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Evaluation of production efficiency of cotton zone for rational land use in Adilabad district, Andhra Pradesh

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Abstract

Adilabad has very high cotton crop concentration index (5.5) but has a very low yield index (46.0) in the state. Cotton zone is confined to north to north-western part of Adilabad district and has been grouped into three regions viz. Adilabad - Bhainsa; Utnoor - Boath and Mudhol - Lohesra, on the basis of the magnitude of crop concentration and spatial expansion of cropping systems. The soil productivity ratings showed distinctive spatial variability in their productive capabilities. The soils qualified are fair to poor grade with high magnitude of crop diversification. Very high cotton productivity was observed in Dilwarpur (160.5) and Sarangpur (144.9) mandals where paddy and cotton combination is noticed. A positive significant correlation between productivity coefficient and storie index suggested that cotton yields can be improved in the zone with better crop management in accordance with the soil capability and site condition.

Additional keywords : Crop concentration, crop productivity, storie index, crop diversification.

Introduction

Agricultural productivity is an important element of rural prosperity and is associated with physico, socio-cultural and techno-economical factors (Bhatia, 1967). Various approaches measuring the agricultural productivity indicate that the agricultural efficiency is generally measured in terms of the maximum return per unit area of land in a particular physico-cultural set up with the application of human efforts at the existing level of development. The crop productivity studies are important particularly for an area having low crop yields wherein the horizontal expansion of agriculture has reached its plateau.

Materials and methods

Adilabad district situated in the north-western part of Andhra Pradesh, lies between 77°46' to 80°0'E longitudes and 18°40' to 19°56' N latitudes, with an altitude of 80 to 550 m MSL. Climate is hot, semiarid with a mean annual rainfall of 1400 mm received in about 80 days and spread over from June to September. The area qualifies for isohyperthermic soil temperature regime and ustic soil moisture regime. Topographically, it has an undulated terrain bordered by the hill ranges of Sahyadri which extends from north-west to south-eastern parts of the district. These hill lands are the main forest resource of the region and form the main water source for both domestic and agricultural use in the downstream areas.

Cotton zone of hill soils covers 27 per cent of the total cropped area of the district and 21.5 per cent of the total cotton area of the state. The ground water potential in the region is very poor as impervious granite-gneissic rocks inhibit further percolation. The geology of the cotton zone is basalt capping over granite.

Socio-economically, it is the most backward area and dominated by small and marginal farmers (88%) having land holdings of size 0.5 to 3.9 ha. The recurrent dry spells in the month of September often leads to the total failure of cotton. Hence, the farmers are reluctant to invest more on inputs.

For this study, the data was collected from the office of the Chief Planning Officer, Adilabad district for the year 1990-91. The mandalwise crop concentration index values were calculated using location-coefficient method of Bhatia (1965), crop productivity by Enyedi (1964) and crop diversification and yield index as per the procedure of Singh (1976).

Soils of cotton zone of Adilabad district were classified according to Soil Taxonomy (Soil Survey Staff 1992). Soil productivity ratings were calculated as per Storie (1976). Correlation and regressions were worked out between crop efficiency and storie index, yield and storie index.

Results and discussion

Productivity of cotton growing area of Andhra Pradesh : Adilabad district has very high cotton concentration index (5.5) which is nearly half to that of net cultivated area, but it has a very low yield index (46.0) in the state (Table 1). The average yield of cotton lint is 112 kg ha^{-1} which is less than half of state average of 228 kg ha^{-1}. The cotton efficiency is very high in Guntur district with an yield index of 168 followed by Prakasam district (134). Hence, the spatial variation in cotton efficiency shows the possible environmental factors limiting the output per unit area in the region.

Table 1. Crop concentration and yield indices of major cotton growing areas* of Andhra Pradesh

Name of the district	Crop conc. Index	Yield Index	(%) cotton area	Lint yield (kg ha^{-1})
Guntur	4.3	168	27.7	412
Prakasam	1.3	134	6.5	326
Kurnool	1.3	86	9.4	209
Warangal	2.0	94	8.5	230
Adilabad	5.5	46	25.1	112

* More than 5% of the total cotton cropped area of Andhra Pradesh (1989-90)

Crop concentration : Cotton is highly concentrated in north and north-western part of Adilabad district (Fig. 1). Mandalwise variation in the degree of concentration shows that out of the total 52 mandals in the district, 23 mandals have high magnitude of cotton concentration. The spatial variation in the magnitude of cotton concentration is mostly influenced by the proportion of cultivated and forest area to the total geographical area of each mandal in the district. The cotton zone has been grouped into three regions viz. Adilabad-Bhainsa, Utnoor-Boath and Mudhol-Lohesra.

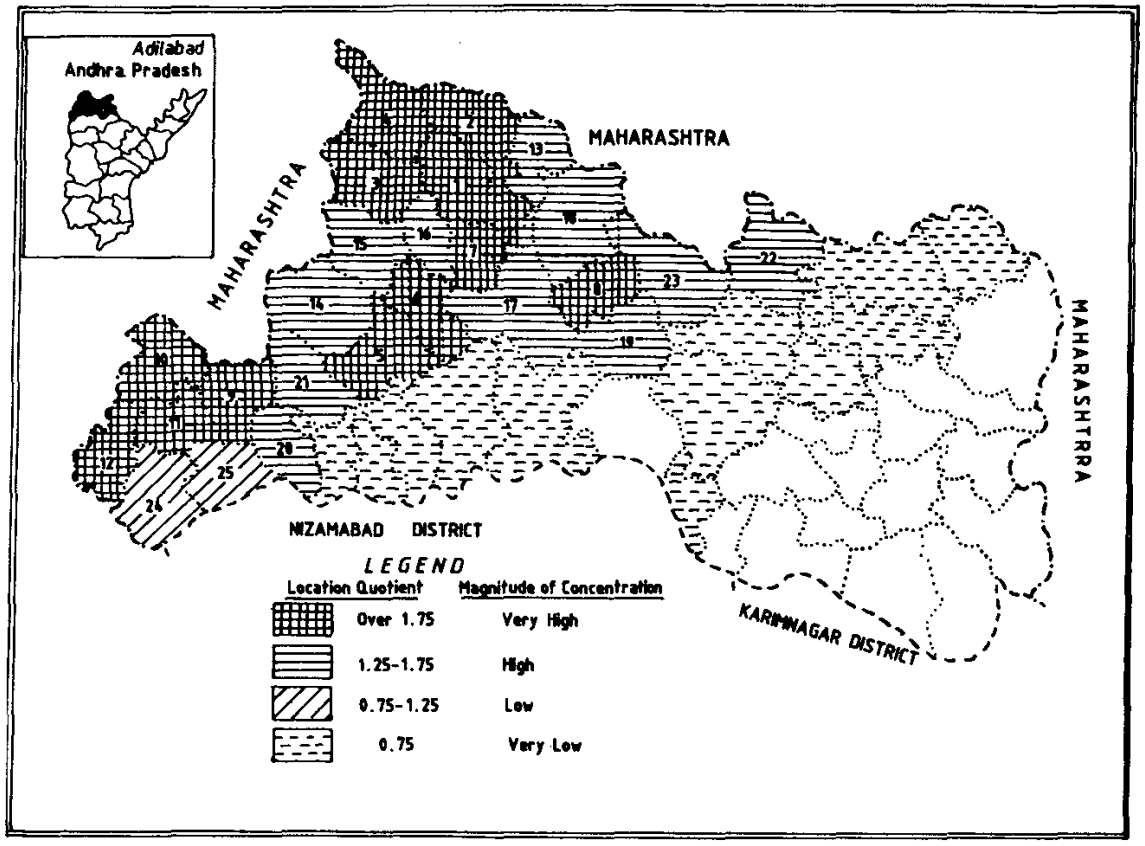

Fig. 1 : Mandal wise cotton crop concentration in Adilabad district, Andhra Pradesh

The data (Table 2) showed that the Region I has 12 mandals with a very high concentration of cotton covering an area of 2,40,541 acres. The average cotton yield in this region is 3.3 q ha^{-1}. The Region II has 10 mandals with high concentration of cotton and has an area of 1,19,602 acres. The average yield of cotton is 3.9 q ha^{-1}. Region-III has low concentration of cotton with an area of 19,125 acres and with an average yield of 5.8 q ha^{-1}.

Table 2. Concentration of net cultivated area, cotton area and yield in the cotton zone of Adilabad

Regions/cotton zone	Net cultivated		Cotton		
	Area (ha)	Index value	Area (ha)	Yield (q ha^{-1})	
				Mean	CV %
		Region I (Very high magnitude)			
Adilabad	38,812	1.0M	21,134	1.95	42.1
Jainath	54,231	2.2H	28,800	3.50	37.3
Talamadugu	33,518	1.4H	18,662	3.75	74.9
Tamsi	44,009	1.8H	21,412	4.22	24.9
Nevedikonda	20,389	0.6L	11,388	3.82	29.1
Inchchoda	37,121	1.6H	21,416	2.96	41.4
Indravalli	37,857	1.2M	19,462	1.61	24.2

Jainoor	20,586	1.0M	10,546	2.81	7.54
Kuntala	25,489	1.4H	13,291	5.90	25.0
Kubeer	45,625	1.9H	28,447	3.32	45.5
Bhainsa	43,732	2.3H	23,971	3.76	50.3
Tanoor	30,807	1.7H	22,012	2.20	41.1
Total	4,32,807		2,40,541	3.3	36.9
		Region II (High magnitude)			
Bela	23,390	1.1M	9,847	2.98	55.2
Boath	37,229	1.3H	17,087	4.53	29.6
B. Hatnoor	26,443	1.2H	10,301	2.68	19.1
G. Hatnoor	20,212	1.6H	9,220	2.04	11.8
Utnoor	32,178	1.0M	12,001	2.01	46.3
Narnoor	35,584	0.9M	13,671	5.37	67.4
Sirpur (u)	19,989	0.7L	8,436	2.79	13.3
Dilwarpur	14,485	0.8L	5,538	7.45	3.1
Sarangpur	29,961	1.1M	12,729	5.67	29.4
Wankhedi	36,624	1.1M	15,895	4.98	63.1
Kerameri	11,396	0.5L	4,877	2.65	6.1
Total	2,84,481		1,19,602	3.92*	31.4
		Region III (Low magnitude)			
Mudhol	42,624	1.7H	12,557	5.84	42.9
Lohesra	19,085	1.0M	6,568	5.83	0.9
Total	61,709		19,125	5.84*	21.9

Crop diversification : The magnitude of crop diversification in cotton zone (Table 3) is high to very high in 22 mandals. Indravalli, Jainoor and Tanoor mandals are lying in low magnitude of diversification because cotton occupies more than 50 per cent of net cultivated area. It is observed that higher the magnitude of the concentration of an individual crop, lower is the degree of diversification. Cotton and blackgram have high magnitude of concentration with low magnitude of jowar, paddy and redgram showing higher degree of diversification.

Table 3. Crop concentration and diversification of cotton zone of Adilabad district

S. No.	Name of the mandal	Index and magnitude of crop concentration					Crop diversification Index Value*
		Cotton	Blackgram	Paddy	Redgram	Jowar	
				Region I			
1.	Adilabad*	1.97	0.80 L	0.19VL	1.14L	0.93L	31.1 H
2.	Jainath	1.93	0.08 L	0.09VL	0.77L	1.02L	30.7H
3.	Talamadugu	2.02	0.34L	0.18VL	1.05L	0.81L	30.0H
4.	Tamsi	1.80	0.46L	0.09VL	1.29H	0.96L	29.9H
5.	Nevedikonda	2.03	3.19VH	0.61VL	0.86L	0.68VL	22.9H
6.	Inchchoda	2.10	0.99L	0.33VL	0.84L	0.73VL	29.3H
7.	Indravalli	1.81	2.29VH	0.25VL	0.49VL	0.85L	39.2L
8.	Jainoor	1.86	2.55VH	0.21VL	0.47VL	0.46VL	32.9L

9.	Kuntala	1.80	0.07VL	1.42H	0.64VL	0.37VL	20.9VH
10.	Kubeer	2.27	0.85L	0.14VL	1.31H	0.62VL	31.2H
11.	Tanoor	2.00	2.19VH	0.32VL	0.54VL	0.75L	36.2L
				Region II			
13.	Bela	1.53	0.36VL	0.19VL	2.45VH	0.96L	30.9H
14.	Boath	1.66	2.17VH	0.43VL	0.86L	1.03L	22.4H
15.	B. Hatnoor	1.47	2.62VH	0.42VL	1.17L	1.06L	22.3H
16.	G. Hatnoor	1.66	3.40VH	0.30VL	0.94L	0.84L	21.5VH
17.	Utnur	1.33	5.31VH	0.72VL	1.88L	0.87L	18.3VH
18.	Narnoor	1.40	3.75VH	0.33VL	1.01L	0.97L	21.0VH
19.	Sirpur (U)	1.53	1.69H	0.67VL	0.95L	1.02L	22.7H
20.	Dilwarpur	1.20	--	1.89VH	0.45VL	0.03VL	20.4VH
21.	Sarangpur	1.60	0.99VL	2.07VH	1.52H	0.19L	21.9VH
22.	Kerameri	1.55	--	--	0.98L	1.14L	23.9H
23.	Wankhedi	1.58	--	--	0.91L	1.12L	28.8H
				Region III			
24.	Mudhol	1.20	4.66VH	1.06L	0.32VL	0.70L	18.1VH
25.	Lohesra	1.20	0.87L	3.2:VH	0.57VL	0.18L	19.3VH

* The numbers depicted in Fig. 1 follow above serial numbers and names of the mandals, H = High, M = Medium; L = Low.

Crop efficiency : The crop efficiency of an agro-ecological region is defined in terms of the output of valued product per unit resource input (Lynam and Herdt 1989). The derived indices of production coefficients for counting the variability of cotton productivity is used to highlight the inherent limitations of shrink-swell soils developed under hot semiarid climate and to stress in the existing land use systems (Table 4) in declining production potentials of soils.

Table 4. Mandalwise cotton distribution (%), productivity coefficient and existing cropping pattern in cotton zone

Mandals	Cotton area (%)	Productivity coefficient		Rainfall (mm)	Existing cropping pattern
		Index	Magnitude		
Adilabad	54.3	66.0	VL	1561.3	RG < J < BG < P*
Bhainsa	54.8	126.4	VH	1165.4	RG < J < P < BG
Tamsi	48.6	123.9	H	1330.4	RG < J < BG < P
Dilwarpur	35.5	160.5	VH	1232.2	P < RG < J < BG
Sarangpur	44.1	144.9	VH	1370.4	P < RG < BG < J
Kubeer	62.8	125.7	VH	-	RG < BG < J < P
Boath	45.1	123.2	H	1267.0	BG < J < RG < P
Narnoor	38.4	125.8	VH	-	BG < RG < J < P
Sirpur (U)	42.2	71.7	VL	1538.5	BG < J < RG < P
Mudhol	28.8	102.1	M	1317.0	VG < P < J < RG
Bela	42.1	76.6	VL	776.6	RG < J < BG < P
Lohesra	33.1	117.1	H	1087.6	P < BG < RG < J

Talamadugu	55.7	128.4	VH	1240.9	RG < J < BG < P
Jainoor	51.2	86.9	VL	1374.4	VG < RG < J < P
Utnoor	37.3	45.3	VL	1501.3	BG < RG < J < P
Jainath	53.1	70.9	VL	1571.2	J < RG < BG < P
Nevedikonda	55.9	128.9	VH	-	BG < RG < J < P
Inchchoda	57.7	105.0	M	-	BG < RG < J < P
Indravalli	51.4	48.8	VL	-	BG < J < RG < P
Kuntala	49.7	127.9	VH	1275.2	P < RG < J
B. Hatnoor	40.5	66.4	VL	-	BG < RG < J < P
G. Hatnoor	45.6	55.3	VL	-	BG < RG < J < P
Tanoor	55.3	73.9	VL	-	BG < J < RG < P
Wankhedi	43.4	131.7	VH	1011.3	J < RG
Kerameri	42.8	70.2	VL	1039.4	J < RG

* RG = Redgram; BG = Blackgram; P = Paddy; J = Jowar

- Rainfall data not available.

The results indicate that the magnitude of cotton efficiency is very high in nine mandals, high in three mandals and medium to very low in thirteen mandals. The production coefficient for cotton in irrigated tracts of Dilwarpur (160.5), Sarangpur (144.9) and Kuntala (137.9) mandals is very high and closely related with seasonal rains amounting from 1230 to 1370 mm and spread over from June to September. The amount and uniform distribution of rainfall in these mandals is sufficient enough in narrowing down the seasonal contrasts of pedoclimate in Vertisols and associated vertic subgroups having high water holding capacity and/or the length of growing period of 180 to 210 days. The magnitude of cotton productivity is very high in six mandals of south-western parts and in three mandals (Talamadugu, Narnoor and Wankhedi) of northern parts of cotton zone. Eventhough, the rainy season begins in second week of June in cotton zone but ends up early in the first week of November in northern parts and late in third week of December in south-western parts. The early withdrawal of south west monsoon is the major factor for very low to medium productivity in thirteen mandals spread over in northern parts of cotton zone because of short dry spells during early crop growth and prolonged dry spells at the time of boll maturity. In addition to rainfall factor, these mandals have a very shallow to shallow Lithic/ Typic Ustorthents with a length of growing period of 90-120 days. It is also observed that very low productivity of cotton is recorded in Utnoor (45.3), Adilabad (66.0), Sirpur (u) (71.7) and Jainoor (86.9) mandals which are associated with moderately deep to deep Lithic/ Typic Haplusterts and receives more than 1500 mm rainfall during southwest monsoon favouring heavy infestation of pests and diseases and resulted to poor yields. The general cropping pattern of cotton zone shows high magnitude of paddy concentration in Lohesra, Sarangpur and Dilwarpur mandals of Swarna and Pochampadu Irrigation product. Redgram + Jowar + Blackgram combination is evident in Adilabad, Bhainsa, Tamsi, Bela and

Talamadugu mandals. The jowar and redgram combination in Wankhedi and Kuntala, paddy and cotton combination in Dilwarpur and Sarangpur mandals were observed where cotton efficiency is very high. In the remaining parts of the cotton zone, blackgram is grown as rabi crop.

Soil types and their potentials : The dominant soil subgroups of this zone are Typic/Lithic Ustorthents, Vertic/Lithic Haplustepts and Typic Haplusterts (Table 5). The soil productivity ratings indicated that these soils qualified for fair to poor grades. The soils in general are poor in nitrogen, phosphorus and organic matter content, which affect the productivity of cotton. The conventional system of cotton cultivation with 'Desi' (local) varieties increases the length of crop period and allows shorter period for regeneration of natural vegetation under hilly terrain. The monsoon rains during crop growing period favours severe erosion on these hill land soils and causes further decline in their production potentials. The productivity coefficient for cotton determined for each mandal with reference to district level indicated that very low crop productivity is associated with poor soils (Lithic Ustropepts, Lithic/Typic Ustorthents) which are spread over 15 mandals of cotton zone. High crop efficiency was observed in soils of fair productivity such as Typic Haplusterts and Vertic Haplustepts which occur in 10 mandals.

A significant positive correlation (Table 6) was observed between crop efficiency and Storie Index, yield and Storie Index, and yield and crop efficiency. The regression equations indicate that there is much scope to improve cotton productivity with better crop management based on soil capability and site conditions.

Table 5. Soils and their productivity of cotton zone in Adilabad district

Name of the Mandal	Dominant Soil Subgroup	Factor of Rating A	B	C	X	Storie Index AxBxCxX	Grade	Class
			Region I					
1. Adilabad	Typic Haplusterts	80	70	100	85	48	Fair	3
2. Jainath	Lithic Ustorthents	95	60	65	86	32	Poor	4
3. Talamadugu	Typic Ustorthents	85	65	65	72	26	Poor	4
4. Tamsi	Lithic Haplusterts	75	70	100	81	43	Fair	3
5. Nevedikonda	Lithic/Typic Ustorthents	75	50	65	77	19	V. Poor	5
6. Inchchoda	Lithic Ustorthents	95	65	60	69	26	Poor	4
7. Indravalli	Lithic Ustorthents	95	50	65	61	25	Poor	4
8. Jainoor	Typic Ustorthents	80	70	75	57	24	Poor	4
9. Kuntala	Lithic Ustorthents	95	60	75	68	29	Poor	4
10. Kubeer	Vertic Hapulstepts	85	65	95	91	38	Poor	4
11. Bhainsa	Typic Haplusterts	80	65	100	77	40	Fair	3
12. Tanoor	Lithic/Typic Ustorthents	95	70	65	45	20	Poor	4
			Region II					
13. Bela	Lithic Haplustepts	80	60	70	73	25	Poor	4

14. Boath	Vertic Haplustepts	85	65	95	81	43	Fair	3
15. B. Hatnoor	Lithic Ustorthents	85	65	75	77	40	Fair	3
16. G. Hatnoor	Lithic Ustorthents	95	65	75	65	30	Poor	4
17. Utnur	Typic Ustorthents	85	65	70	77	30	Poor	4
18. Narnoor	Vertic Haplustepts	85	65	95	86	45	Fair	3
19. Sirpur (U)	Vertic Haplustepts	80	65	95	72	36	Poor	4
20. Dilwarpur	Typic Haplusterts	85	70	100	76	45	Fair	3
21. Sarangpur	Typic Haplusterts	80	65	100	85	44	Fair	3
22. Wankhedi	Lithic/Typic Ustorthents	95	65	75	58	27	Poor	4
23. Kerameri	Lithic Ustorthents	95	60	70	76	30	Poor	4
				Region III				
24. Mudhol	Vertic Haplustepts	85	70	85	81	41	Fair	3
25. Lohesra	Lithic Haplustepts	95	50	75	77	27	Poor	4

Table 6. Relationship of crop efficiency, yield and Storie index

Parameters	(r value)	Regression equation
Crop coefficiency (Y) - Storie Index (X)	0.93	y = 48.2 + 1.62 x
Yield (Y) - Storie Index (X)	0.66	y = 1.88 + 0.06 x
Yield (Y) - Crop efficiency (X)	0.82	y = 0.49 + 0.04 x

Conclusions

The production coefficient studies help in understanding the impact of existing cropping systems by considering productivity as well as sustainability in the agro-ecoregion. It is evident that wide spread conversion of forest land to agriculture is neither economically viable nor socially acceptable by local tribal people. To improve the agricultural economy of the region, the cotton based cropping systems such as intercropping with soybean or pigeonpea, or double cropping with blackgram can be tried extensively on Typic Haplusterts and Vertic Haplustepts. The Lithic or Typic Haplustepts needs soil and water conservation measures for adopting different agroforestry, agro-horticultural systems which are economically viable. Grasslands have to be developed on very poor soils which in turn help in livestock improvement in the region.

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