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Economic Evaluation of Some Soils of Arid Regions of Anantapur District for Groundnut Cultivation

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Abstract: The present study was carried out in Bukkarayasamudhrum mandal of Anantapur district of Andhra Pradesh to assess the economic viability of different soil units for supporting groundnut crop. Advanced remote sensing and GIS technologies were used to map the soil resources at phase level. The non-parametric approach revealed that 57.6 % of the area is moderately suitable for groundnut cultivation and 21 % of area is marginally suitable due to limitation of rooting depth and heavy soil texture. Economic land evaluation results showed that non-calcareous, moderately deep soils with loamy sand surface texture gives comparatively higher benefit cost ratio than other soils.

Key words: *Soil series, groundnut, land suitability classes, economic evaluation, remote sensing.*

Introduction

Worldwide, there are changes in soil properties and decline in soil quality due to contamination of inorganic and organic chemicals (Arshad and Martin 2002). At the same time, the major challenge is to increase yield to meet the demands for food without compromising the environment. Soil survey is the most common procedure for mapping soil resources which divides the area into parcels of land or mapping units. Maps generated during soil survey not only help in understanding soil genesis and development and also provide information on suitability of soil resources for variety of crops (Dharumarajan and Singh 2014).

Groundnut (*Arachis hypogea* L.), is a major legume oilseed crop grown in India and accounts for 45 per cent of the total area and 55 per cent of the total production of oilseeds in the country (Madhusudhana 2013). Groundnut is traditionally cultivated as rainfed crop mainly by marginal and small farmers. In India, groundnut yield varies from 550 to 1100 kg per ha with the total production of 4.3 to 9.6 million tonnes in different years and contributes about 19 % to world groundnut production. Though groundnut is grown on soils varying from black cotton soils to gravelly red soils, generally loose and friable soils are good for pod development. Preferably, sandy and loamy soils are good for groundnut cultivation (Naidu *et al*. 2006). Waterlogging, poor drainage, sodicity and acidity are major soil constraints for its economic cultivation.

Anantapur, located in Rayalaseema region of Andhra Pradesh is the leading producer of groundnut in India and this region contributes around 3 % to total production of the country. Though this region is agro-ecologically marginally suitable for rainfed groundnut production, the farmers continue to adopt groundnut-based cropping system (Virmani and Shurpali 1999).

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Hence continuous poor performance of groundnut production over the years caused distress among the farmers community. The major causes for poor performance are erratic rainfall, low soil fertility and low available water holding capacity and poor socio economic condition of marginal and small farmers. In this context, the present study was conducted to evaluate economic suitability of soils of Bukkarayasamudhrum mandal, Anantapur district representing arid region of south India for groundnut cultivation.

Materials and Methods

Study area

The study area is located between 13°37' 51" and 14°48' 09" N and 77°33' 47" and 77°47'45" E in Anantapur district of Andhra Pradesh, India (Fig.1). The climate of Bukkarayasamudhrum mandal is warm which is classified as hot arid bioclimatic condition. The average minimum and maximum temperatures are 22.9 and 34° C, respectively, and average annual rainfall is 556 mm. The total length of growing period (LPG) is less than 90 days. The elevation varies from 295 to 595 m MSL. The major part of mandal has nearly level to very gentle slope with 1-3 per cent slope.

Datasets used and interpretation

Landform analysis was carried out using Survey of India toposheets and the contours were generated from the Shuttle Radar Topography Mission Digital Elevation Model (SRTM DEM) using ArcGIS 10 software. Land use/land cover was delineated by onscreen visual interpretation of Resourcesat LISS IV data. The landform, slope, and land-use/land-cover layers were integrated and landform ecological units (LEU) map was generated. The LEU map was used as a base map for ground truth verification and identification of soil profile location.

Survey methodology

Preliminary traverse was carried out using LEU map and soil profiles were located based on land surface features such as drainage pattern, slope characteristics and land use (Natarajan and Sarkar 2010). Morphological characteristics of 91 soil profiles were studied as per USDA Soil Survey Manual (Soil Survey Staff 2003). The profiles were grouped into different soil series based on differentiating characteristics. The area under each series was further divided into phases and their boundaries were delineated based on the variations observed in the texture of the surface soil, slope, erosion, presence of gravels and stoniness. Horizon-wise samples were collected for laboratory analysis. In laboratory, particle-size distribution was carried out by International pipette method (Jackson 1973) and organic carbon was estimated by Walkley and Black (1934) method. Soil reaction (1:2.5 soil water suspension), electrical conductivity, cation exchange capacity and exchangeable bases were determined as per Jackson (1973).

Soil suitability evaluation for groundnut crop

Evaluation of site suitability for groundnut crop was carried out as per FAO framework on land evaluation (FAO 1983) modified by Naidu *et al*. (2006). Soil characteristics, such as depth, texture, gravelliness, pH and calcareousness, land features like slope, erosion and drainage and climatic factors such as amount of rainfall and its distribution and length of growing period were used to assess the suitability of land for different crops. To delineate the extent of different suitability classes, "Overlay" analysis concept was used in GIS environment.

Socio economic data collection

Socio-economic analysis was carried out to evaluate the different soil units for economics of groundnut cultivation under different size classes of farmers. Benefit Cost (B: C) ratio was analysed by collecting detailed information using a structured questionnaire from 100 respondents across the mandal. The sample farmers were classified in to small ($\leq$2 ha), medium (>2 to $\leq$10 ha) and large (> 10 ha) based on their land holding sizes. The cost of cultivation includes cost of inputs such as seed, manure and fertilizers, plant-protection chemicals, payment towards human and bullock labour and interest on working capital. The gross returns were calculated by summing up the value of main product and by-product. By deducting total cost from gross returns, net returns were obtained.

Results and Discussion

Landform analysis

Based on the analysis of contour crenulations and the drainage network morphometry as well as the

photomorphic interpretation of LISS IV image, the study area was classified into 5 landforms *viz.* Denudational hills in granites and gneisses (structural hills), dissected pediment (low hills/hillocks), pediplain, alluvial deposits and valley. Pediplain covers 49.4 % of the area followed by alluvial deposits (29.2 %) and valley (7.8 %). Dissected pediment and denudational hills occupy 7.2 % of area.

Land use/ land cover

Land use - land cover map of Bukkarayasamudrum mandal was prepared using Resourcesat-2 LISS IV data. The lands with single crop occupy 62.9 % of total geographical area followed by double crop (12.2 %). Scrub lands occupy 6.3 % of area and fallow lands occupy 3.5 % area. The major crops grown were groundnut, pigeon pea, castor, sunflower, pomegranate, citrus and guava.

Land ecological unit

Based on landform, land use and slope 33 landscape ecological units were delineated in Bukkarayasamudrum mandal. In the denudational hills, three LEUs were identified based on variation in slope (E and F) and land-use/land-cover classes (forest and scrub). Three LEUs were identified on the dissected pediments and 15 LEUs were identified in the pediplain landform. Alluvial plain was further differentiated into 7 LEUs based on the variation in two slope classes (A and B) and land use (single crop, double crop and fallow).

Soil characterisation and mapping

The soils of Bukkarayasamudrum mandal were mapped into 8 soil series with 52 phases. Morphological and physico-chemical properties of the representative pedons of soil series are presented in table 1 and 2.

Chennampalle Series

Soils of Chennampalle series are shallow (25-50 cm), well drained, dark reddish brown, sandy loam in surface, and gravelly sandy clay loam in sub-surface. These soils are very strongly alkaline (pH of 9.0-9.16). The organic carbon content varied from 0.54 to 0.84 %. The mapping unit CPb2ER4 covers the largest area followed by CPc2B. These soils are classified as Loamy-skeletal, mixed, isohyperthermic Lithic Haplargids and cover 17.1 % of the area.

Venkatapuram Series

Soils of Venkatapuram series are slightly deep (50-75 cm), well drained, calcareous, yellowish red to dark reddish brown, clayey and are classified as Clayey-skeletal, mixed, isohyperthermic, Typic Haplargids. The mapping unit VPhA occupies major area. These soils are neutral in surface and slightly to moderately alkaline in sub-surface. Organic carbon content varied from 0.56 to 0.74 % and cation exchange capacity varied from 13.3 to 21.73 cmol (p+) kg^{-1}.

Dayyadakuntapalle Series

Soils of Dayyadakuntapalle series are slightly deep, well drained, gravelly reddish brown to yellowish red, fine loamy soils and are classified as Loamy-skeletal, mixed, isohyperthermic Ustic Haplargids. The soils cover 13.8 % of total geographical area of Bukkarayasamudrum mandal.

Nilampalle Series

Soils of Nilampalle series are moderately deep, well drained, gravelly, dark reddish brown to dark red, clayey and are classified as Clayey-skeletal, mixed, isohyperthermic Typic Haplargids. These soils are slightly to moderately alkaline in reaction. Organic carbon content ranged from 0.42 to 0.84 %. This soil covers an area of 18.3 % of Bukkarayasamudrum mandal and mapping unit NPhA covers larger area followed by NPh2B.

Rekulakuntapalle Series

Rekulakuntapalle soils are deep (100-150 cm), well drained, gravelly, dark red to red clayey and are classified as Clayey-skeletal, mixed, isohyperthermic Ustic Haplargids. Soil pH varied from 7.26 to 7.66 and OC content from 0.39 to 0.91 %. The soils cover about 2 % of total geographical area of Bukkarayasamudrum mandal. Coarse surface texture and gravelliness are the indication that these soils are undergoing moderate to severe erosion (Lalitha *et al*. 2016).

Yadavalaparti Series

The soils of Yadavalaparti series are slightly deep, well drained, calcareous, dark reddish brown to reddish brown fine-loamy soils and are classified as Fine-loamy, mixed, isohyperthermic Typic Haplargids. These soils are moderately alkaline to strongly alkaline in nature and calcareous. Organic carbon in surface is

high (1.3 %) compared to sub-surface. The soils cover an area of about 9.8 % of Bukkarayasamudrum mandal.

Lolluru Series

Lolluru series are moderately deep, well drained, very dark greyish brown, calcareous clayey soils formed from alluvium and are classified as Fine, mixed, isohyperthermic Typic Haplargids. These soils are calcareous and moderately to very strongly alkaline in reaction. Organic carbon content of the soil ranged from 0.32 -0.60 %. These soils cover 5 % of the total geographical area of Bukkarayasamudhrum mandal.

Govindapalle Series

The soils of Govindapalle series are deep, moderately well drained, dark brown to very dark grey clayey and are classified as Fine, mixed, isohyperthermic Ustic Haplargids. These soils are moderately alkaline, calcareous soils and their organic carbon content ranged from 0.22 – 0.87 %. It covers 11.9 % of total geographic area of Bukkarayasamudrum mandal. Nearly 40 per cent of area is affected by strongly alkaline pH (>8.4). Improper management practices and faulty irrigation practices are the major cause for increasing pH in the soil of the mandal.

Land suitability evaluation

Drastic change in temperature and rainfall over years shows that there is no stable length of growing period for crops which limits the choice of crop (Naveen 1991). Rainfall and length of growing period of the region is moderately suitable for groundnut cultivation. The non-parametric approach revealed that soils of Chennampalle series are marginally suitable to non-suitable mainly due to factors such as limitation of rooting depth, gravelliness and rockiness. The other soils developed over granitic landforms are moderately suitable due to gravelliness. The soils of Yadavalaparti and Lolluru series are moderately suitable to groundnut cultivation due to limitation of heavy texture. Govindapalle series is marginally suitable due to poor drainage and heavy texture. Date indicated that 57.6 % of area is moderately suitable followed by 21 % of area is marginally suitable and 7.3 % area is non-suitable for groundnut. Though, climate is a major constraint for production of groundnut, adoption of suitable site specific soil and water conservation measures is needed for sustainable production.

Economic evaluation

The economic evaluation of rainfed groundnut system on different soil units of Bukkarayasamudrum mandal is presented in table 3 and 4. Average total cost of cultivation for groundnut crop in Bukkarayasamudhrum mandal is Rs. 15,911 ha^{-1}. Out of which Rs. 1,711 is cost of owned inputs, Rs. 14,199 is cost of purchased inputs. The total cost includes cost for labour. The groundnut yield in Bukkarayasamudrum mandal varied from 740 to 2470 kg ha^{-1} with an average of 1504 kg ha^{-1}. The average gross return was Rs.48,913 $ha^{-1}$and net return is Rs.33,002 ha^{-1} and the average benefit-cost ratio is 1.99. Moderately deep soils (75-100 cm) have a higher B:C ratio of 2.05 compared to that of slightly deep (50-75 cm, B:C ratio=2.00) and shallow soils (25-50 cm, B:C ratio=1.97) for groundnut cultivation. Loamy sand surface texture soils had higher B:C ratio (2.42) compared to that of other surface texture soils. Non calcareous soils showed higher B:C Ratio (2.02) compared to calcareous soils (1.95). Slightly gravelliness soils (15-30) recorded higher B:C ratio (2.04) compared to non-gravelly soils (1.98) for groundnut cultivation. Overall, moderately deep gravelly soils with loamy sand surface texture showed more benefits compared to other soils. The mapping units such as CPb2B1, DPc2B1, NPCB showed B:C ratio of more than 2.5 in medium farmers category whereas mapping units like NPc2C1, VphA, NPc2A had high benefits (B : C ratio of >2.5) in large farmers category.

Conclusion

The non-parametric approach revealed that soils developed from granitic landform are moderately to not suitable due to problems of rooting depth, gravelliness and rockiness. The soils of alluvial landform are moderately to marginally suitable for groundnut cultivation due to heavy texture of soil. Economic land analysis results showed that non-calcareous, moderately deep soils with loamy sand surface texture recorded comparatively higher B:C ratio than other soils. These results can be recommended to the local stakeholders for increasing their economic benefits through selecting suitable land parcels for cultivation of groundnut.

Table 1. Morphological characteristics of Bukkarayasamudhrum mandal soils

Depth (cm)	Horizon	Boundary	colour	Structure	Gravels	Stickiness	plasticity	Special features	Calcareo usness	Drainage
Series: Chennampalle : ***Loamy-skeletal, mixed isohyperthermic Lithic Haplargids (4762 ha)***										
0-15	Ap	cs	5YR 3/4	1 m sbk	5	ms	mp	-	e1	well drained
15-40	Bt1		2.5YR3/4	2 m sbk	60	ms	mp	-	e1	
Series: Venkatapuram : ***Clayey-skeletal, mixed (cal) isohyperthermic Typic Haplargids (2452 ha)***										
0-18	Ap	cs	5YR 3/4	1 m sbk	5	ms	mp	-	e1	well drained
18-37	Bt1	gs	2.5YR3/4	2 m sbk	60	ms	mp	-	e1	
37-60	Bt2	as	2.5YR3/4	1 m sbk	80	ms	mp	-	e1	
60-65					Weathered parent material					
Series: Dayyadakuntapalle: ***Loamy-skeletal, mixed isohyperthermic Ustic Haplargids (3850 ha)***										
0-11	Ap	as	5YR 3/3	1 f sbk	10	ns	np	-	-	
11-36	Bt1	gs	5YR 4/4	2 m sbk	20	ms	mp	argillan	-	well drained
36-62	Bt2	as	5YR 4/6	1 m sbk	50	ms	mp	argillan	-	
62-75	Cr				Weathered parent material					
Series: Nilampalle: ***Clayey-skeletal, mixed isohyperthermic Typic Haplargids (5105 ha)***										
0-11	Ap	as	2.5 YR3/4	1 f sbk	10	ms	mp	-	-	
11-39	Bt1	gs	2.5 YR3/4	2 m sbk	10	ms	mp	argillan	-	
39-65	Bt2	gs	2.5 YR3/6	2 m sbk	10	ms	mp	argillan	-	well drained
65-83	Bt3	as	2.5 YR3/6	1 m sbk	50	ms	mp	argillan	-	
83-100	Cr				Weathered Parent material					

Series: Rekulakuntapalle: ***Clayey-skeletal, mixed isohyperthermic Ustic Haplargids (564 ha)***

0-19	Ap	as	5 YR5/6	1 f sbk	-	ns	np	-	-	
19-43	Bt1	cs	2.5 YR3/6	1 m sbk	45	ms	mp	argillon	-	
43-65	Bt2	gs	2.5 YR4/6	1 m sbk	40	ms	mp	argillon	-	well drained
65-90	Bt3	gs	2.5 YR4/6	1 m sbk	35	ms	mp	argillon	-	
90-128	Bt4	gs	2.5 YR4/6	1 m sbk	30	ms	mp	argillon	-	

Series: Yadavalaparti*: Fine-loamy, mixed isohyperthermic (cal) Typic Haplargids (2749 ha)*

0-12	Ap	as	5 YR 3/4	1 m sbk	-	ms	mp	Conca	e1	
12-31	Bw1	cs	5 YR 3/3	2 m sbk	-	ms	sp	Conca	e1	well drained
31-55	Bw2	cs	5 YR 3/3	2 m sbk	-	ms	sp	Conca	e1	

Series: Lolluru : ***Fine, mixed isohyperthemic (cal) Typic Haplargids (1413 ha)***

0-14	Ap	cs	10YR 3/2	2 m sbk	-	ms	mp	Conca	e3	
14-35	Bw1	gs	10YR 3/2	3 m sbk	-	vs	vp	Conca	e3	Well drained
35-55	Bw2	cs	10YR 3/2	2 m sbk	-	vs	vp	Conca	e3	
55-87	Bw3	as	10YR 3/2	2 m sbk	-	vs	vp	Conca	e3	

Series: Govindapalle : ***Fine, mixed isohyperthermic (cal) Ustic Haplaragids (3336)***

0-16	Ap	cs	10YR 3/2	massive	-	ms	mp	Conca	e2	
16-33	Bw1	gs	10YR 3/3	2 m sbk	-	vs	vp	Conca	e1	Moderately Well drained
33-54	Bw2	gs	10YR 3/1	3 m sbk	-	vs	vp	Conca	e2	
54-76	Bw3	gs	10YR 3/1	3 m sbk	-	vs	vp	Conca	e2	
76-110	Bw4	gs	10YR 3/1	2 m sbk	-	vs	vp	Conca	e3	

Table 2. Physio-chemical characteristics of Bukkarayasamudhrum mandal soils

Depth (cm)	Horizon	Sand (2.0-0.05) mm	Silt (0.05-0.002) mm	Clay (<0.002) mm	Coarse fragments v/v (%)	Texture (USDA)	pH (1: 2.5 water)	EC (1: 2.5) dSm^{-1}	O.C %	CEC (cmol (p+) kg^{-1})	CEC/ Clay
Series: Chennampalle											
0-15	Ap	74.6	9.6	15.8	10-15	sl	9.16	0.118	0.54	19.51	1.23
15-40	Bt1	71.1	8.9	20.0	35-40	scl	9.01	0.358	0.84	22.92	1.14
Series: Venkatapuram											
0-18	Ap	44.42	22.89	32.68	5	cl	7.09	0.070	0.56	13.3	0.41
18-37	Bt1	45.80	16.20	38.00	40-60	sc	8.53	0.127	0.74	21.73	0.57
37-60	Bt2	45.5	12.5	42.0	40-60	sc	8.56	0.187	0.74	20.33	0.48
Series: Dayyadakuntapalle											
0-11	Ap	65.99	23.21	10.80	15	ls	8.31	0.85	0.42	13.3	1.23
11-36	Bt1	62.23	21.96	15.82	50	scl	8.53	0.126	0.39	18.18	1.15
36-62	Bt2	33.61	34.60	31.79	50	scl	8.74	0.166	0.21	16.90	0.53
Series: Nilampalle											
0-11	Ap	46.43	39.86	13.71	10	sc	8.24	1.24	0.42	19.51	1.42
11-39	Bt1	49.90	38.33	11.77	15	sc	7.81	0.134	0.54	16.85	1.43
39-65	Bt2	42.30	40.34	17.36	35	c	7.82	0.126	0.49	23.06	1.33
65-83	Bt3	48.94	35.97	15.09	50	sc	8.35	0.165	0.84	18.18	1.20
Series: Rekulakuntapalle											
0-19	Ap	57.19	32.30	10.51	-	scl	7.27	0.400	0.60	18.18	1.73
19-43	Bt1	34.63	33.58	31.79	45	cl	7.57	0.145	0.67	27.5	0.87
43-65	Bt2	35.1	32.4	32.5	40	scl	7.66	0.185	0.39	31.04	0.96

65-90	Bt3	30.63	32.58	36.79	35	sc	7.26	0.100	0.49	33.7	0.92
90-128	Bt4	44.15	22.44	33.41	30	sc	7.31	0.200	0.91	25.72	0.77
Series: Yadavalaparti											
0-12	Ap	76.63	12.48	10.90	-	sl	8.60	0.136	1.30	13.3	1.22
12-31	Bw1	38.65	42.15	19.20	-	scl	9.82	0.136	0.72	31.04	1.62
31-55	Bw2	53.21	28.12	18.67	-	scl	8.56	0.187	0.57	19.51	1.04
Series: Lolluru											
0-14	Ap	43.45	12.45	44.2	-	c	8.50	0.126	0.32	20.84	0.47
14-35	Bw1	37.02	17.75	45.23	-	c	8.63	0.120	0.60	16.4	0.36
35-55	Bw2	51.14	13.77	35.09	-	sc	8.97	0.160	0.39	12.42	0.35
55-87	Bw3	54.36	8.51	37.13	-	sc	9.48	0.155	0.46	12.42	0.33
Series: Govindapalle											
0-16	Ap	67.55	11.33	21.12	-	scl	8.73	0.128	0.46	21.73	1.03
16-33	Bw1	33.10	26.74	40.16	-	c	8.51	0.140	0.38	35.13	0.87
33-54	Bw2	40.64	9.55	49.81	-	c	8.58	0.136	0.42	36.89	0.74
54-76	Bw3	44.18	12.34	43.48	-	c	8.59	0.140	0.87	39.52	0.91
76-110	Bw4	46.91	11.73	41.36	-	sc	8.26	0.146	0.22	31.62	0.76

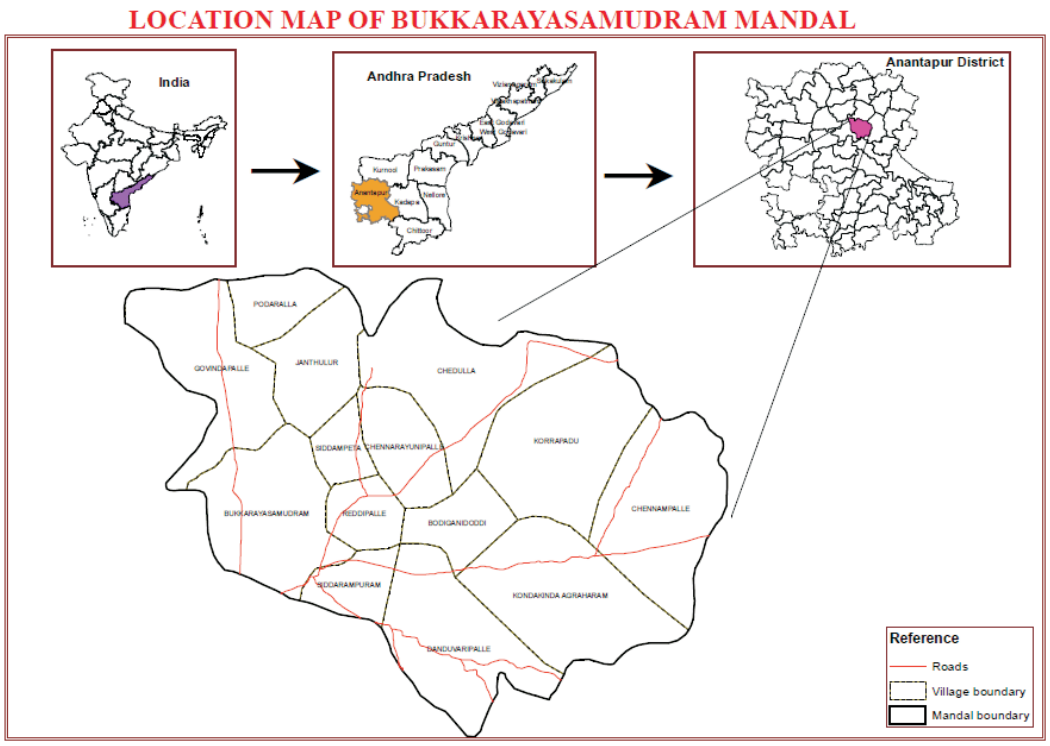
Table 3. Cost of cultivation and net returns for groundnut cultivation in different soil units

Soil Unit	Yield ($Kgha^{-1}$)	Gross Returns ($Rsha^{-1}$)	Total cost ($Rsha^{-1}$)	Owned inputs cost ($Rsha^{-1}$)	Purchased inputs cost ($Rsha^{-1}$)	Net Returns ($Rsha^{-1}$)	B :C Ratio
CPb2B1	2220	69654	19693	2845	16848	49961	2.5
CPc2B	1180	40490	14139	1373	12766	26351	1.9
CPc2B1	7400	22724	8981	949	8031	13743	1.5
DPb2B	2470	75582	22785	2845	19939	52797	2.3
DPc2B	820	26347	8590	949	7640	17757	2.1
DPc2B1	990	37009	10260	1186	9074	26749	2.6
DPh2B	780	23825	11365	1140	10225	12460	1.1
DPhA	1480	45448	16519	3545	12974	28929	1.8
DPiB1	1290	40980	15671	2081	13589	25309	1.6
DPiBi	1480	69983	19023	251	18772	50960	2.7
GPiA	1810	63201	19832	1992	17841	43369	2.2
NPc2A	2220	69654	18113	2845	15267	51541	2.8
NPc2B	740	22724	13341	1773	11568	9383	0.7
NPc2C	1480	39397	14762	2309	12453	24634	1.7
NPc2C1	2220	99418	25413	378	25035	74004	2.9
NPCB	2220	69654	19302	2845	16457	50352	2.6
NPcC1	1110	29640	11548	1423	10126	18092	1.6
NPcC2	2220	65949	19333	375	18958	46616	2.4
NPh2B	2470	70642	20558	2845	17713	50084	2.4
NPh2B1	2100	63232	24556	2845	21711	38676	1.6
NPHA	1190	37316	13320	1262	12058	23996	1.8
RPcC2	820	25441	12263	949	11314	13178	1.1
VphA	870	32975	11768	711	11057	21207	1.8
YPhA	1030	31163	10803	1186	9617	20360	1.9
YPmA	1650	50388	15840	1897	13943	34548	2.2

Table 4. Economic land evaluation for groundnut crop

Soil Unit	Depth	Surface texture	Erosion	Gravelliness (%)	Large farmers		Medium farmers		Small farmers	
					Yield (kg ha^{-1})	BC Ratio	Yield (kg ha^{-1})	BC Ratio	Yield (kg ha^{-1})	B:C Ratio
CPb2B1	25-50	b	moderate	15-35	-	-	2220	2.5	-	-
CPc2B	25-50	c	moderate	<15	440	1.9	990	2.2	1670	1.5
CPc2B1	25-50	c	moderate	15-35	740	1.5	-	-	-	-
DPb2B	50-75	b	moderate	<15	-	-	-	-	2470	2.3
DPc2B	50-75	c	moderate	<15	-	-	820	2.1	-	-
DPc2B1	50-75	c	moderate	15-35	-	-	990	2.6	-	-
DPh2B	50-75	h	moderate	<15	740	0.9	820	1.3	-	-
DPhA	50-75	h	slight	<15	-	-	1480	1.8	-	-
DPiB1	50-75	i	slight	15-35	-	-	1410	1.9	1810	1.5
GPiA	100-150	i	slight	<15	560	0.7	1700	2.3	2390	2.3
NPc2A	75-100	c	moderate	<15	-	-	-	-	2220	2.8
NPc2B	75-100	c	moderate	<15	740	0.7	-	-	-	-
NPc2C	75-100	c	moderate	<15	740	1.9	-	-	2220	1.6
NPc2C1	75-100	c	moderate	15-35	-	-	-	-	2220	2.9
NPCB	75-100	c	slight	<15	-	-	2220	2.6	-	-
NPcC1	75-100	c	slight	15-35	-	-	1110	1.6	-	-
NPcC2	75-100	c	slight	35-60	-	-	-	-	2220	2.4
NPh2B	75-100	h	moderate	<15	-	-	-	-	2470	2.4
NPh2B1	75-100	h	moderate	15-35	-	-	1980	1.1	2220	2.2
NPHA	75-100	h	slight	<15	-	-	850	1.7	2220	1.9
RPcC2	100-150	c	moderate	<15	820	1.1	-	-	-	-
VphA	50-75	h	slight	<15	370	0.8	920	1.7	1110	2.5
YPhA	50-75	h	slight	<15	-	-	820	1.7	1240	2.1
YPmA	50-75	m	slight	<15	-	-	1650	2.2	-	-

b-loamy sand; c- sandy loam, h-sandy clay loam, i- sandy clay, m-clay:



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