.8	0.1-0.4	<0.1
pH	6.0-7.5	5.5-6.0&7.5-8.0	5.0-5.5&8.0-8.5	<5.0 &>8.5
Depth to mottling (cm)	>110	85-110	60-85	<60
Ground water table (cm)	>150	125-150	100-125	<100
Bulk density (Mgm3)	<1.31	1.31-1.47	>1.47	
Permeability (cm/h)	>7.9	7.9 - 5.00	<5.0	
Clay CEC	>12.4	8.9-12.4	<8.93	

Land evaluation for irrigation was made as per the parametric method (Sys et al., 1991) with multiplication of soil series rating with its proportion of area (AAFRD, 2004). The capability index for irrigation (Ci) was calculated according to the formulae:

$$Ci = A * B/100 * C/100 * D/100 * E/100 * F/100$$

Where: Ci: capability index for irrigation; A: rating of soil texture; B: rating of soil depth; C: rating of $CaCO_3$ content, D: salinity/alkalinity rating; E: drainage rating and F: slope rating. The capability classes are defined with capability index (CI) as Excellent (CI >80 with symbol, S1), Suitable (S2-CI of 80-60), Slightly suitable (S3-CI of 45-60), almost unsuitable (N1-CI of 30-45) and unsuitable (N2-CI less than 30).

Finally, USLE equation with five factor combinations was used to compute soil loss for each soil unit as: $A=R\times K\times LS\times C\times P$ where A is the computed as spatial average of soil loss (t ha^{-1} y^{-1}); R is the rainfall-runoff erosivity factor (MJ mm ha^{-1} h^{-1} y^{-1}); K is the soil erodability factor (t ha h ha^{-1} MJ^{-1} mm^{-1}); LS is the slope length steepness factor (dimensionless); C is the cover management factor (dimensionless, ranging between 0 and 1.5); and P is the erosion control (conservation support) practices factor (dimensionless, ranging between 0 and 1) (Wischmeier and Smith, 1978).

RESULTS AND DISCUSSION

Climate analysis

We initially defined "cultivable areas by month, setting criteria of minimum monthly rainfall of 100 mm and minimum temperature of 21°C based on commercial banana requirements of 1200 to 1500 mm, dry months of 4 to 6 and 250C to 300C optimal air temperature over the entire growing period (Wayan Nuarsa, 2018; Ranjitkar, et al., 2016). The summation of mean monthly aridity (De Martonne Aridity Index) for the period of 1901 to 2002 is 18.43 indicating semi arid conditions with mean annual rainfall of 679.59 ± 237.52 mm, of which the kharif rainfall contributes 340.69 mm (50.28% of total rainfall) and mean air temperature of 30.7°C to 36.9°C. The De Martonne Aridity Index (Im) below 15 (Table 3) is reported for monthly decadal data sets for June to September to define climate as semiarid but needs to be irrigated under seasonal droughts. On the basis of angot pluvial index basis, the upper threshold (20 mm) is restricted to the August (mean of 1.69) September (mean of 2.79)/October (mean 2.16) and cause high erosive potential with a probability of occurrence more than 50% (Dragot˘a, 2006). Over 109 years of monthly rainfall data was used to compute the angot index and worked out the wet dry spells. It is estimated that January, February and March are very dry, whereas 98 very dry spells occur in April, 67 in May and 64 in June with equally dry spells of 37 in June/July. The normal rainfall in July/August is 25 times but of 17 wet seasons in August and 20 in September. More than 50% of probability in case of September and 43% in October.

Table 2: Mean, Standard deviation(SD) and coefficient of variation (CV, %) of Demortonne index, BGI and Angot pluvial index for period of 1901 to 2009.

Descriptive statistics	January	February	March	April	May	June	July	August	September	October	November	December	Sum
							De Martonne index						
Mean± SD	0.02± 0.03	0.08± 0.16	0.16± 0.25	0.57± 0.61	1.44± 1.13	1.27± 0.61	1.90± 0.85	2.51± 1.37	4.31± 2	3.52± 1.81	2.10± 1.56	0.53± 0.6	18.43± 3.68
CV(%)	133.06	189.93	152.4	107.76	78.39	48.1	44.92	54.58	46.44	51.25	74.06	112.2	19.97
							Angot pluvial index						
Mean ± SD	0.01± 1.39	0.06± 0.13	0.12± 0.19	0.41± 0.45	1.02± 0.73	0.91± 0.46	1.25± 0.54	1.61± 0.8	2.79± 1.12	2.16± 1.02	1.31± 0.94	0.30± 0.33	11.96± 0.05
CV(%)	139.41	209.66	157.58	109.62	71.85	49.96	43.25	50.06	39.93	47.41	72.26	109.95	0.4

Soil characteristics

These soils are grouped into five depth classes of Soil Survey Division Staff (2017) as: very shallow soils (less than 25cm) include three series viz., P1, P2 and P17; shallow (25-50cm) include:-P3, P4, P5, P6, P19, moderately deep soils (50-100cm) include: P7, P8, P12, P13, P14 and remaining soils are deep to very deep (>150 cm, Table 3). These soils are grouped into eight textural classes viz., sandy clay loam, clay, gravelly clay loam, gravelly sandy clay loam, clay loam, sandy loam, gravelly clay and sandy clay. The textural grouping clearly indicates the dominance of clay soils (>50 per cent) in the region. The mean clay for A horizons is 39.64±14.25% with a range of 12.7% in P18 to 60.2% in P21 (Table 3). The sand content more than 60 per cent is recorded in P10, P11 and P15 with a mean silt of 17.6±7.17 per cent. The mean pH is 7.68 ± 0.68 with coefficient of variation of 7.99 per cent in soils on quartzite (P1 to P5) but 8.01 ± 0.2 with coefficient of variation (cv) of 2.47 per cent in soils over shale. The strong alkalinity (pH 8.5) is attributed to the weak buffering of CaCO3 dissolution that could help to stabilise flocculation and subsequent occlusion within aggregates (Rowley, et al., 2020). The Pulivendula soil (P21) has extremely low organic carbon of 2.6gkg-^{1} but is more than 10gkg-1 was recorded in P8, P13 and P19 with mean of 7.26 ± 3.13gkg-^{1}. These soils have calcium carbonate (CaCO3) content of 10g/kg in P1 to 160 g kg-^{1} in P12 but showed more CaCO3 with mean of 87.62 ± 46.57g/kg in soils on shale as against the soils on quartzite (mean of 20 ± 10gkg-^{1}). The high pH (>9.0) in B horizons have strong positive and significant at 1% level correlate with CaCO3 (r = 0.52**) and exchangeable sodium (r= 0.39* table value of 0.37 df of 45). The organic carbon has a mean of 13.58 ± 4.24 gkg-^{1} to categorize as medium to high status (Pam Hazelton and Brain Murphy, 2016). Only 20 per cent of soils have organic carbon above 10g kg-^{1}. The organic carbon shows negative correlation with pH (r = - 0.55**, p = 0.01 level, table value of 0.48) and exchangeable sodium (r = 0.38*, p =0.05 level, table value of 0.38). The cation exchange capacity (CEC) of soils is low in P11 (7.2 cmol (+) kg-^{1}) to very high in P8 (54.5 cmol(+)kg-^{1}). The mean CEC is 23.93 ± 7.64 cmol(+)kg-^{1} in soils on quartzite as against the soils on shale with mean CEC of 30.52 ± 13.12 cmol(+)kg-^{1}. The data shows that seventy two per cent of soils have high (48%) to very high CEC (24%) and confine to gently sloping areas with high clay content (Landon, 1991). It is estimated that the mean calcium carbonate content in B horizons is 88.94 ± 44.64% with cv of 50.19%. It is further worked out that the per cent increase of CaCO3 in B horizons with respect to A horizons is 18% whereas clay is 46 per cent. The relative increase of CaCO3 in relation to clay in B horizons is computed as every 1 per cent increase in clays leads to 0.38 per cent of calcium carbonate content in the soils indicating poor leaching environment in the region. In general, these soils have per cent base saturation more than 100 and have ESP (exchangeable sodium per cent) less than 15% except in P9, P20 and P21. The one way ANOVA analysis shows that there is a significant difference between the horizons for sand, clay, organic carbon and CEC at p <0.01 where as pH, EC and ESP at p < 0.05 level (Table 3). These soils have mean bulk density of 1.27±0.9 with cv of 7.05 indicating below the critical values (1.63g/cm^{3}, Amusan, et al., 2006). The estimated K values for soils of Pulivendula tehsil vary from 0.15 ± 0.03 t ha hr / haMJ^{-1} mm^{-1} (14 soil series not susceptible to water erosion: K < 0.20, 0.25 ± 0.023t ha hr / ha MJ^{-1} mm^{-1} for 10 soil series with weakly susceptible to water erosion: K = 0.20 – 0.30 and

0.33 t hahr/ haMJ^{-1} mm^{-1} for Santakovur series (SVK) with medium susceptible to water erosion (K = 0.30–0.40, Uddin, et al. , 2016).

Land suitability analysis for banana

The agriculture land suitability evaluation is to predict the potential and limitation of the land for crop production (Pan and Pan, 2012) and also used for alternative kinds of agriculture (He, et al., 2011). The process of land suitability classes is based on the assessment of soil site characteristics along with climate analysis (Sonneveld, et al., 2010). The agro climatic assessment of banana shows that climate is marginally suitable with mean annual rainfall of 679.59 ± 237.52 mm and mean air temperature of 30.7^{0}C to 36.9^{0}C with dry months more than 5 months (March to May). The aridity index is 18.43 indicating semi arid conditions wherein kharif rainfall contributes 340.69 mm (50.28% of total rainfall). However, banana requires 1,000 to1,500mm rainfall (Sailesh Ranjitkar, et al., 2016), but grown as cash promising crop in substantially lower seasonality precipitation of Kadapa basin under drip irrigation. The suitable areas required for banana are flat areas and slopes of less than 12 degree.

The suitability of 43 soil mapping units for banana are evaluated using the criteria of Sys, et al (1993). Based on Table 4, soil mapping units (SMU) 1 to 8 in hills and ridges (54812ha, 42.62% of total area) are not suitable for banana cultivation having strong association with rock outcrops. This unit consists of shallow gravelly soils (Kanampalle, Ganganapalle, Rachanakuntapalle, Mupendranapalle and Lingala series) with limitation of low water holding capacity, poor organic carbon, root restricting layers below 50 cm and low available K/Zn. These units are potentially unsuitable but respond well to inputs use and conservation measures to upgrade to S3. The interhill basin covers 45255 ha (35.19% of total area) with 20 soil mapping units. Among 20 SMUs, only 8 SMUs (viz., 12,18,21,23,24,25,26, and 28) are moderately suitable but needs careful management of organic carbon and covers 14.13 per cent of area in interhill basin (18174 ha) while 7 SMUs (22688ha,17.65% of area), viz., 11,13,14,17,19, 20 and 27) are marginally suitable with limitation of sub soil calcium carbonate, low organic carbon, strong alkalinity, coarse fragments and low available K and DTPA-Zn. The soil depth more than 100 cm is ideal for banana cultivation but feeder roots confined to 45 cm only (Shanmugavelu, et al., 1992). Fifteen soil mapping units (SMU 29 to 43) on colluvio-alluvial plains (28542ha, 22.19%) have very deep, moderately well drained, calcareous, strongly to moderately alkaline black soils with high shrink swell potentials. Only five SMUs (32, 38, 40, 41 and 43) are marginally suitable for banana with limitations of coarse texture, coarse fragments, calcium carbonate, exchangeable Na/K and drainage (Table 4). As a whole, it is estimated that 56091ha (38.33 per cent of area) is suitable for banana and spatially distributed from north west to south east all along the canal net work (Fig. 2). The results from land evaluation for drip irrigation shows that among 13 units of marginally suitable for banana are evaluated 9 SMUs as highly suitable (34502 ha) whereas 8 SMUs (13882ha) of moderately suitable. The results of soil erosion estimations using USLE showed that the soil erosion risk zones are arranged in ascending order as: high - medium (39142ha, 31.16%) > high (276696ha, 22.05%) > medium (23378ha, 18.6%) > extremely high (16364ha, 13.03%) > low-medium (12025ha, 9.57%) > very high (7007ha, 5.58%, Table 3).

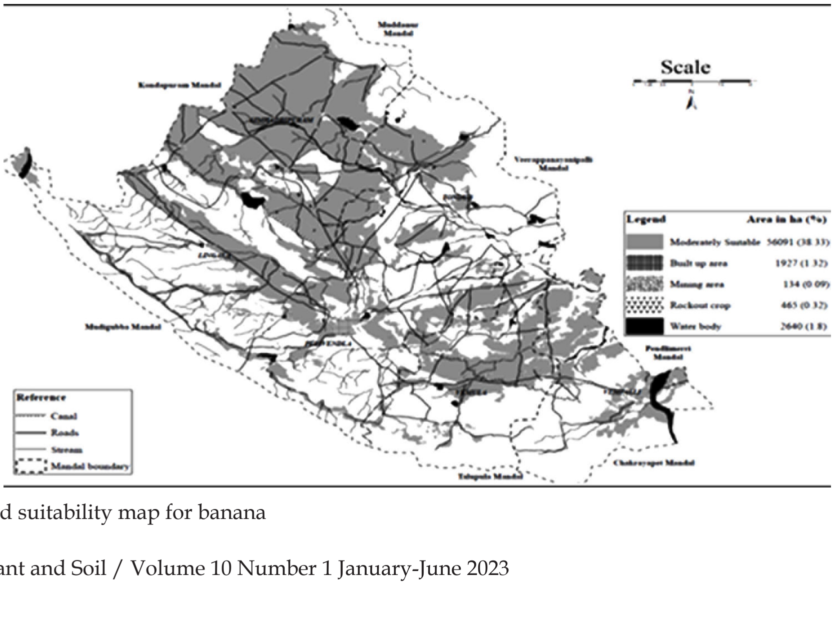

Fig. 2: Land suitability map for banana

Table 3. Textural and chemical properties of major soil series of Pulivendula tehsil

Soil series	Particle size distribution (%)			pH	EC (dSm-1)	Organic carbon	CaCO3	CEC cmol/kg	ESP	Depth (cm)	Bulk density	Erodability index (K)
	Sand	silt	clay			g/kg					Mgm^{-3}	
Kanampalli (Kpl)	72.1	4.3	23.6	8.3	0.14	16.3	10	12.9	0.16	21	1.37	0.16
Ganganapalle (Ggp)	32.1	20.5	47.4	7.1	0.23	17.7	30	30.5	0.39	15	1.17	0.19
Lingala (Lgl)	44.4	23.8	31.8	8.1	0.22	11.9	20	26.6	0.15	47	1.24	0.28
Rachakuntapalle (Rkp)	57.3	18.3	24.4	7.2	0.16	8.4	-	25.7	0.16	40	1.33	0.27
Mupendrana-palle (Mpl)	29.5	29	41.5	8.4	0.38	10.7	40	29.1	0.76	40	1.18	0.23
Tallapalle (TlP)	40.9	19.6	39.5	7.9	0.19	9.7	70	28.3	1.13	40	1.25	0.25
Santhakovur (Skv)	48.8	18.7	32.5	7.9	0.29	9.2	150	21.7	2.76	62	1.29	0.33
Tatireddipalle (Trp)	14.9	27.8	57.3	7.7	0.22	11.2	40	54.5	0.26	55	1.12	0.16
Cherlapalle (Cpl)	32.5	21.2	46.3	8.1	0.34	6.2	110	33.2	23.64	105	1.23	0.17
Kottalu (Ktl)	74.9	10.3	14.8	7.9	0.16	3.6	20	7.6	1.97	142	1.44	0.21
Murarichintala (Mct)	71.1	14.2	14.7	8	0.25	4.7	10	7.2	0.14	155	1.41	0.27
Vemula (Vml)	32.8	24.9	42.3	8	0.2	7	160	30.1	1.79	72	1.22	0.22
Sunkesula (Skl)	50.1	15.4	34.5	8	0.3	11.1	40	28	1.61	70	1.29	0.18
Simhadripuram (Spm)	23.2	21.5	55.3	8	0.25	8.4	140	42.7	6.46	92	1.18	0.15
Velpula(Vpl)	60.7	13.5	25.8	7.9	0.14	3.3	50	13	2.31	138	1.38	0.25
Agraharam (Ahm)	23.6	18.2	58.2	8.3	0.21	9.3	110	44.2	2.22	120	1.19	0.1
Balapanur (Bpr)	23	24	53	8	0.41	5.7	100	37.4	11.04	14	1.19	0.16
Parnapalle (Prp)	78.4	8.9	12.7	7.8	0.31	5	20	10.3	4.95	150	1.45	0.26
Gondipalle (Gpl)	29.5	19.4	51.1	7.9	0.21	14.7	150	35.8	0.87	44	1.18	0.16
Goturu (Gtr)	42	13.9	40	8.2	0.47	8.4	90	36.9	15.77	70	1.29	0.19
Pulivendula (Pvd)	38.6	1.2	60.2	8.5	1.47	2.6	110	24.2	67.89	135	1.32	0.1
Pernapadu (Ppd)	33.4	19.3	47.3	8	0.19	6.3	130	45	0.33	103	1.24	0.24
Agadur (Agd)	32.6	19.8	47.6	7.8	0.19	5.4	100	42.6	0.45	145	1.24	0.13
Tondur (Tdr)	29.8	22.3	47.9	8.1	0.25	5.8	100	41.9	4.6	152	1.22	0.14
Bhadrampalle (Bpl)	45	5.9	49.1	7.9	0.33	4.1	100	27.3	8.78	150	1.32	0.14

A horizon

table cont....

Mean ±SD	42.5± 17.7	17.6± 7.1	39.6± 14.2	8.4± 0.5	0.30± 0.26	8.36± 4	74.00± 51.8	29.3± 12.5	4.92± 17.9	87.08± 48.81	1.27± 0.09	0.2± 0.06
CV%	41.6	40.7	35.9	6	86.5	48.5	70.1	42.7	363.9	56.05	7.05	30.48
B horizon												
Mean ±SD	22.14	19.61	58	8.76	1.05	4.8	88.94	44.19	24.4 ±102.4			
CV%	50.18	33.29	15.5	5.07	141.4	56.72	50.19	26.98	419.5			
F value (Between the horizons)	27.44**	0.77	36.75**	5.49*	5.31*	18.89**	0.93	31.03**	6.05			
p	0.01	-	0.01	0.05	0.05	0.01	-	0.01	0.05			

Table 4: Area and extent of soil-land form associations with soil loss estimations

Land form	Soil mapping unit	Area		Soil loss (t/ha/year) / soil erosion risk	Banana		Drip	
		ha (hectares)	Percent (%)		Rating	Suitability class	Rating	Suitability class
Hills and ridges	Rockoutcrops (R)-Kanampalli(Kpl)	7953	6.18	25.11/high	3.34	N2	17.96	N2
	Rockoutcrops®--Ganganapalle (Ggp)	7464	5.8	57.94/high	9.65	N2	21.6	N2
	Rockoutcrops®-Rachanakuntapalle (Rkp)	24939	19.39	9.91/high-medium	3.72	N2	24.3	N2
	Rockoutcrops®--Lingala(Lgl)	6410	4.98	102.80/ extremely high	4.26	N2	25.52	N2
	Rachanakuntapalle (Rkp) – rockoutcrops®	1333	1.04	8.93/high medium	4.12	N2	53.2	N2
	Ganganapalle (Ggp) -Rockoutcrops®	677	0.53	57.94/ extremely high	16.4	N2	33.25	N2
	Rockoutcrops® -Mupendranpalle (Mpl)	3572	2.78	8.6/high medium	15.6	N2	29.93	N2
	Mupendranpalle (Mpl) -Rockoutcrops®	2464	1.92	8.56/ high medium	11.32	N2	76.95	S1
Interhill basin	Tallalapalle (Tlp)	1829	1.42	8.97/ high medium	14.21	N2	90.25	S1
	Murarichintla (Mct)	1934	1.5	8.90/ high medium	15.83	N2	85.5	S1
	Tatireddipalle (Trp)	788	0.61	1.33/low medium	49.42	S3	95	S2
	Kottalu (Ktl)	372	0.29	3.46/ medium	69.04	S2	68.4	S1
	Santhakovur (Skv)	548	0.43	11.84/high	41.42	S3	72.2	S1
	Mur-arichintala (Mct) -Tallapalle (TlP)	508	0.39	8.92/ high medium	43.73	S3	95	S3
	Cherlapalle (Cpl)	184	0.14	5.27/ high medium	19.81	N1	85.5	S1
	Balapanur (Bpr)	6559	5.1	24.23/very high	41.18	S3	95	S1
	Simhadripuram (Spm)	7583	5.9	1.82/low-medium	43.73	S3	90.25	S1

	Simhadripuram (Spm)-Agraharam (Ahm)	9125	7.1	2.68/ medium	61.29	S3	67.5	S1
	Balapanur (Bpr) Sunkesula (Skl)	4294	3.34	3.65/ medium	52.89	S3	56.53	S1
	Vemula (Vml)	1667	1.3	7.65/ high medium	40	S3	85.5	S2
	Velpula (Vpl)	1326	1.03	4.12/ medium	68.64	S2	85.74	S1
	Parnapalle (Prp)	446	0.35	1.36/low-medium	30.78	N1	90.25	S2
	Agraharam (Ahm)	2690	2.09	3.59/ medium	76.71	S2	90.25	S1
	Sunkesula (Skl)	2778	2.16	2.97/ medium	64.6	S2	90.25	S2
	Agraharam (Ahm)-Sunkesula (Skl)	802	0.62	3.61/ medium	71.87	S2	80.75	S2
	Agraharam (Ahm)-Simhadripuram (Spm)	369	0.29	2.78/ medium	66.82	S2	17.96	s1
	Sunkesula (Skl)-Simhadripuram (Spm)	741	0.58	2.65/ medium	58.34	S3	21.6	S2
	Velpula (Vpl)-Vemula (Vml)	712	0.55	5.36/high medium	61.16	S2	24.3	S2
Colluvial-alluvial pediplains	Bhadrampalle (Bpl)-Agadur (Agd)	788	0.61	19.34/high	29.84	N1	25.52	S2
	Tondut (Tdr)-Pernapadu (Ppd)	1351	1.05	85.36/ extremely high	31.12	N1	53.2	S1
	Tondur (Tdr)	3568	2.77	102.80/ extremely high	29.07	N1	33.25	S1
	Agadur (Agd)	633	0.49	1.86/low -medium	48.45	S3	29.93	S1
	Pernapadu (Ppd)-Gondipalle (Gpl)	853	0.66	5.68/high -medium	29.17	N1	76.95	S2
	Tondur (Tdr)-Agadur (Agd)	709	0.55	90.56/ extremely high	34.88	N1	90.25	S1
	Pulivendula (Pvd)-Pernapadu (Ppd)	101	0.08	15.32/high	23.27	N2	85.5	S1
	Goturu (Gtr)-Gondipalle (Gpl)	1501	1.17	2.75/low-medium	33.8	N1	95	S1
	Pernapadu (Ppd)	3689	2.87	17.31/high	34.2	N1	68.4	S1
	Pernapadu (Ppd)-Tondur (Tdr)	4358	3.39	85.36/ extremely high	32.15	N1	72.2	S1
	Gondipalle (Gpl)	1683	1.31	3.10/ medium	22.72	N1	95	S3
	Goturu (Gtr)	1707	1.33	1.33/low-medium	41.18	S3	85.5	S1
	Agadur (Agd)-Pernapadu (Ppd)	3613	2.81	15.36/high	42.75	S3	95	S1
	Bhadrampalle (Bpl)-	448	0.35	24.23/very high	17.44	N2	90.25	S1
	Pulivendula (Pvd)	3540	2.75	17.31/high	15.99	N2	67.5	S1
	Total	128609	100				56.53	

CONCLUSION

The problem of selecting suitable land for banana cultivation is a long standing and empirical in climatically sensitive and drought prone area of Pulivendula tehsil of YSR Kadapa district. In the present study, land evaluation for banana under drip irrigation was made with the use of long term climate data and utilization of land resources data base simply by matching the geoenvironmental properties with land use requirements. The results from suitability analysis shows that 56091ha of land in interhill basins and colluvio-alluvial deposits is evaluated as suitable (S2 and S3) for banana cultivation as against the current area of 22000ha. Further the study shows that 34502ha of suitable land for banana is evaluated as highly suitable for drip irrigation system with an extremely high erosion risk area of 16364 ha. The suitable land conservation directives like construction of field bunds, bench terraces with rocks and planting of vetiver grass on the bunds and edges of the terrace to stabilize the structures. In terms of banana production, the regional research is critical for developing and testing the appropriate management methods for farmers to cope with the effects of climate change. More broadly, data availability for banana research must be significantly improved, which necessitates, among other things, more collaboration between pedoecological groups, agricultural and climatic sciences. More research must be conducted to investigate the impact of abiotic pressures and potential adaptation alternatives for banana production. More research must be conducted to investigate the impact of abiotic pressures and potential adaptation alternatives for banana production. Furthermore, the research can aid in the improvement and adaption of land use policy to better allow climate change adaptation. Policy makers an also help by enacting measures that promote consumer acceptance of banana types. Finally, a regional research framework should be promoted in order to facilitate mutual interaction as well as common data collecting and analysis. The current study is a first attempt to build such a regional research framework on climate change and banana production. However, the challenges ahead remain enormous, necessitating cooperation and teamwork among all stakeholders engaged and at all levels to ensure that banana production can prosper in the future.

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