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SPATIAL PATTERN OF CARRYING CAPACITY OF LAND IN CUDDAPAH DISTRICT

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ABSTRACT: The arable land is a finite natural resource. It cannot feed an indefinite number of people within a measured area. Hence, increasing the carrying capacity of land with the objective of feeding the ever increasing population is of paramount importance. In this study an endeavour is made to assess the carrying capacity of land in Cuddapah District, Andhra Pradesh based on the standard Nutrition Units of both production and consumption. The density of population per hectare of land under food crops is also calculated, which is called as "Food Crop Density". Food Crop Density is compared with the carrying capacity, thus arriving at a population food balance ratio. Based on the population-food ratio, the surplus/deficit areas are identified in the District.

INTRODUCTION

Land cannot feed an indefinite number of people within a measured area. It has a definite capacity in a given situation depending upon the quality of land, landuse and technological level. Starting from the primitive subsistence agriculture to the developed commercial agriculture, the capacity of land to feed people has very much increased. The question whether it is possible to increase the carrying capacity of land with the objective of feeding the increasing population is of importance. Hence, a study of the carrying capacity of land is necessary to understand the man-land relationship.

THE STUDY AREA

Geometrically, Cuddapah District lies between $13^{0}43^{1}$ to $15^{0}14^{1}$ N latitudes and $77^{0}55^{1}$ to $79^{0}29^{1}$E longitudes. It is one of the most economically backward districts in Andhra Pradesh. The district is situated in a semi-arid and drought prone region where the rainfall is inadequate and uncertain to support stable agriculture. The district receives an annual rainfall of only 679 mm.The variability of rainfall in the district is high.The water balance study shows that there is water deficit in all the months of the year.

The district is a part of the Deccan platean and geologically lies in Cuddapah basin. It has a geographical area of 15,253 sq.kms., out of which the net area sown occupies only 29 per cent. About 24.8 per cent of the gross cropped area in the district is irrigated. As the development of irrigation is restricted only to a few pockets in the district, the vagaries of monsoon have a devastating effect on the agricultural economy of the district.

CARRYING CAPACITY

The carrying capacity of land is defined as the number of people that a unit area of land can

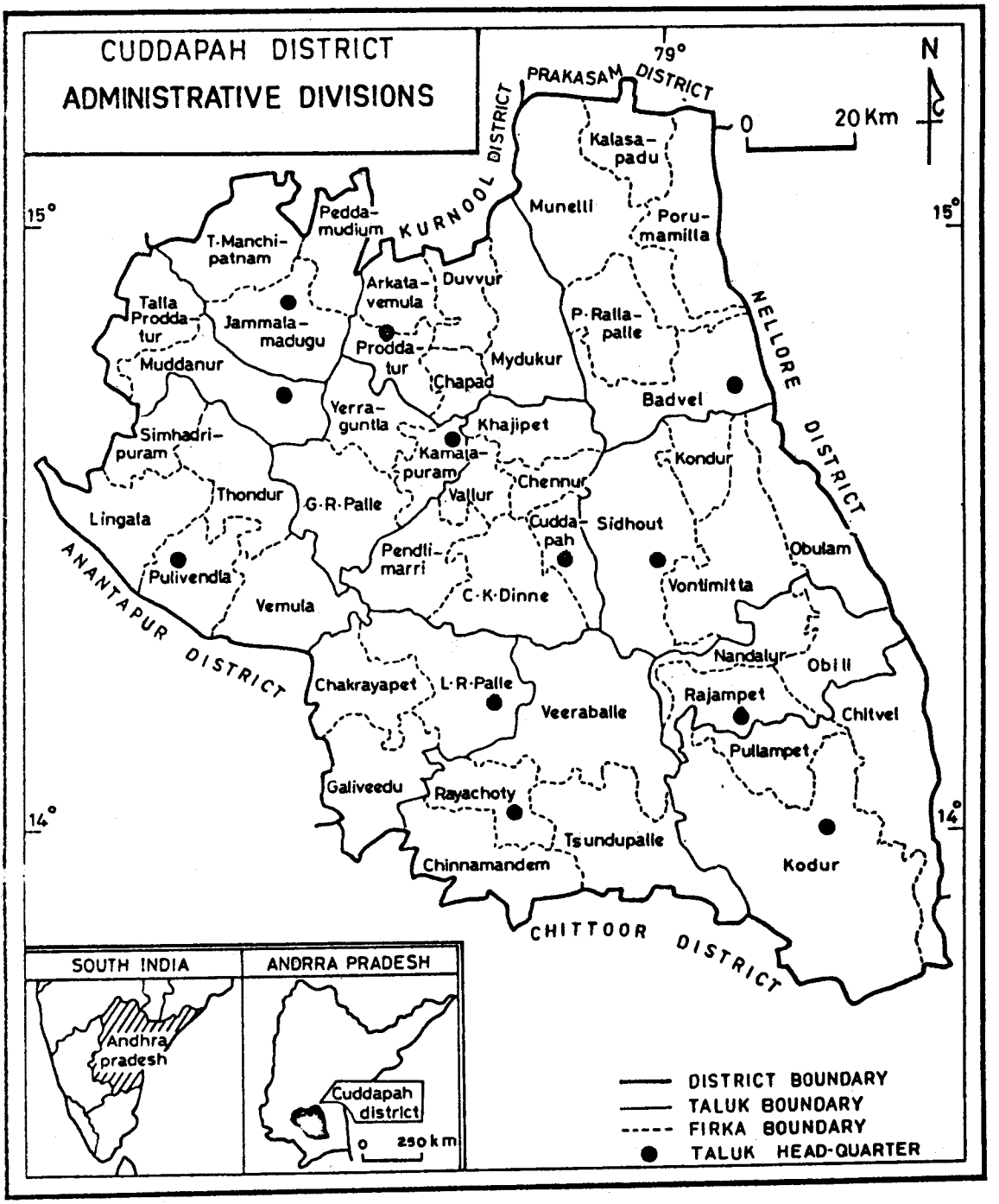

CUDDAPAH DISTRICT
ADMINISTRATIVE DIVISIONS
79°
N
PRAKASAM DISTRICT
0
20 Km
15°
14°
KURNOOL DISTRICT
NELLORE DISTRICT
ANANTAPUR DISTRICT
CHITTOOR DISTRICT
Kalasa-padu
Munelli
Poru-mamilla
Pedda-mudium
T.Manchi-patnam
Arkata-vemula
Duvvur
Talla Prodda-tur
Jammala-madugu
Prodda-tur
Mydukur
P.Ralla-palle
Muddanur
Chapad
Badvel
Yerra-guntla
Khajipet
Simhadri-puram
Kamala-puram
Kondur
Thondur
G.R.Palle
Vallur
Chennur
Lingala
Cudda-pah
Sidhout
Pendli-marri
Obulam
Pulivendla
Vontimitta
C.K.Dinne
Vemula
Nandalur
Obili
Chakrayapet
L.R.Palle
Rajampet
Veeraballe
Chitvel
Pullampet
Galiveedu
Rayachoty
Tsundupalle
Kodur
Chinnamandem
SOUTH INDIA
ANDRRA PRADESH
Andhra pradesh
Cuddapah district
0 250 km
DISTRICT BOUNDARY
TALUK BOUNDARY
FIRKA BOUNDARY
TALUK HEAD-QUARTER

FIG. 1

support at a given technological level and system of landuse. Allan (1949) defined the carrying capacityof land as "the maximum number of people that a given land will maintain in perpetuity under a given system of usage without land degradation setting in". The carrying capacity of land in terms of human biomass can be the standard employed to measure the agricultural efficiency in oriental society, since major share of agricultural land is occupied by food crops. Stamp (1958) opined that "carrying capacity in a sense is a measure of farming efficiency". The concept of carying capacity of land (in terms of population) was introduced by Stamp (1958) in his presidential address to the International Geographical Congress at Rio de Janeiro in 1956. Evidently, the idea struck him in the light of an ever-increasing pressure of population on land resources. For measuring the carrying capacity of land he employed two parameters i.e.(1) Standard Nutrition unit, and (2) Caloric value of Food Crops. Here, higher the caloric output per unit area, greater will be the carrying capacity of land.The concept of carrying capacity has close ties with the man environment theme in geography. The concept is applied both by physically oriented geographers, particularly those interested in soils and crops as well as geographers concerned with behavioural research. "Bio-physical carrying capacity" conducted mainly by Biologists and Foresters encompassed several aspects. The main aim of these studies was to determine the critical limits beyond which physical characteristics like soils, and biological characteristics like flora and fauna are not to be degraded by human activity. In this paper two different approaches are adapted. In the first method the carrying capacity is calculated using the concepts of potential production unit (PPU) and Standard Nutrition Unit (SNU) (Stamp, 1958).In the second approach the available calories per person/ per day from the agricultural production are calculated for an administrative unit. These values are compared with the standard required calories per head per day.This is called food-balance sheet method (Thiwari, 1988).

STANDARD NUTRITION UNIT (SNU) AND POTENTIAL PRODUCTION UNIT (PPU)

Stamp (1958) has suggested the concept of "Standard Nutrition Unit (SNU) and Potential Production unit (PPU)". SNU denotes the number of calories required for an average person to keep him active and healthy. PPU denotes the measure of an average yield of an acre of an average farm land of any area.

For measuring the carrying capacity of land in terms of population, two parameters are to be considered. They are (1) the quantity of food required to support one average person in health and full activity and (2) the land required to produce one SNU consumption of food according to the prevailing type of farming and quality of land.

The standard nutrition unit for production is generally measured above 20 to 25 per cent of the standard nutrition unit for consumption, because this excess goes waste in preparation of food grains for consumption. As per the Food and Agricultural Organisation (FAO) recommendations, the standard nutrition unit implies 1,000,000 calories/annum/average person, which includes a wastage of 1,00,000 calories. But as per the average daily food intake suggested by the Ministry of health, Government of India, the SNU for consumption amounts to 2275 calories/person/day or 830,505 calories/person/annum.In the present study the quantity suggested by the Ministry of Health is adapted as SNU for consumption. Twenty per cent is added to SNU to get SNU for production (996606 Cal./person/annum). the caloric value derived per acre of land based

on the existing cropping pattern is taken as PPU for the given administration unit.

METHODOLOGY EMPLOYED

The carrying capacity is measured in terms of caloric output of food crops, which occupied three-fourths of the cropped area in Cuddapah District. The data on crop concentration and average crop yields for the year 1984-85 is taken into consideration. The production of each food crop is multiplied by its caloric value.The population for the year 1984 is derived by projecting the 1981 population. The aggregate caloric output of all the food crops is calculated making necessary adjustments for wastage which is estimated to be about 20 percent of the total production. To assess the carrying capacity, the total caloric output is divided by the area under food crops to obtain the per hectare food grain output in calories(PPU).Using PPU and SNU for production, the carrying capacity in terms of persons/hectare/year is arrived at for each firka. The density of population per hectare of land under food crops is also calculated, which is called as "food crop density". Food crop density is compared with the carrying capacity thus arriving at firka wisecapacity balance sheet. Based on the balance sheet, the surplus/ deficit areas are identified in the district.

For the present study almost all the food crops except some vegetables are taken into consideration. They include paddy, jowar, bajra, ragi, korra, greengram, redgram, horsegram, bengalgram, gingelly, groundnut, safflower, sugarcane, lemon, oranges, mangoes, chillies, onions and coriander. The following are the parameters used in this study.

1.	PPU		$\frac{\text{Caloric value of the food crops}}{\text{Area under food crops}}$
2.	SNU (Consumption)	=	830505 calories/ person/ year
3.	SNU (Production)	=	996606 calories/ person/ year
4.	Carrying capacity (Persons/hectare/year)	=	$\frac{\text{PPU}}{\text{SNU (Production)}}$
5.	Food crop density	=	$\frac{\text{Population per unit area}}{\text{Area under food crops in the unit area}}$

PATTERN OF CARRYING CAPACITY IN CUDDAPAH DISTRICT

The average carrying capacity of the district is 4.9 persons/hectare/year in 1948-85. But at Firka level, there are wide spatial variations ranging from as low as 1.73 person/ hectare/ year in T. Manhipatnam firka to a maximum 6.92 persons/hectare/year in chapad firka(fig.1.)

(i) Areas with Very High Carrying Capacity : (6.75 person/hectare/year).

Only one firka, namely Chapad showed very high carrying capacity during 1984-85.The very high carrying capacity in this firka is mainly due to its location in a favourable

TABLE - 1

Carrying capacity Indices (Cuddapah District)

S.No.Firka	PPU (Calories/ hectare/year) (Million calories)	Carrying capacity (persons/ hectare/year)	Food crop density (persons/ hectare/year)	Population food balance (person s/hectare/ year)
1. Cuddapah	6.2	6.2	57.1	-50.9
2. Chennur	4.9	6.7	9.4	- 2.7
3. Khazipet	7.4	5.7	8.1	- 2.4
4. Vallur	3.7	3.7	5.7	- 2.0
5. C.K. Dinne	3.6	3.7	6.9	- 3.2
6. Pendlimarri	3.9	3.9	4.7	- 0.8
7. Rajampet	5.9	5.9	9.6	- 3.7
8. Nandalur	5.9	5.9	5.7	0.7
9. Obili	5.4	5.4	5.4	0.0
10. Kodur	5.7	5.7	8.2	- 2.5
11. Pullampet	4.2	4.2	8.4	- 3.8
12. Chitvel	5.7	5.7	4.7	1.0
13. Rayachoty	4.2	4.2	6.4	2.2
14. Chinnamandem	4.4	4.4	3.9	0.8
15. Tsundupalle	4.6	4.7	3.9	0.8
16. Veeraballe	4.2	4.2	3.9	0.3
17. L.R. Palle	3.9	4.2	3.5	0.7
18. Chakrayapet	4.4	4.4	3.5	0.9
19. Galiveedu	3.9	3.9	3.5	0.4
20. Yerraguntla	3.2	3.2	3.2	0.0
21. G.R. Palle	3.2	3.2	2.5	0.7
22. Kamalapuram	4.8	5.8	4.7	1.1
23. Jammalamadugu	2.5	2.5	6.2	- 3.7
24. Peddamudium	2.5	2.5	1.2	1.3
25. Muddanur	3.4	3.5	4.4	0.9
26. T. Manchipatnam	1.7	1.7	1.7	0.0
27. T.Proddatur	2.7	2.7	2.7	0.0
28. Pulivendla	2.9	3.0	4.2	- 1.2
29. Lingla	2.7	3.0	2.5	0.5
30. Simhadripuram	2.9	3.0	4.2	- 1.2
31. Thondur	3.2	3.2	4.4	- 1.2
32. Vemula	3.4	3.5	3.0	0.5
33. Arkatavemula	2.9	3.0	2.0	1.0
34. Mydukur	5.4	5.4	7.4	- 2.0
35. Duvvur	5.9	6.2	5.8	0.4
36. Chapad	6.9	6.9	6.4	0.5

37. Probdatur	3.2	3.5	13.6	-10.1
38. Porumamailla	3.2	3.2	7.9	- 4.7
39. P.Railapalle	2.5	2.5	7.6	- 5.1
40. Badvel	3.2	3.2	9.6	- 6.4
41. Munelli	3.2	3.2	4.7	- 1.5
42. Kalasapadu	3.2	3.2	6.7	- 3.5
43. Sidhout	3.9	3.9	5.4	- 1.5
44. Kondur	4.4	4.4	3.5	0.9
45. Obulam	4.2	4.2	6.9	- 2.7
46. Vontimictta	4.9	5.8	6.7	-0.9
District average	5.0	4.9	6.4	-1.5

Table 2.

Distribution of carrying capacity in Cuddapah District

Carrying capacity (persons/hectare/year	Category	No. of firkas	Percentage in total No. of firkas
< 3.00	Very low	9	19.6
3.00 - 4.25	Low	20	43.4
4.25 - 5.50	Moderate	9	19.6
5.50 - 6.75	Very high	1	2.2
Total		46	100.0

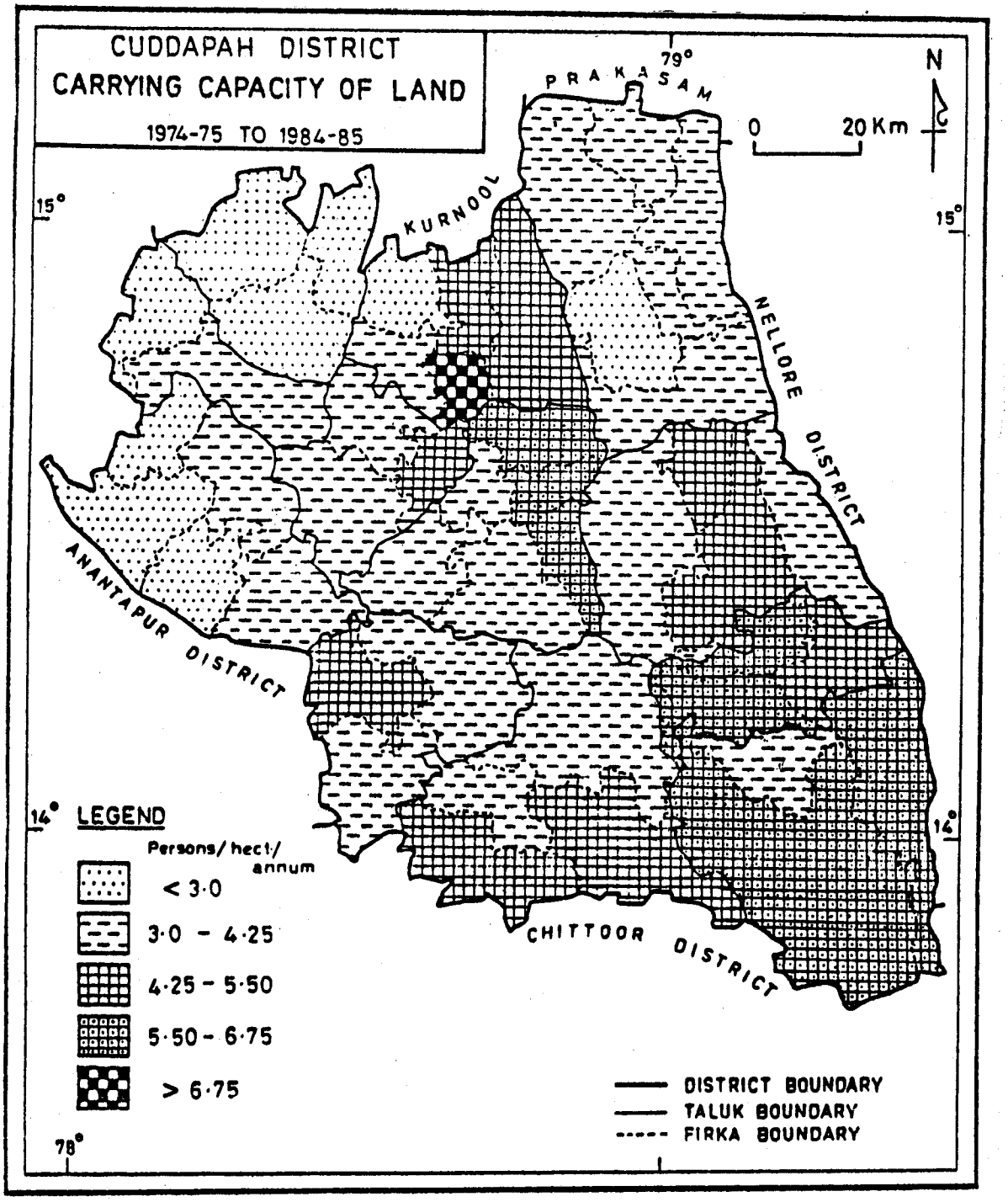
physical environment in the alluvial plain of the Pennar river. This region is mainly covered with red loamy soils.These conditions facilitated in raising a range of crops like paddy, groundnut, pulses, millets apart from sugarcane and fruit crops.The firka has a carrying capacity of 6.92 persons/ hectare/ year.

(ii) Areas with High Carrying Capacity : (5.50 to 6.75 persons/ hectare/year).

High carrying capacity is found in 7 firkas of the district comprising about 15 per cent of the total firkas.These firkas, namely kodur, Rajampet, Chitvel, Nandalur, Cuddapah, Chennur and Khazipet are situated in the central and southern parts of the district which are covered partly or fully by the alluvial plains of the Pennar and its tributaries like Cheyyeru, Papaghni and Kunderu.These firkas are mostly covered by red loans and to some extent by red clays and red sands with almost a flat terrain. These firkas also enjoy comparatively good ground water potential besides having canal irrigation under Kurnool-Cuddapah canal system.All these factors helped to adpt multiple cropping with comparatively better yields resulting in high carrying capaicty.

iii) ModerateCarrying Capacity Areas: (4.25 - 5.50 Persons/ hectare/year).

Nine firkas comprising about 20 per cent of the total firkas are found in this category. They


CUDDAPAH DISTRICT
CARRYING CAPACITY OF LAND
1974-75 TO 1984-85
79°
PRAKASAM
N
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20 Km
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KURNOOL
NELLORE DISTRICT
ANANTAPUR DISTRICT
14°
LEGEND
Persons/ hect/ annum
< 3·0
3·0 - 4·25
4·25 - 5·50
5·50 - 6·75
> 6·75
CHITTOOR DISTRICT
DISTRICT BOUNDARY
TALUK BOUNDARY
FIRKA BOUNDARY
78°

FIG. 2

include Tsundupalle, Chinnamandem and Chakrayapet lying in the south-western part of the district forming the lower part of the Papaghni basin. Obili, Vontimitta and Kondur are situated in the eastern part of the district and located in the confluence zones of Cheyyeru, Sagileru and Pennar rivers. Kamalapuram, Mydukur and Duvvur firkas lie in the Central and Northern parts of the district mainly in the Kunderu valley. These areas are either partly covered by alluvial plains or by the rugged terrain. They form a transitional zone between the alluvial plains and the less fertile piedmont regions. Less fertile soils, low irrigation development has resulted in moderate carrying capacity.

(iv) Low Carrying Capacity Areas: (3.00 - 4.25 persons/ hectare/ year).

This category of land accounts for the largest area covering 20 firkas comprising about 43 per cent of the firkas of the dsitrict. Most of these firkas are located in the mid-western and eastern parts of the district. These areas are mostly covered by red sands and have very poor irrigation backing. The intensity of cropping is very low with nearly 60 per cent of the arable land devoted to a single rainfed crop giving very low yields. Hence, these areas have a low carrying capacity. Jowar, groundnut and pulses are the crops mainly grown in these firkas.

(v) Very Low Carrying Capacity Areas (< 3.00 Persons/ hectare/ year).

Nine firkas of the district come under this category. As many as 8 firkas are contiguous and are located in the north-western part o t the district. Only one firka, namely, P. Rallapalle is located in the north- eastern part of the district. Among all the firkas, the firkas in the north -western part of the district have least agricultural potential with very low carrying capacity. Much of this region forms part of the piedmont and is covered by black loams and clays. It has a very low carrying capacity, since a single rainfed crop is usually cultivated in this zone.

PATTERN OF FOOD CROP DENSITY

The pressure of population on land is generally measured on the basis of the density of population. In some of the studies " Agricultural density" is also used to serve this end. This index is generally used assuming that all the arable land is devoted to food crops. But, usually all the arable land is seldom used to grow food crops. Hence, in the present study only the area under food crops is considered to measure the population pressure. A new index "Food crop density" is used to serve this purpose. Food crop density is defined as the density of population per unit area under food

Table 3.

Pattern of Food Crop Density in Cuddapah District

Carrying capacity (Persons/hectare/year	Category	No. of firkas	Percentage in total no. of firkas
< 3.00	Very low	8	17.4
3.00 - 4.25	Low	10	21.7
4.25 - 5.50	Moderate	7	15.2
5.52 - 6.25	High	8	17.4
> 6.75	Very high	13	28.3
Total		46	100.00

crops.In the present study populations in firkas are divided by the area under food crops in their respective firkas and the values derived are used to study firka-wise spatial patern of food crop density in the district (Table 1).

The district has an overall food crop density of 6.42 persons/hectare/year.But, at firka level, wide spatial variations are noticed. The food crop density variations range from as low as 2.0 persons in the Peddamudium firka located in the northern part of the district to as high as 57.1 persons in the Cuddpah firka. In Cuddapah firka, the high food crop density is mainly due to the location of Cuddapah town, the district headquarters with more than one lakh population.The next highest density is found in Proddatur firka (13.6) which has a large town namely Proddatur.

(i) Very High Food Crop Density Areas : (< 6.75 persons/hectare)

Very high food crop density is noticed in 13 out of 46 firkas. Many of these firkas like Cuddapah, Chennur, C. K. dinne, Khazipet, Proddatur and Mydukur lie in the river valley plain, while others like Porumamilla, Badvel, P.Rallapalle, Obulam, Rajampet, Pullampet and Kodur lie in the piedmont region which has a hilly terrain. Almost all these firkas are located in the central and eastern part of the district. High population and less arable land has resulted in very high food crop density in these firkas.

(ii) High Food Crop Density Areas (5.50 - 6.75 Persons/hectare).

High food crop density is registered in 8 firkas. Among them, Vontimitta and Nandalur are located in the south- eastern part and Kalasapadu firka in the north - eastern part of the district.These firkas are partly covered by hilly terrain although some parts are covered by fertile alluvial plains. The remaining firkas are located either adjacent to big towns like Cuddapah or some medium towns like Rayachoty, Jammalamadugu etc.

(iii) Moderate Food Crop Density Areas : (4.25- 5.50 persons/ hectare).

Out of the 7 firkas in this category, 3 firkas are scattered in the eastern part and the remaining 4 are in the central part of the district. Obili, Chitvel, Kamalapuram, Pendlimarri, Duvvur, Mudanur and Munelli firkas come under this category. Moderate irigation facilities and moderately favourable physical conditions have resulted in moderate density.

(iv) Low Food Crop Density Areas: (3.00 - 4.25 persons/ hectare).

Low food crop density is noticed in 10 firkas constituting about 20 per cent of the totla firkas. As many as 6 out of the 10 firkas are contiguously located in the south-western part of the district.. These ffirkas include L.R.Palle, Veeraballe, Chakrayapet, Galiveedu, Chinnamandem and Tsundupalle. These firkas do not have either medium or large urban settlements. Pulivendla, Yerraguntla, Vallur and Kondur are the other firkas in thid category.

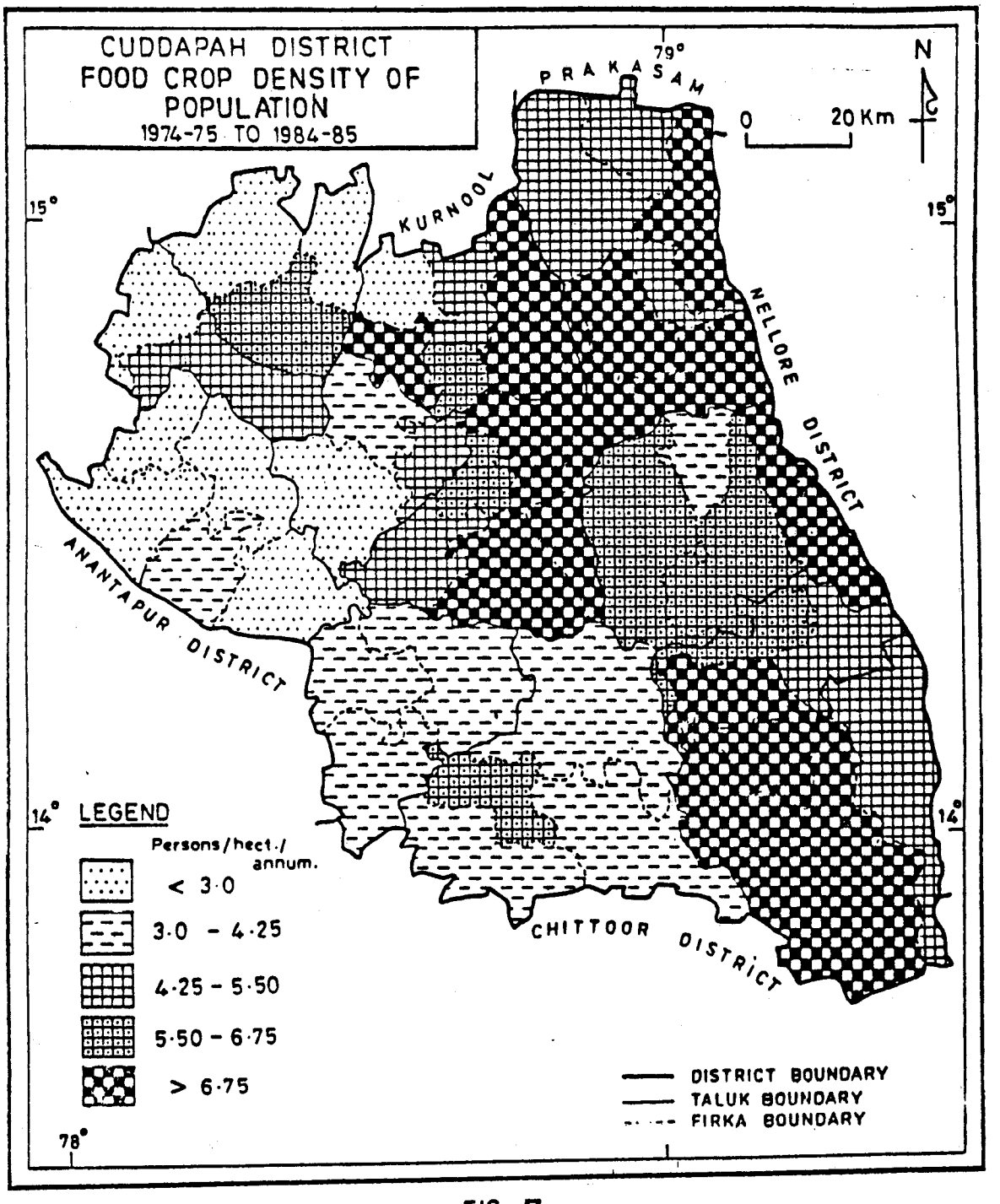
(v) Very Low Food Crop Density Areas:(< 3.00 persons/hectare)

Eithgt firkas have very low food crop density in 1984-85. The entire north-western region of the district falls under this eategory but for only one or two firkas with low or moderate density of population interrupting their contiguity.

POPULATION-FOOD BALANCE

After studying the spatial pattern of carrying capacity and food crop density, population-food ratios are worked out for each firka on the basis of carrying capacity of land. This study helps to identify the areas with surplus carrying capacity and deficit capacity.

The study has shown that the district on the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FIRKA BOUNDARY
78°

FIG.. 3

Table 4.

Population-Food Balance in Cuddapah District
(On the Basis of Carrying Capacity)

Balance (Persons/hectare/year)	Category	Number of firkas	
		Deficit carrying capacity	Surplus carrying capacity
< 1.0	Very low	1	11
1.0 - 2.0	Low	5	8
2.0 - 3.0	Moderate	7	-
3.0 - 4.0	High	4	-
> 4.0	Very High	6	-
Total		23	19

Note: In 4 firkas the carrying capacity is equal to food crop density

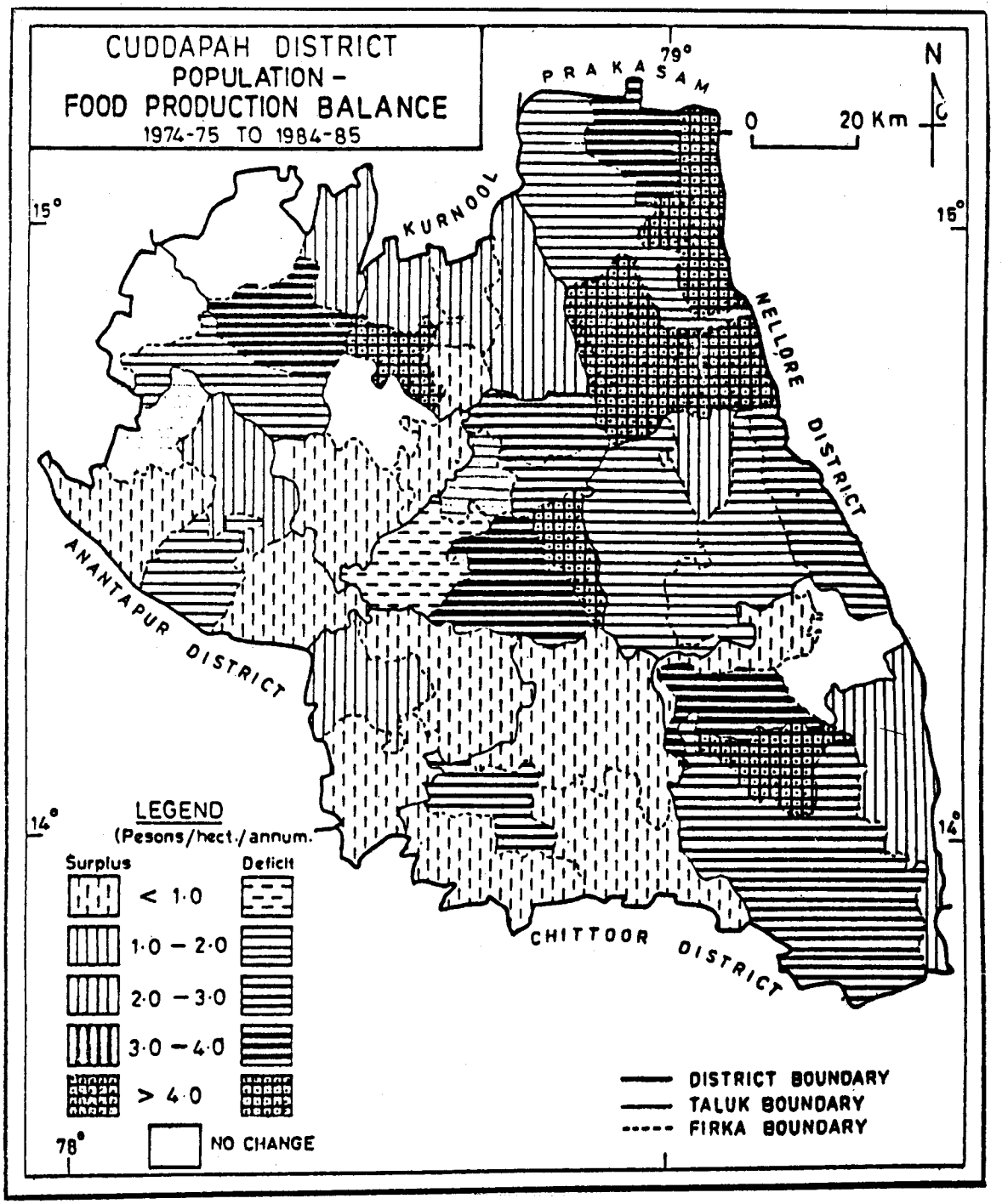
whole has an average carrying capacity of 4.9 persons/hectare/year, while the average food-crop density is 6.42 persons/hectare. It shows that the district as a whole suffers from food deficiency to the extent of 1.5 persons/hectare/year. The firka level analysis revealed that 23 firkas (50% of the firkas of the district) suffer from food deficit while 19 firkas (about 40% of the firkas) enjoy surplus carrying capacity. In 4 firkas namely T.Manchipatnam, T. Proddatur, Yerraguntla and Obili, the existing carrying capacity is just equal to the food crop density.

(i) Areas with Surplus carrying capacity:

Though 19 firkas enjoy surplus carrying capacity, the extent of surplus is not much. Very low surplus of carrying capacity (1.0 persons/hectare) is found in 11 firkas, and low surplus of carrying capacity (1.0 - 2.0 persons/hectare) in 8 firkas. No firka has moderate, high or very high surplus carrying capacity. Most of the firkas with surplus carrying capacity are located in the western part of the district. The firkas with very low surplus are found in the south-western part of the district. They have low food crop density and low to moderate carrying capacity. The firkas with low surplus of carrying capacity are found in the north-western part of the district which is characterised by very low food crop density and low carrying capacity. The above analysis shows that the surplus carrying capacity in some areas of the district is not due to high carrying capacity but due to low food crop density of population.

(ii) Areas with Deficit Carrying Capacity:

The study revealed that 50 percent of the firkas in the district suffer from deficiency in carrying capacity when compared with population. The highest deficiency(-50.9 persons/hectare/year) is noticed in Cuddapah firka because of very high density of population which is due to the location of class-I town in it. However, in general the deficiency in the carrying capacity varies from as low as 0.25 persons in some firkas to a maximum of 10.1 persons/hectare/year in Proddatur firka. In general, firkas which have urban centres within them suffer from food deficiency. The deficit is low (1.0-2.0 persons/hectare)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> 4·0
NO CHANGE
DISTRICT BOUNDARY
TALUK BOUNDARY
FIRKA BOUNDARY

FIG.4

in 5 firkas, moderate(2.0-3.0 persons/hectare/ year) in 7 firkas, high (3.0-4.0 persons/hectare/year) in 4 firkas and very high (4.0 persons/ hectare/year) in 6 firkas. A careful study of the carrying capacity and food crop density distributiion shows that firkas with high deficiency are also have high carrying capacity. In most of the firkas the very high and high deficiency in carrying capacity is due to low carrying capacities but due to high food crop densities.

The overall deficiency of carrying capacity in the district in general and 50 per cent of the firkas in particular, clearly points out that the already degraded physical environment of the district is going to be further disturbed, unless suitable measures are taken to improve the carrying capacity of the land through modernisation of agriculture.The possibility of increasing the agricultural potential in the western part of the district has to be explored, since this part of the district is having the lowest carrying capacity. The physical environment in the eastern part of the district with high food crop density and high deficit of the carrying capacity will be the most vulnerable one in the near future. Since, this part forms part of the already degraded Eastern Ghats, utmost attention is to be paid to the protection of the ecology in this area.This high potentiality should be maintained with suitable soil management measures so the it remains as a food resource for the future generation.

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