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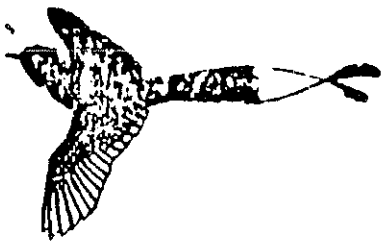

BIOMASS AND SOIL NUTRIENT BUDGET IN KARNATAKA

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INTRODUCTION:

The state of Karnataka has a wealth of natural resources on which man and his livestock fully depend for sustainance. The human population and that of livestock are continually increasing yearly at the rate of 2.67% (census 1981) and 3.31% (census 1983). This surely necessitates proper resource management of biomass which involves a careful and detailed insight of its production, supply and demand.

To arrive at a proper planning of the resource base we have attempted to provide a sketch of the true state of affairs by pulling together as much information as possible for the state.

Karnataka, as a state is rather heterogeneous in terms of land use, croping pattern, soil type, rainfall, livestock population, climate and topography. Thus, the demand and availability of biomass would vary widely in different parts of the state. Thus, for planning the resource it is worthwhile to delineate different regimes which are homogeneous in terms of above mentioned factors. So, the first task was to attempt identifying homogeneous regimes of Karnataka. Having identified these regimes the balances of production and demand of biomass with respect to food, fuel, fodder, manure and shelter has been worked out.

DATA BASE:

Following are the organisations and handbooks from which the data has been collected.

(i) State Bureau of Economics and Statistics.

(ii) State departments of agriculture, forest, animal husbandry and veterniery services and sugar department.

(iii) National Sample Survey.

(iv) Field studies of Ungra village by ASTRA and Uttara Kannada studies by Centre for Ecological Sciences.

(v) Handbooks of Agriculture and Nutrition.

(vi) University of Agricultural Sciences.

(vii) Karnataka Co-operative Milk Producers Federation Ltd.

Talukwise data for 176 taluks of Karnataka were used in delineation of zones:

(i) Area under different agricultural crops.

(ii) Area under forests and barren and rocky lands were estimated from the vegetation map (Sinha 1984, Fig.1) waste land map (NRSA - 1982) respectively.

(iii) Area under urban settlements, fallow, sacred groves and tree crops, cultivable waste and permanent pastures.

(iv) Human and Livestock population.

(v) Soil map (Fig.2).

(vi) Topography map (F.I.P. Maps - Gaussen et.al 1962-65). The administrative and hypsometry maps of Madras, Mysore, Godavari, Bombay (1:5m) and Cape Comorin were compiled together to get the topography map of Karnataka (Fig.3).

(vii) Mean Monthly Rainfall.

The yield data of all the crops for 27 years (1955-81) were also collected from Bureau of Economics and Stastistics, Bangalore.

All other information and assumptions used in preparing the budget has been mentioned at appropriate places in the text.

DELINEATION OF ECOLOGICAL ZONES:

The 176 taluks were sorted out using principal component analysis. Clusters (Distribution of dense points with a wide gap in between) were obained for i) cropping pattern, ii) land use, iii) rainfall, iv) animal population separately. These cluster maps were mapped on Karnataka map.

Superimposing the 7 maps of soil, vegetation, topography, and the cluster maps, we obtained 6 ecological zones for Karnataka (Fig.8). The detailed methodology is as follows:

a. Cropping Pattern:

For identifying the clusters with respect to croping pattern crops were chosen such that at least 5% area is under that crop for all 176 taluks. 13 crops were chosen for this analysis. They are Rice, Jowar, Ragi, Maize, Tur, Pulse, Other pulses, Sugarcane, Groundnut, Cotton, Bajra, Millets and Wheat. In principal components analysis a set of new variables are defined which are linear combinations of the orginal variable (proportion of area under different crops in this case) such that the axes in 13 dimensional space of these new variables are orthogonal. Also variation is maximum along the first axes, next largest along 2nd axis and so-on. The number of principle components selected for analysis depends on the total variance explained by these components. Here for crops the first two principle components explain 83% of variances. Thus any taluk can be represented in A1-A2 space of 2 leading eigen vectors. Principle component

analysis thus reduces the dimensionality of the problem from 13 to 2.

The first component has the highest weightage to rice and lowest to jowar (see Fig. 9a). Second component has highest weightage to ragi and lowest to jowar. Thus in A1-A2 space, A1 becomes rice axes and A2 becomes ragi axes. The distribution of taluks in A1-A2 amplitude space is shown in Fig.10.

We get three dense clusters and scattered points in between. By assigning these scattered points to these clusters using human judgement, we arrive at three clusters namely rice belt, jowar belt and ragi belt. Mapping these taluks on Karnataka map, the three cropping zones were deliniated.

b. Land Use:

In the case of land use we have 6 parameteres namely forest land not available for cultivation, other uncultivated lands, fallow land, net area sown and net area irrigated. In this case the first two principle components explains 76% of the variations. The distribution of taluk in A1-A2 space does not show well defined dense points (see Fig.9b). The first component has highest weightage to net area sown and lowest to forest. Second principle component has highest weightage to forest and lowest to uncultivated area. Here again using human decision 3 groups were made. After mapping on Karnataka we get three clusters. The main regions are:

i. High forested area.
ii. High net sown area.
iii. Moderately high fallow land.

c. Animal Population:

In this case we have 5 parameteres namely human population, cattle population, buffaloes, sheep and goats. 88.4% of the variations is explained by first two components. The distribution of taluks is quite scattered. But again, some groupings were done using eye judgement (see Fig.9c). The clusters map on Karnataka can be seen in Fig.6. The points not hatched are left as boundary points. The regions can be identified as:

i. Zone with low population and high cattle population.

ii. Zone with high population of sheep and goats and high human population.

iii. Moderate livestock and Human population.

d. Rainfall:

We have 12 parameters here i.e., monthly rainfall. The first two principle components explain 98% of the variation. The

distribution of points in A1-A2 amplitude is shown in Fig.9d. The first principle component has highest weightage to July rainfall and second component has highest weightage to June and (-ve) lowest to July. Without going into more detailed clustering methods, approximately the taluks can be assigned to some or the other cluster. The clusters thus derived as shown in Fig 7. We have 5 main regions here.

i. Above 300-350 cm rainfall.
ii. Above 450 cm rainfall.
iii. Above 120-300 cm rainfall.
iv. Above 70-120 cm rainfall.
v. Above 50-70 cm rainfall.

Now, After superimposing the 7 maps of Karnataka the Fig.8. shows the six ecological zones thus deliniated. Now a taluk may be in more than one ecological zone. The data is assumed to be uniformely distributed within a taluk and proportion of area of each taluk is used as weightage for that ecological zone. The six ecological zones are:

- COASTAL ZONE.
- CRESTLINE ZONE.
- NORTHERN TRANSITIONAL ZONE.
- SOUTHERN TRANSITIONAL ZONE.
- NORTH MAIDAN ZONE.
- SOUTH MAIDAN ZONE.

Characteristics of the different zones are sumarized in table 2. Fig.11 and Table 1 shows the land use pattern for the 6 zones.

CHARACTERISTICS OF THE DIFFERENT ZONES:

1. COASTAL ZONE: The coastal region is a narrow coastal plain lying inbetween the Western Ghats and Arabian sea. This zone comes under direct influence of north-west monsoon and receives 320 cm on average heavy rainfall between June to August. The duration of rainfall is 5-7 months and the climate is humid. The soil is coastal alluvial. Coastal sandy soil is found near the coast and further east it becomes lateritic clay. The vegetation near the sea shore is small sized, creeping and scattered. Away from the coast grows shrubs and trees which occupy 7.57% of total area. The special mangrove vegetation exists in a very degraded form. Sacred groves and tree crops occupy 9.53% of the total area. The settlements occupy 12% of the area in this region. This region is characterized by the highest population density of 3.97 persons/ha with livestock dominated by cattle and buffaloes.There are extensive tracts of barren hilly lands and other wastelands (45%) in this zone. The interior plains which was once occupied by evergreen forests have been replaced by agricultural crops which occupy 26.0%. The main crops are paddy coconut and cashewnut.

2. CRESTLINE ZONE: This region lies immediately after coastal zone on the eastern side. This is mainly forested hilly region. The hills are chained and continuous and descend downwards to Tamil Nadu and Kerala. The average height ranges from 600-1350m, near Kudremukh - Bababudan hills the height reaches to 1892m. This region gets heavy rainfall upto 635 cm in Karkala and Belthangady taluks. The average rainfall in this region is around 382 cm. It has lateritic and pockets of red loam soil. The settlements occupy only 4.95% area and has the lowest population density of 1.03 persons/ha. It also has a fairly low livestock density of .62/ha with 75% cattle, 20% buffaloes and 5% goat and sheep. The region exhibits luxuriant dense vegetation which embounds various timbers of great importance. The area under forests in this region is 61.1%. The vegetation ranges from evergreen to other degraded physiognomies to scrub and scattered trees and shrub types. Large tracts of vegetation has been cleared for growing tea and coffee. The barren areas occupy 2.3% and other uncultivated wastelands occupy 11.55% of the total area.

The cultivated area is the minimum of around 15%. The main cereal crop is paddy which is grown in the valleys. Coffee and tea is cultivated on the hill slopes. Several varieties of spices, like, pepper, chillies, cardamum are the specialities of this region. The area under sacred grove and tree crops is 4.87%.

3. NORTH TRANSITIONAL ZONE: The third zone lies adjacent to northern crestline zone, extending from Belgaum to Chikmagalur. The average height of the plateau varies from 300-600 m above sea level. The average rainfall is about 162 cm and the soil is lateritic and red loam.

The vegetation is mainly deciduous type and the forest area is around 28% of the total land.

Population density is moderately high with 1.82 persons/ha and the area under settlements is 5.3% of the zone. The livestock density is 1.062/ha with 67% cattle, 19% buffaloes and 14% sheep and goats.

Barren and rocky areas cover 2.18% and other uncultivated wastelands 14.91% of the total area. Cultivated lands are moderately high in this region occupying 48.38%. The main crops are paddy, jowar and groundnut. The sacred groves and tree crops coverage is only 1.46% of the total land.

4. SOUTH TRANSITIONAL ZONE: This zone is an extension of north transitional zone towards south and lies adjacent to southern crestline zone.

The north and south transitional zones represents a region of transition to the Deccan Plateau and lies at an altitude of 600-900 m. It receives an average rainfall of 200 cm and has a mixture of red loam and black soils.

The urban settlements occupy 6.67% and the population density is quite high in this zone having 1.44 persons/ha. The livestock density is 1.05/ha and it constitutes 64% cattle, 10% buffaloes, and 26% of sheep and goats. 49% of the area is under forests which is the next highest and comprises mostly mixed plant species of dry and mosit deciduous types. Barren areas are around 5.55% and other wastelands are nearly 1.54%.

The sown land is 34% and the main crops are rice, ragi and coffee.

5. NORTH MAIDAN ZONE: This region is an undulating plain, situated in the northern Deccan Plateau region at an elevation ranging from 300-900 m. The rainfall is low and highly variable with an average of 66 cm a year. There is a long dry season of 7 to 8 months. The soils are fertile and mainly comprises of black cotton soil.

The forest area is only 2.4% and is of scrub type. Practically all the existing forests in this dry zone are confined only to hilly tracts and the plains have been gradually brought under cultivation. The hilly tracts are quite often barren which produces nothing and covers 8.36% of the area.

The area under cultivation is 68% which is the maximum in comparison to other regions. The main crops are jowar, cotton, groundnut, pulses, millet and sugarcane.

The area under settlements is 4.21%. The population density is 1.66 persons/ha in this region. The livestock density is medium of 1.017% ha, which is constituted by 38% cattle, 17% buffaloes, 21% sheep and 24% goats.

6. SOUTH MAIDAN ZONE: This is the southern Deccan Plateau which is an undulating plain with small hillocks with an elevation of 600-900 m. The rainfall is very low, on an average it is around 74 cm and confined to 4-5 months. The soils are red sandy and red loams. There is a relatively high population density of 3.0 persons/ha and 1.617 livestock/ha. The livestock is made up of 45% cattle, 13% buffaloes, 26% sheep and 17% goats.

The forest area is 5.33% with mostly scrub and deciduous type of forests. The vegetation is potentially dry deciduous type but due to overexploitation it is reduced to scrub. The barren and other uncultivated lands constitute a fairly large area covering 36.65% of the area. The settlements also has the highest coverage of 9.22% of the region. The sown area is 47%. The main crops are ragi, rice and pulses.

Overall, in Karnataka the forests occupy 14.17% barren and rocky areas 7.15%, cultivated area 52%, settlements 6%, sacred groves and tree crops 1.64% and uncultivated wastelands (permanent pastures, fallows, cultivable waste). The state has a population density of 1.98 persons/ha and livestock density of

1.03/ha. The livestock comprises of 47% cattle, 15% buffaloes, 38% sheep and goats. 14.3% of the sown area is under irrigation. The cultivated area is 9.9 million hectare, out of this 6.59 million hectare is under grains, 1.06 million hectare under pulses, 0.15 million hectare under sugarcane and 0.82 million hectare under coconut, groundnut and oil seeds. Fruits and vegetables occupy 0.03 million hectare.

BROAD MODEL OF BIOMASS PRODUCTION AND DEMAND

All the agricultural and forest produce comes from solar energy through biomass based on photosynthesis. An evaluation of biomass production, utilization and demand has been undertaken and is outlined in Fig.12.

The biomass producing lands (terrestrial)are the following category of lands.

i) Forests, sacred groves and tree crops

ii) Uncultivated lands - this category of land include fallows, cultivable waste permanent pastures, barren and rocky lands.

iii) Cultivated land

i) Forests: Forests produce substantial amount of biomass on which depends the fuel, fodder, timber, leaf manure and other commercial requirements.

Forests can be broadly classified into two categories for our convenience. a) Reserved forests, b) Community forests -, these forests include protected, unclassed and village forests. The reserved forests produce several varieties of hard and soft wood timbers of great commercial use. The forest department supplies 5-7 lakh tonnes of firewood for domestic use. The community forests mainly has to bear the burden of common mans need of fuel, fodder, timber and leaf manure.

The minimum requirement of fuel for cooking is 0.84-0.98 Kg/day/capita wood or 3192-3700 K cal fuel. Out of the total demand 36.5% of urban and 17.2% of rural fuel demand is met by other sources than firewood (NSS-1981). The mode of collection of firewood is 44.42% by purchase of wood, 42.67% by lopping shrubs and twigs and 12.91% by gathering in dry zones (Ravindranath et al. 1981). In the wet zones 43.17% of firewood is collected by purchase and 56.83% by lopping shrub and twigs (Misra.et al. 1984)

ii) Uncultivated lands: All the uncultivated lands are available for livestock grazing. These lands except barren land have an average productivity of 5t/ha/yr (barren lands are assumed to produce only 2t/ha/yr), but only 20-50% of this production can be obtained by the livestock as most of the lands are covered by unpalatable plant species.

The livestock produces fresh dung which is (1:2) proportional to the feed it ingests (personal communication - Farooque Mohammed-1985). This has also been verified by comparing the Nitrogen content as intake (feed) and egestion (dung and urine). It has been assumed that 10-30% of the produced dung is not collected due to its inaccessibility in the remote forest areas. A considerable amount of 0.0563Kg/day in rural and 0.0196 Kg/day in urban (NSS 1981) per capita is wasted as fuel. Most of the collected dung is assumed to be used as manure for enhancing the fertility of agricultural crops.

(ii) Cultivated Lands: Huge quantities of agricultural biological mass comes from cultivated lands. This agricultural produce satisfies the hunger of human as well as livestock.

Food Items:

The main agricultural crop in all the regions are cereals. Approximately 3.4% of the grains is assumed to be wasted as post harvest losses or storage losses and 4.6% of the grains is used as seeds.

Depending on production and demand of calories of 2134 K cal/capita (explained later in the text) in the region for the various food items, the region has to import or export the food items. The non-edible portion of cereals are mostly fed to animals.

Out of the total sugarcane production approximately 40% was diverted for jaggery making (Indian Express, June 1st, 1985). It has been estimated that 50% of the remaining sugarcane has been used for sugar making and 10% as cane juice etc.

The production of sugar is 11%, Bagasse 27% and mollasses 2.7% of the sugarcane (Prasad 1969). Only 5% of the bagasse may be available for marketing for preparation of paper, cardboard, and other commercial items. The remaining 22% of the bagasse is utilised by the factory itself for its fuel purpose. The mollasses produced can be either fed to animals or can be used for preparing alcohol.

The production of jaggery is 9% and bagasse 50% (Sugar department - personal communication). The bagasse produced here is usually entirely used as fuel for preparing jaggery.

The oil seed kernels produces 60% as oil cake and 40% as oil. The edible portion of oil is used for cooking and non-edible portion of oil is used for soap making, varnish, paints etc. The edible part of the oil cake is used as cattle feed and non-edible as manure. In general, edible oil cakes are fed to animals and the dung enriched by feeding cakes as manure later.

Large quantities of fishes are produced in the differen water bodies of Karnataka.

Agricultural residue: Large quantities of biomass produced as agricultrual wastes from the agricultural crops. These are being used variously such as fodder, fuel, thatch, manure and other economic usages. It has been estimated that approximately 92% of the produced stalk from cereal crops is used as fodder, 4% as thatch, 2% as manure and 2% other usages.

Major portion of cotton stalk, groundnut shell coconut shell, leaves are used as fuel. Groundnut shell is also used in preparing crude card-board. Coconut husk is the main source for making coir.

Paddy husk is mainly used as fuel in most parts of Karnataka. In some places it is left for decomposition so as to enrich the soil.

Coconut leaves and arecanut leaves are used for mulching, fuel and thatching purposes. The upper tender portion of the leaves (66%) is used as thatch, while the down rachis portion (33%) is used for mulching and burning.

It is estimated that half of the decomposed thatching material is available for manuring purpose every year.

The stubble and root of the cereal crops left in the field contribute towards fertility of the crop field.

The agricultural wastes produced from plantation of crops of other crops, is on average 2t/ha/yr. It is assumed that 40% of the agricultural waste produced from this category is used as fodder, 40% as fuel and 20% as manure.

FOOD

Annual production of different food items (based on 27 years average yield and assuming 3-4% of the production of cereals goes as post harvest losses and 100 Kg/ha as seeds) is given in the table.3.

With the population of 37 millions, per capita availability works out to be 599 gm of grains, 22.7gm of pulses, 84gm of sugar, 12.8gm of oil, 8gm of fruits and vegetables, 14gm of fish and 103gm of milk. Converting these into calorific & protein terms, 2706 K cal and 44.6 gm are available to a person per day.(Fig.13). Now the requirement of calories per capita is equal to

$$G + Mb + Ma \qquad \text{(Michell 1979)}$$

Where,

$$Mb = 70 \times W^{.75}$$

$$G = \left|\frac{W}{Days}\right| \times 2500$$

Ma = 30-50% of Mb in case of light work
= 60-100% of Mb in case of heavy work
W = Average weight of animal
Days = Average life span

Here, for our calculation average weight of the human being is assumed to be 50 Kg and average lifespan to be 60 years.

With these assumption the calory requirement per capita per day is 1717 K cal for light work, 2638 K cal for heavy work and 2045 K cal for moderate work.

We also require 0.8 gm of protein per day for each Kg of body weight i.e 40 gm of protein is required for each day for each person.

Table.4 shows the per capita availability of food in terms of calories and proteins for each zone. Coastal, crestline, and South maidan regions are deficit in caloric terms by 61.7%, 21.9% and 5.6% respectively. Coastal, crestline, north transitional zone and south maidan zones are deficit by 54.3%, 43.5%, 10% and 16% in protein terms. Overall the state has 27% and 12% excess of food in caloric and protein terms. But if we consider the average yearly increase of 2.67% then with the same production our state will be just sufficient in caloric terms in 1991 and about 11% deficit in protein terms.

This analysis however ignores two complexities. Firstly, food production is not uniformly distributed in all the regions. This will depend on climate, irrigation facilities, soil types etc. Secondly, a large portion of the states population does not even earn enough to buy adequate quantities of food even though they may be available.

IMPORT AND EXPORT OF FOOD GRAINS

Cereals: The total annual requirements of cereals in Karnataka would be 67-68 lakh tonnes assuming that the average per capita per day consumption is o.5 Kg of cereals, which would be equivalent to 40gm of protien. The Central Government (table below) through Food and Civil Supplies, Government of Karnataka provide 11.34 lakh tonnes of cereals per year and the total average annual cereal production is 81.5 lt. Therefore, the excess quantity of 24.84 lakh tonnes of cereals can be exported out of the state annually.

Pulses: The annual pulse production of the state is around 3.1 lakh tonnes whereas the annual requirement would be 20 lt if 0.15kg/day/person is consumed (Misra et. al 1984) which is equivalent to 4gm of proteins. But as 66-82% (Nair & Sumithra 1985) of the population are facing poverty and if we assume that 66-82% of the population are able to consume only half of the pulses requirement, then the state would need 7.49 + 5.26 = 12.76

lakh tonnes. Thus our state would import 7.8 lakh tonnes of pulses.

Sugar: Our State is estimated to produce 11.75 lt (7.12 sugar + 4.56 jaggery). The sugar goes to the central pool of sugar. If our daily sweet requirement is 40gm/day/capita then the total sweet requirement would be 5.4 lt. The Central Government provides 2.02 lt and some additional sugar to our state.

Oil: The total cooking oil requirement, on the basis of 8.75gm/day/capita would be 1.18 lakh tonnes/year. The Central government supplies 0.56 lt of cooking oil. It is estimated that groundnut and coconut can produce around 1.78 lakh tonnes of oil.

Quantity of food items supplied from the Central Government

Sugar	16491 quintals/month (factory sugar)
	- 20000 quintals imported sugar (irregular supply/month)
Palmolein	- 4700 m tonnes/month
Rice	- 57500 m tonnes/month
Wheat	- 37000 m tonnes/month

Source: Food and Civil Supplies

Milk Production:

The production of milk is a function of the animal breed, the quantity and quality of feed taken by the animal. The ratio of feed intake and milk produced for local and cross-breed animals are 1 kg : 0.16 litre and 1 kg : 0.29 litre respectively. (Karnataka Co-operative Milk Producers Federation Ltd)

The production and per capita availability of milk in the different zones has been given in the Table.5. Per capita availability per day is far less tahn the average requirement of 220 gm per day per capita of milk (Report of the National Commission of Agriculture Part II).

Agricultural Waste:

On average, each hectare of cultivable land can produce 2 tonnes of waste in a year (Commission on Agriculture). Here, we have attempted to estimate the actual quantity of waste produced from each crop as far as possible from several sources. The ratio of edible and non-edible portions for paddy, groundnut, cotton have been taken from Vimal & Tyagi (1980), jowar, ragi, maize, bajra, wheat and sugarcane from Department of Agriculture, Bangalore (1985). The production of coconut and arecanut leaves have been taken after Prasad (1984). Coconut shell and husk has worked out to be 1440 Kg/ha and 2385 Kg/ha/yr respectively. The total agricultural waste produced in Karnataka is estimated to be 256.6 lakh tonnes (Table.6).

The waste produced from the different crops have also been verified by Harvest index method (Mitchell 1979).

(Kg harvest) x Hi = Kg Crop

Hi = Harvest index

The growth budget data for plants are generally limited to aboveground production and are after given as harvest index (Hi) which is proportion of harvested biomass that is the crop.

Stubbles and roots produced by the various cereal crops have been calculated by considering that per hectare of paddy, jowar, ragi, wheat and maize produce 1.5 tonnes of root and stubbles and that of bajra, millet, high yielding and other crops produce only 1.0 tonne (Shivashankar - personal Communication).

FUEL

The available food has also to be cooked. With 500 gm of grains and 200 gm of pulses and other items, the daily requirement of 0.84-0.98 kg of fuelwood (or 3192-3700 K cal) per day or 124 lakh tonnes firewood per year (168 lt in 1991) is needed with the present efficiency of woodstoves. The figures were arrived at by considering that 1/2 kg of cooked material require 200 gm of wood or 760 K cal (M.S Hegde - porsonal communication). The ratio between cooked and uncooked food material worked out to be 3.0-3.5:1.

In Karnataka 36.5% of fuel needs of urban and 17.2% of the rural population is met by other sources, like kerosene, electricity, LPG, etc (NSS 1981). This implies that an annual requirement of 85-92 lakh tonnes of fuelwood for the state for cooking alone. There are additional domestic demands for water heating.

Substantial part of the fuelwood demand is met through burning agricultural wastes namely, coconut shells, coconut and arecanut leaf rachis, groundnut shells, paddy husk and cotton stalk. Total agricultural wastes going as domestic fuel is around 60 lakh tonnes (Table.8). It can be seen that agricultural wastes meet almost 50% of the fuel needs of the state. The cotton sticks in north maidan zone provide a very substantial input towards meeting fuel needs. Part of the fuel needs of 5-7 lakh tonnes is met by fuel supplied through forest depots. Approximately, 5.5 lakh tonnes of dung is also used as fuel mainly in dry regions.

Around 32 lakh tonnes equivalent fuel is used as by other sources like, electricity, LPG etc. The remaining 21 lakh tonnes is required to be met from 11.8 lakh hectares of protected, unclassed village and private forests and wastelands. As the wastelands at present are unlikely to produce anything under the present conditions, whole pressure is mostly exerted on the above mentioned unreserved forests. This is in a demand of 1.75-2

But again of the balance 13.37 lakh tonnes only 3.31 lt of fodder is available from agricultural lands. In zone three, 7.30 lakh tonnes of grazing can be possile from 3.77 lakh hectares, but the cultivated land provides only 4.2 lakh tonnes of the needed 7.3 lakh tonnes. In zone four 15.97 lakh tonnes of fodder is feasible to be met from 9.7 lakh hectares of uncultivated land, leaving aside 2.62 lakh tonnes of fodder. However, again of the required 15.97 lakh tonnes, only 9 lakh tonnes is available from agricultural lands. In these four zones there is reasonable availability of grazing in the wet season, but acute shortage in the dry seasons.

In the fifth zone the required 72.6 lakh tonnes of fodder can be met from agricultural wastes. But the grazing lands produces only 21.6 lakh tonnes of the required 72.6 lakh tonnes. In the sixth zone out of 62.85 lakh tonnes needed fodder only 38 lakh tonnes of fodder is available. Whereas, out of 62.85 lt fodder required only 37.87 lakh tonnes of fodder may be produced from the grazing lands. This must imply that animals are almost totally on a starvation regime in the latter half of the dry season. The maidan regions are also tracts of very erratic rainfall, the situation becomes all the more difficult in years of scanty precipitation.

Fodder demand and production in Karnataka as a whole can be seen in Fig.15.

All over the state the situation that prevails is one of exhaustion of fodder from cultivated land, simultaneously with complete drying up of natural grass growth in months of February to April. When thus desperate, the animals will graze on anything and everything, damaging in this process all chances of regeneration of tree growth. In this season, the villagers also set fires everywhere, hoping to stimulate some fresh growth with the early pre-monsoon showers. These fires further damage young tree growth and seedlings and saplings.

In Karnataka 26.14 million livestock (1983) require 357 lakh tonnes of fodder and in 1991 if the rate steadily increases (3.3%, 1977 onwards), the fodder requirement would be 460 lakh tonnes for over 33 million livestock.

Import and Export of Fodder:

According to the records of Animal Husbandry department there is no import or export of fodder from Karnataka..

During 1985-86 drought period 3993 tonnes of fodder was purchased from Punjab (Jan-March 1986). Some quantity of bagasse was brought from Belgaum Sugur Factory also.

Thus, it is clear that our state though produces less fodder than the actual requirement for livestock very little or negligible quantity of fodder is imported. Therefore, our livestock exerts a great pressure on the grazing lands and so

forth the quality of these lands year by year continues to deteriorate.

MANURE

A major demand on plant biomass is for use as manure to replenish the nutrients removed from the soil through harvest of food grain, plantation crops and other produce. It is therefore, essential that nitrogen, phosphate, potash and other nurtients thus taken out must be replenished by the use of chemical fertilizers as well as organic manure.

We have worked out the nutrient budget (N,P,K) of the states cultivated land. The nutrient contents removed from the soil were based on the production of 27 year yield average and the value of N P K removal was taken from Agriculture Handbook.

Our calculations indicate that harvests lead to a removal of 1.595 lt of nitrogen, 0.512 lt of phosphate and 2.27 lt of potash from land under local cereal grains. 2.653 lt of Nitrogen, 1.135 lt of Phosphate and 2.33 lt of Potash are removed from land under plantation crops, commercial and high yield cereal varieties and other crops.

A total of 2.14 lt of Nitrogen, 0.93 lt of Phosphate and 0.79 lt of Potash is returned through chemical fertilizers. (Fertilizer Association of India 1984). This would leave a balance of 2.11 lt of Nitrogen, 0.717 lt of Phosphate and 3.8 lt of Potash. This is met partly by roots and stubbles left standing in the crop to the tune of 0.326 lt, 0.377 lt and 1.107 lt and other agricultural wastes including decomposed thatch to the tune of 0.2062 lt, 0.97 lt and 0.30 lt for Nitrogen, Phosphate and Potash respectively.

The livestock of the state are expected to produce 53.65 lt of dry dung.(Table.11). Now assuming 80% of this is collected and out of which 5-6 lt of dung is used as fuel, then only 42.9 lt of dung would be available for manuring. This would provide about 0.643 lt of Nitrogen and 0.6 lt of Phosphate and 0.6 lt of Potash. Now let us assume that about 3 tonnes of leaves are removed per hectare from 11.78 lakh hectares of unreserved forest. If so, this would provide 0.56 lt of Nitrogen, 0.189 lt of phosphate and 0.647 lt of potash.

In addition a total of 0.42 lt of Nitrogen are returned through the cultivation of leguminous green manure crops.

With all these rather generous estimates the total returns are 4.29 lt, 2.19 lt and 3.49 lt as against 4.25 lt, 1.65 lt and 4.6 lt of Nitrogen, Phosphate and Potash respectivley.(Table.12). It is clear that Nitrogen and Phosphate returns, just equals to that of removal, while potash removal is 24% higher. (This analysis doesnot account for the loss of nutrients from soil by leaching). This holds good for average crops production only. Apart from the above mentioned crops almost 3.2 lakh hectares of

tree crops are required to be manured atleast once in two years. In order to get higher yields with the use of better varieties during the recent years, much more nutrients have to be added to soil to prevent the depletion of soil fertility. It is worth mentioning that half of the nutrient demand is met through chemical fertilizers. A regular use of chemical fertilizers may deplete the soil fertility by over exhaustion of micronutrients. Therefore, though we are returning enough macronutrients (for average yields)but the micronurtrients through organic manures are not added as is required. Therefore, there is continual depletion of our cultivated lands.

SHELTER

A major component of demand for plant biomass is for constructing houses and huts. The urban demands are for bricks, tiles and wood for doors and windows. The rural mass demand is for small timber and thatching material.

No concrete data is available on this requirement, we have tried to collect as much information as possible and pool it together.

Studies conducted by Misra et al (1984) at Unchungi village and Prof. Jagadish (Personal Communication) at Ungra village have been taken as the data base for Malnad (I-IV zones) and dry region (V-VI zones) respectively. The studies have the following observations:

a) Out of the total rural houses, 64% are thatched in Malnad and 22.4% in dry zones.

b) Out of the total rural houses in Malnad and dry regions - 35.8% and 68.18% are tiled and 41.04% of the walls of these are made of burnt bricks.

c) 21% and 40% of the animal huts in Malnad region are thatched with straw and leaves respectively.

d) We have assumed that all the houses in the urban sector are cemented.

Thatch:

Let us assume that average per capita requirement of land is 50 sq feet, 40 sq feet and 20 sq feet for human beings, cattle or buffalo and sheep or goats respectively. To cover 2'x1' area with straw the requirement is 2 Kg and 5'x2' area by leaves would be 4 full coconut leaves (without rachis) or 16 Kg leaves by weight.

Based on these assumptions the total estimated annual requirement of thatch for rural huts and animal sheds work out to be 2.02 lakh tonnes, 1.47 lakh tonnes of straw and 3.33 lakh tonnes, 4.48 lakh tonnes of leaves respectively. (Table.13)

Overall a total biomass of 11.3 lakh tonnes is required for thatching purposes annually. As the thatching material decomposes fast it has to be replaced every year.

Timber, bricks and tiles required for housing:

A number of new houses are built every year. A study conducted by Prof. Jagdish in Ungra village has shown that new houses come up annually on an average rate of 1% of the population. We have attempted to come with estimates of the various usages of timber, bricks, tiles requirements for housing.

The following generalisations have been made. [The timber requirement for each house was based on studies of Mr.Basu (Personal Communication)]

I. Urban Sector

a) All the houses in urban sector are cemented and the built area is 720 sq feet.

b) Each house requires 17000 bricks (Mr. A. Badami Personal Communication). The fuelwood required to make bricks is 450 Kg/1000 bricks and the timber required for doors and windows is 0.6-0.7 M3.

II. Rural Sector

a) All the tiled houses in rural sector have an inbuilt area of 720 sq feet.

b) Each house requires 1440 tiles and the fuelwood required to make tiles is 450-500 Kg/1000 tiles.

c) 41.04% of the tiles houses use bricks for the walls and each house requires 17000 bricks.

d) Timber requirement for doors and windows is around 0.6-0.7 M3.

e) Timber required for roof of tiles houses is about 54 F3.

f) Timber required for roof of thatched huts is about 15 F3/hut.

g) Timber required as poles of thatched huts is around 16.25 F3/house

The total requirement of timber for urban and rural houses has been shown in Table:14 & 15. It can be seen that for urban houses 0.49 lakh tonnes of timber is needed for doors and windows and 8.8 lakh tonnes of firewood is needed to make the bricks. For the rural houses the timber required for windows and doors are 0.677 lakh tonnes. Timber for roofing thatched and tiled houses are estimated to be 1.7 lakh tonnes. Poles for the

thatched houses works out to be 0.24 lakh tonnes. The overall timber requirement for housing is estimated 3.15 lakh tonnes and firewood required for preparing bricks and tiles comes to 14.85 lakh tonnes.

An additional quantity of timber as poles and roof beams works out to be 0.203 + 0.0615 + 0.101 + 0.0162 = 0.43 lakh tonnes for animal huts. Fuel required to make the tiles is estimated around 0.598 + 0.0181 = 0.08 lakh tonnes.

The total states requirement for housing 3.68 lakh tonnes of timber and 14.93 lakh tonnes of fuelwood for bricks and tiles. The forest department supplies approximately 1.08 lakh tonnes of wood and 128413 poles (No) shown in the Table below. This has to meet the furniture and other urban demands as well.

The production of timber and Forest produce during 1983-84 (upto the end of Dec)*

Rosewood	- 3503 M^3
Teakwood	- 7644 M^3
Sawn timber	- 2975 M^3
Other timber	- 89437 M^3
Poles	- 128413 (No)
Bamboo	- 19767 (tonnes)
Plywood	- 31811 M3

Estimated to be equivalent to 1.084 lakh tonnes + 128413 Poles.

(* Source: Forest Department)

Industrial Demand:

It has been reported that as a result of shortage of wood raw material supply almost all the industrial units on average are working less than half of the installed capacity. (Table: 16a,b,c,d).

Forest Production:

The total annual aboveground production of the forests is estimated to be 276 lakh tonnes and the growing stock is 187.6 million cubic meter. (Table:17). The evergreen and semievergreen productivity has been taken after Rai 1982 (9-10 t/ha/yr). Deciduous forests (dry deciduous, moist deciduous, secondary deciduous) has been estimated to produce 12-15 t/ha/yr. Scrub produces 8-12 t/ha/yr. (Ravindranath et al 1982 have estimated 12 t/ha/yr). Thicket, scattered trees and shrubs and

scrub type of forests must be producing around 5-8 t/ha/yr.

Now, if we consider that 60% of the total production is contributed by wood and 40% by leaves and branches, then the total annual production of wood works out to be 166 lakh tonnes. 87% of the wood production i.e., 144.4 lakh tonnes of wood can be utilised for fuel purposes, 11% or 18.26 lakh tonnes as timber and 2% or 3.32 lakh tonnes as industrial raw material. The forest department extracts only 1.7 million cubic meter or approximately 12.85 lakh tonnes of wood. (Shyam Sunder 1985). Apart from that available from the reserved forests a maximum of about 20-25 lakh tonnes of wood is expected to be extracted from unreserved forests (unclassed and village forests, private forests etc.,)

Thus, the remaining 106 lakh tonnes can possibly be exploited from the forest based on our estimations. But, at the same time the existing trend of deterioration in forest cover is evident (Sinha 1987) and cannot be overlooked. Estimates of domestic consumption alone work out to the magnitude of 370 lakh tonnes (Subramanian 1985). Wood also is utilized by others like, industries, brick and tile factories, sericulturists, hotels, canteens, bakeries and crematoriums etc,. From all these it becomes apparent that the wood extraction far exceeds the optimum.

The Production of Timber and Forest Produce during the year (1983-84 end of December 1983):*

Rosewood	- 3503 M^3
Teakwood	- 7644 M^3
Sawn timber	- 2975 M^3
Other timber	- 89437 M^3
Pulp wood	- 11054 M^3
Plywood	- 31811 M^3
Matchwood	- 2225 M^3
Poles	- 128413 (No)
Sleepers	- 665 (No)
Firewood	- 220472 M^3
Minor forest produce	- 28427.388 tonnes
Canes	- 599310 (No)
Plywood	- 83601.55 M^3

Matchwood	- 4103.2211 M^3
Chipboard	- 26216.816 M^3
Packing care	- 2781.265 M^3
Eucalyptus	- 74847.3 tonnes
Bamboo	- 145014.99 (tonnes)
Firewood	- 577659 M^3
Railway sleepers	- 185893 M^3

** Total=11.93 lakh tonnes + 665 (No sleepers) + (Poles and canes in No) 727723

* Source Forest Department.
** Estimated.

Discussion and Conclusion

Food:

Karnataka as a whole ecosystem is at present self sufficient in food. However, for its long sustained production and supply the following recommendations are put forth:

a) Emphasis should be made to intensify agricultural programmes to increase the yield per hectare area instead of increasing the cultivated area. Multiple and intercropping should be encouraged.

b) Farmers should be acquainted with the new farming techniques.

c) Good quality seeds, fertilizers etc., should be provided at concessional rates to all farmers.

d) Dry farming in drought areas must be encouraged by providing drought resistant seeds at concessional rates alongwith extending proper drainage facilities.

e) The cropping pattern in Western Ghats should be mainly concentrated for rice cultivation and plantation crops.

f) Irrigation facilities should be improved in dry zone as well as Western Ghat region.

-Western Ghat receives high rainfall but most of the rain water goes off to the sea, as there is no proper storage facility.

-Dry zone receives very less amount of rainwater, therefore implementation and maintanance of small scale irrigation projects deserves special attention.

Fuel:

There is acute scarcity of firewood supply. The minimum domestic needs however, can be met from wastelands, agricultural wastes, forest department supply of firewood, but cannot meet the industrial firewood demand.

Due to shortage of fuel supply from forest department large quantities of agricultural wastes and dung is being burnt which could have been used as inputs for manuring and other beneficial usages. The wastelands and forests on one hand is continually being degraded due to lopping and on the other hand the poor housewives and children are daily wasting their precious energy and time in collecting twigs, which otherwise could have been used in a more profitable cause. There is considerable scope for improving efficiency of fuel as well as enhancing the production of plant biomass useful for fuel.

Some recommendations are given below:

a) Efficient woodstoves for a variety of applications should be designed and efforts should be made to propagate the technology.

b) High biomass yielding trees should be grown as much as possible in wastelands. The trees chosen should serve both as fuel, fodder or as manure. A proper screening of plant species should be made which can grow in the different ecological regions of Karnataka.

c) Stress on other alternate sources like biogas for cooking, solar energy utilisation etc., must be encouraged.

d) Efficient pressure-cookers at low cost must be designed to be used on wood stoves.

Fodder:

The fodder requirements in all the zones is far greater than the actual production. Most of the livestock are being fed from straw and other agricultural byproducts. During the drought years of low agricultural production the fodder supply is greatly hit and the cattle literally starve.

The actual lands available for grazing is very less which holds 4.8 livestok/ha. These lands have come down considerably due to extensive agriculture. Thus the permanant pastures are unable to produce anything than non-palatable plants due to the grazing pressure.

Ultimately, the livestock has to meet their food

requirement from reserved forest stock, thus exerting great pressure on forests ground flora resulting into deterioration of the ecosystem.

We should make the available lands more productive so that our animal livestock can be maintained properly.

a) We should maintain livestock as many as we can feed.

b) The existing cultivable wastelands, permanant pastures etc., can be grown with such fodder crops of which the stem portion can be used as fuel and leaf as fodder. (Eg. 3 rows of Napier grass and 1 row of Desmandus variegatus can give 300t/ha/yr of fodder and 125 t/ha/yr of fuel (Personal communication with P. Chandrashekara) .

c) A wasteland development board in Karnataka should be brought up to bring land under fuel and fodder.

d) A separate forage department should be set up to: i) Identify the different varieties of fodder which can be grown in the different agro-ecological zones. ii) Maintenance and supply of good quality grasses. iii) Necessary technical help to the users.

e) The sanctuaries can be maintained for good grass cover and should be allowed to be clipped only.

f) Irrigation facilities in maidan zones if improved then much more area can be brought under paddy and ragi - from which much more straw can be produced along with grains.

Deterioration of forests from grazing pressures can be checked as follows:

a) Grazing in forests should be restricted with fee only in rainy season.

b) Farmers should be encouraged to raise their own fodder and stall feed their animals.

c) Public awareness regarding the consequences of grazing should be created.

d) The unproductive livestock should be replaced with productive ones by either slaughtering them for meat or by sterilising them to prevent further increase.

e) The entrance of sheep and goats in the forests should be totally banned.

f) Amounts recovered from grazing fees should be used for fodder development.

Shelter:

Large quantity of biomass is used in housing. More than 50% of the houses in the rural sector are thatched and a sizeable amount of this is wasted and decomposed especialy in the high rainfall areas. It is advisable that low cost lasting, roofing materaial must be constructed and supplied. This would prevent yearly wastage of thatching material. Building construction require large quantities of bricks and tiles. These are manufactured in kilns which require enormous quantities of fuelwood. These industries must be provided technical help to reduce the fuel consumption by bringing special kilns. The use of compacted unburnt bricks of same strength can also be encouraged.

Inexpensive and alternative use of timber should be studied for housing.

Manure:

Crops obtain the required food for their growth from soil. The capacity of the soil to provide nutrients to the crops will diminish and the crop yields will come to a standstill if nutrients are not added from outside in form of manure or fertiliser. Cattle manure, leaf manure and green manure are the three common manures which are used in Karnataka. Green manuring practices are being slowly abandoned due to the want of time. The supply of dung and leaf manure is limited. Manure use can be supplemented with fertilisers, but the fertiliser application is useful only in regions where irrigation facilities prevail. Excessive use of chemical fertilizers also deplete the micronutrients of the soil. We can improve the fertility of our lands as following:

a) Proper low cost manurial practices depending on the available resources should be studied and recommended in the different ecological regions. (Ex: If 25% of aboveground parts of sugarcane alongwith root and stubbles are returned to soil then one can save 3-4 tonnes/ha of manure or 24 Kgs of Nitrogen, 5 Kgs of Phosphate and 50 Kgs of Potash (Prof. Shivshankar Personal Communication.)

b) Depending on the extent and quality of cultivated crops, some forest lands should be leased out to the willing farmers for exclusive manure use only. The farmers should be held responsible for the maintenance of their forests.

c) Prospects of green manure usage should be studied and encouraged.

d) Bones of dead animals if collected and processed, can yield 1-3% of Nitrogen and 22% of Phosphate.

e) Slaughter house refuse material may also contain 8-9% of

Nitrogen and 7% of Phosphate.

f) Large quantities of Nitrogen, Phosphate and Potash contents can be obtained from tannery refuse, hoof and horn shavings.

g) More than 2 lakh tonnes of ash can be obtained from houses and factories which can provide 0.017 lt of nitrogen, 0.01 lt of phosphate and 0.0112 lt of potash.

h) Human sewage if utilised properly can contribute 0.3 lt of Nitrogen, 0.15 lt of Phosphate and 0.02 lt of Potash.

i) Urine of cattle contains approximately 63% of the Nitrogen intake by the animal. Therefore, urine and excreta should be collected and stored carefully.

References:

1. Bureau of Economics and Statistics (1955-1982). Fully revised estimates of Principal crops for years 1955 1982, Government of Karnataka, Bangalore.

2. Bureau of Economics and Statistics (1982). Karnataka - Districts at a glance 1981-1982, Government o Karnataka, Bangalore.

3. Basu,S. (1985). Personal Communication

4. Badami, A. (1985). Personal Communication

5. Central Tobacco Research Institute, Rajahmundry, ICAR, (1985) Personal Communication

6. Department of Sugar (1985), Personal Communication

7. Department of Agriculture (1984), Personal Communication

8. Fertiliser Association of India, Southern region 1984. Agricultural and Fertiliser statistics.

9. Farooque Mohammed (1985), Personal Communication

10. Gaussen, H., Legris, P., Viart, M. (1962-65) International map of the vegetation. Madras, Bomba Godavari, Cape Camorin, Mysore and Pondicherry.

11. Gadgil, M., Sinha, M. (1985). The Biomass budget of Karnataka. In: Karnataka State Environment Report (1983-84).

12. Gadgil, S., Bagavat, S., Joshi, N.V., and Hegde, L.M. (1982 Cluster analysis of rainfall stations of Karnataka. Pub: Bureau of Economics and Statistics

13. Ganapathy, P.M., Director, Indian Plywood Industries Resear Institute, Bangalore-22.

14. Hegde, K.M. (1986). Personal Communication

15. Hegde, M.S. (1985). Personal Communication

16. Indian Council of Agriculture (1984). Handbook of Agricultu

17. Indian Council of Medical Research (1966) The nutritive value of Indian foods and planning satisfactory diets. Special Report Series, No.42, ICM Delhi

18. Jagdish, K.S. (1986). Personal Communication

19. Karnataka Animal Husbandry and Veterinary Services (1983). Thirteenth Quinquennial Livestock census, Karnataka.

20. Karnataka Forest Department (1984), Annual Report 1983-83

21. Karnataka Co-operative Milk Producers Federation Limited (1984). Personal Communication.

22. Mishra, B.K., Hegde, M.S., Subramanian, D.K., Prasad, S.N. (1984). Studies on a village ecosystem of North Kanara district of Karnataka. IIsc Technical Report.

24. Mitchell, R. (1979). The Analysis of Indian Agro-Ecosystems. Pub: INTER PRINT (1-180pp)

25. National Sample Survey (1981). An analysis of 1977-78, National Sample Survey on household energy consumption (32nd round) Karnataka

26. National Remote Sensing Agency (1980-82). Wasteland map-Karnataka and Goa. Pub: Department of space, Government of India

27. Prasad, S.N. (1984). Impact of Agro-forestry practices on Environment. In: Karnataka State of Environment Report (1983-84)

28. Prasad, C.R.P. (1979). Alcohol and producer gas. In: Energy planning for Karnataka. 1980-2000 A.D.

29. Report of the National Commission of Agriculture Part II, Policy and strategy. 188-189pp

30. Reddy, S., and Reddy, A. (1982). The energy sector of the metropolies of Bangalore Part I - Firewood. Technical Report KCST

31. Ravindranath, N.H., Nagaraju, S.M., Somashekar, H.I., Channeswarappa, A., Balakrishna, H., Balachandran, B.N., and Reddy, A.K.N. (1981). An Indian village ecosystem - care study of Ungra village, Part I, BIOMASS, 1:61-76

32. Rai, S.N. (1981). Productivity of Tropical rain forests of Karnataka. PhD thesis, University of Bombay.

33. Sinha, M. (1984). The vegetation map of Karnataka. In: Karnataka State of Environmenta Report 1983-84.

34. Sinha, M., and Gadgil M. (1985). Our dwindling resource base. In: A manual of Eco-development with special reference to the Western Ghats. Ed: M.Gadgil, P.R. Bhat and K.H. Hegde.

35. Sinha M., (1987). The status of vegetation cover in Karnataka. In Press.

36. Sen, K.C. (1971). Nutritive values of Indian cattle feed and the feeding of animals. ICAR

37. Subramanian, D.K. (1984). Energy utilization in Karnataka In: Karnataka state of Enviroment Report 1983-84.

38. Sunder, S.S., and Reddy, Y.A.N. (1985). Pressure on our Forests. In: Karnataka State of Environment Report (1984-84)

TABLE:1

LAND USE (Sq.Kms)

Zones	I	II	III	IV	V	VI	TOTAL
Geographical Area	4087.80 (2.16%)	19166.60 (10.13%)	7761.60 (4.1%)	16364.[illegible] (8.6%)	93822.90 (49.6%)	47971.40 (25.36%)	189174.60
Forest Area	309.67 (7.57%)	11711.26 (61.1%)	2155.02 (27.76%)	8175.79 (49.96%)	2267.70 (2.4%)	2559.67 (5.33%)	27179.17 (14.17%)
Sacred Groves and Tree Crops	389.63 (9.53%)	933.42 (4.87%)	133.39 (1.46%)	412.[illegible] (2.52%)	512.55 (0.55%)	794.12 (1.655%)	3155.50 (1.67%)
Sown Area	1045.82 (25.53%)	2917.38 (15.22%)	3755.60 (48.38%)	5523.[illegible] (33.75%)	63391.50 (67.56%)	22604.17 (47.12%)	99237.42 (52.45%)
Settlements	485.05 (11.86%)	948.17 (4.95%)	410.69 (5.3%)	1091.[illegible] (6.67%)	3949.67 (4.21%)	4425.43 (9.22%)	11310.60 (5.89%)
Barren Area	141.50 (3.46%)	442.09 (2.306%)	169.50 (2.18%)	929.[illegible] (5.55%)	8034.55 (8.56%)	4010.30 (8.36%)	13709.00 (7.15%)
Fallows, Pastures and Cultivable waste Area	1716.13 (41.98%)	2214.27 (11.55%)	1157.40 (14.91%)	[illegible] (1.54%)	15644.95 (16.69%)	13577.51 (28.29%)	34552.91 ([illegible])

TABLE:2

Characteristics of the different zones

Zones		I	II	III	IV	V	VI	TOTAL
Topography (m)		0-300	300-1800	300-600	600-900	300-900	600-900	
Rainfall (cm)		320	382	162	200	66	74	
Main soil		Coastal alluvial	Lateritic	Lateritic red loam	Red loam	Black cotton	Red sandy loam	
Vegetation type		Coastal	Evergreen + Moist Deci	Deciduous	Deciduous	Scrub	Scrub + Deciduous	
Human Population (Million)	Rural	1.11	1 6998	1.03	1.9	11 34	8.85	25 55
	Urban	0.511	0.29	0.37	0.47	4 28	5 57	11.58
Animal Population (Thousand)	Cattle	338.9	900.05	555 037	1123.9	3705.86	3512.46	10136 24
	Buffalo	88 9	241.56	158.71	184.01	1609 43	1014 41	3297 06
	Sheep	0.69	18 51	48.3	127.26	2042.73	2003 14	4240 66
	Goats	9.72	41.89	117.29	193.37	2279.92	1249 56	3891 75
Main Crops		Rice Cashew Coconut	Rice Coffee Areca Spices	Rice Jowar Groundnut	Rice Ragi Coffee	Jowar Cotton Groundnut Pulses Millet Sugarcane	Ragi Rice Pulses	Jowar HYV Paddy Ragi Cotton
Population Density Persons/ha		3 97	1.03	1.81	1.44	1 66	3.00	1.3c
Rural Population Persons/ha		2 72	0.88	1.33	1.16	1 20	1 84	1 37
Urban Population Persons/ha		1 25	0.15	0.48	0 29	0.45	1 16	0 61
Livestock Density Livestock/ha								
	Cattle	0 83	0 46	0.71	0.68	0 39	0 73	0 53
	Buffalo	0.22	0.126	0.20	0.11	0.17	0 21	0 17
	Sheep	0.002	0.01	0 002	0.78	0.217	0 417	0.224
	Goat	0.024	0.022	0.15	0 19	0 24	0 26	0 205

TABLE:3

Annual Food Production in Karnataka
(Average 1955-19[illegible])

Food Items	Area (Lakh.ha)	Production/ Year (Lakh tonnes)	Production in Kilo calories	Production in Protein terms (Tonnes)
Grains	65.91	51.50	2923.40	389741.57
Pulses	10.58	3.10	107.42	58824.60
Sugar + Jaggery	1.47	11.59	440.49	69514.90
Oil	8.12	1.76	65.66	38760.00
Milk	-	13.43	226.06	50362.50
Fruit & vegetables	0.30	1.09	5.72	2154.60
Fish (Fresh)	-	1.93	22.29	11590.00

TABLE:6

Per capita per day availability of calories (Kcal) and Protein (gms) in the different zones of Karnataka

Food Items	Kcal I	gms I	Kcal II	gms II	Kcal III	gms III	Kcal IV	gms IV	Kcal V	gms V	Kcal VI	gms VI	Kcal [illegible]	gms [illegible]	Kcal [illegible]	gms [illegible]
Grains	603.6	4.2	1274.2	9.2	[illegible]	[illegible]	[illegible]75.0	29.[illegible]	[illegible]	35.0	[illegible]	[illegible]	[illegible]	25.5	[illegible]	[illegible]
Pulses	18.7	0.98	14.6	0.8	55.7	[illegible]	[illegible]	1.06	151.8	8.2	[illegible]	[illegible]	75.59	[illegible]	[illegible]	[illegible]
Sugar	0.7	0.011	203.8	3.2	[illegible]	[illegible]	146.6	2.3	654.4	7.3	[illegible]	[illegible]	322.70	5.0	[illegible]	[illegible]
Oil	29.4	1.30	15.6	1.3	[illegible]	[illegible]	21.02	1.3	[illegible]	4.3	26.41	1.8	[illegible]	[illegible]	[illegible]	[illegible]
Milk	56.6	2.1	114.21	4.2	[illegible]	[illegible]	128.45	6.75	59.11	3.3	[illegible]	[illegible]	102.52	[illegible]	[illegible]	[illegible]
Fruit + Vegetable	0.2	neg	5.5	0.2	[illegible]	neg	12.8	0.7	[illegible]	neg	7.9	0.2	4.19	[illegible]	[illegible]	[illegible]
Fish	115.8	9.2	38.9	3.7	[illegible]	neg	[illegible]	2.[illegible]	0.66	.06	[illegible]	0.05	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL:	816.05	18.28	1666.[illegible]	22.6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible].77	58.16	2012.8	33.55	[illegible]	[illegible]	[illegible]	[illegible]
DEFICIT:	61.7%	54.3%	21.9%	43.5	-	[illegible]	-	-	-	-	5.6%	[illegible]	-	-	-	[illegible]
EXCESS:	-	-	-	-	[illegible]		[illegible]	5%	[illegible]	45%	-	-	[illegible]	[illegible]	[illegible]	-

DEFICIT:	61.7%	54.3%	21.9%	43.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EXCESS:	-	-	-	-	[illegible]		[illegible]		5%	[illegible]	45%	-	-	[illegible]	[illegible]	[illegible]	[illegible]	

TABLE:5

Production and demand of Milk (per day)

	I	II	III	IV	V	VI	TOTAL
Milk Production (lt)	0.0009	0.0022	0.0017	0.003	0.[illegible]	0.0152	0.0367
Milk Demand (lt)	0.0036	0.0044	0.0031	0.0052	0.[illegible]	0.0317	0.0524
Balance (lt)	-0.0027	-0.0021	-0.0014	-0.0022	-0.[illegible]	-0.0165	-0.0455
Per day availability in terms of calories (K cal)	56.65	114.21	119.762	128.45	89.11	106.85	102.5

TABLE:6

Total Agricultual Waste Producted in Kanataka

	I (t)	II (t)	III (t)	IV (t)	V (t)	VI (t)	TOTAL (Lakh tonnes)
Stalk (Cereals)	100445.00	[illegible]	396041.30	838077.[illegible]	6550438.70	3765445.00	118.[illegible]
Cotton Stalk	-	45.60	135220.80	15855.[illegible]	2577556.00	71305.00	28.00
Others	37976.80	[illegible]	133838.00	327387.[illegible]	2322823.00	564618.80	35.64
Sugarcane Stalk	3740.52	128331.00	83885.70	110005.[illegible]	2295940.00	1197400.00	36.19
Rice Husk	33057.32	[illegible]	91561.00	78333.[illegible]	93858.21	1209134.00	15.64
Areca Leaves	70107.83	296249.00	23112.70	97746.[illegible]	-	67442.00	5.54
Coconut Shell and Husk	43839.44	[illegible]	851.64	12406.[illegible]	9400.15	262281.50	3.44
Coconut Leaves	114495.10	[illegible]	2663.30	42037.[illegible]	22893.84	615679.90	9.026
Groundnut Shell	157.44	616.51	6025.66	4939.[illegible]	155219.20	[illegible]	1.87
TOTAL (Lakh tonnes)	4.04	10.89	8.73	15.[illegible]	140.25	77.34	256.[illegible]

TOTAL (Lakh tonnes)	4.04	10.89	8.73	15.[illegible]	140.25	77.34	256.[illegible]

Estimated Agricultural Waste available for burning (Domestic purpose)

	I	II	III	IV	V	VI	TOTAL
Paddy husk	33057.3	74247.4	91560.9	78233.7	93258.21	120913.40	15.80
Cotton stalk	-	45.6	135220.8	15855.2	257755.80	71305.50	28.03
Others	7[illegible]5.4	38597.9	2:767.6	65477.4	464564.60	113923.70	7.13
Coconut shell + husk	42839.4	35819.3	851.64	12496.0	9400.00	242281.50	3.45
Groundnut shell	157.4	616.51	6025.6	4929.7	155219.00	20870.70	1.88
Arecanut rachis	23235.6	57795.0	7627.2	32256.4	-	22255.90	1.83
Coconut rachis	37787.4	36586.6	878.88	13572.14	7554.90	233174.40	2.998
TOTAL (Lakh tonnes)	1.45	2.31	2.69	2.26	33.08	18.82	61.11

TABLE:8

Estimated Agricultural Waste available for burning (Domestic purpose) and total fuel demand (Lakh tonnes)

	I	II	III	IV	V	VI	TOTAL
Agricultural waste for burning	[illegible]	2.31	2.69	2.26	33.08	18.82	61.11
Total Domestic fuel demand	5.[illegible]	[illegible]	4.68	7.85	- [illegible]	47.9	124.31

TABLE:9

Fodder Demand in the different zones of Karnataka (Lakh tonnes)

Zones	CACr	CACr	CCrY	CAL	CAL	CLY	BA	BY	SCr	SL	G	TOTAL (1977)	TOTAL (1982-83)	TOTAL [illegible]
I	0.0557	[illegible]	[illegible]	1.9099	[illegible]	[illegible].8362	2.6190	0.1[illegible]	0.0002	0.0001	0.0316	8.1[illegible]	9.[illegible]	
II	0.1602	0.5[illegible]	[illegible]	7.1864	5.4000	[illegible].7860	6.5250	0.71[illegible]	0.0028	0.0574	0.1335	22.6[illegible]	27.5[illegible]	-
III	0.3019	0.3[illegible]	[illegible]	5.0900	2.6[illegible]	1.0400	3.7070	0.6517	0.0042	0.1512	0.3746	16.6149	17.7[illegible]	-
IV	0.3200	1.1527	[illegible]	8.7170	7.3570	1.9230	4.4330	0.7136	0.0224	0.3902	0.6176	25.9000	31.5[illegible]	-
V	0.6765	0.8269	0.[illegible]75	36.[illegible]	18.9[illegible]	7.5150	35.2500	7.3430	0.1230	6.4457	7.2314	119.2[illegible]	14[illegible]	-
VI	1.6026	8.6538	[illegible]	22.4760	25.6400	5.2585	23.6960	4.1650	0.5027	6.5777	3.9910	103.2530	125.7[illegible]	-
TOTAL:	3.1217	11.7766	[illegible]	79.99[illegible]	63.3756	18.3587	76.2270	13.7853	0.6559	13.1263	12.4288	292.8083	357.7[illegible]	[illegible]

CACr = Cattle adult cross male.

CACr = Cattle adult cross female.

CCrY = Cattle cross young.

CAL = Cattle adult local male.

CAL = Cattle adult female.

CLY = Cattle local young.

BA = Buffalo adult.

BY = Buffalo young.

SCr = Sheep cross.

SL = Sheep local.

G = Goats.

C[illegible]	= Cattle cross young.	S[illegible]	= Sheep cross.
[illegible]	= Cattle adult local [illegible]	[illegible]	= Sheep [illegible]
CAL	= Cattle adult female.	G	= Goats.
[illegible]	= Cattle local young.		

TABLE:10a

Fodder Production from different category of lands

		I	II	III	IV	V	VI	TOTAL
Barren Areas	A	[illegible]	0.6620	0.1695	0.9090	8.0360	4.0100	13.7100
	F	[illegible]	0.6620	0.1695	0.9090	3.2100	4.0100	[illegible]
Forest Groves and Tree cropss	A	[illegible]	12.6600	2.2700	8.5900	2.7800	3.3500	[illegible]
	F	[illegible]	25.3000	4.5400	17.1760	2.7800	6.7070	[illegible]
Fallows Pasture & Cultivable waste	A	[illegible]	2.2100	1.1570	0.2525	15.6600	[illegible]	[illegible]
	F	[illegible]	4.4300	2.3100	0.5050	15.6600	27.1500	[illegible]
TOTAL	A	[illegible]	15.3000	3.5900	9.7500	26.4500	[illegible]	[illegible]
	F	[illegible]	30.1600	7.0211	18.6800	21.6600	37.5700	[illegible]

A = Area (Lakh hectares)
F = Production (Lakh tonnes)

TABLE:10b

Fodder available from agricultural wastes (Lakh tonnes)

	I	II	III	IV	V	VI	TOTAL
Agricultural wastes	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE:II

Dung produced inthe various zones 'Lakh tonnes'

Zones	Dung Fresh Weight	Dung Dry Weight	Dung not collected	Dung used as fuel	Dung available for manuring
I	4.9700	1.4900	0.2980	0.2559	1.1928
II	12.7760	4.1300	0.8266	0.3477	3.3064
III	8.8970	2.6690	0.5338	0.2296	2.1353
IV	15.7700	4.7300	0.9463	0.4015	3.7853
V	72.5900	21.7700	4.3550	2.0250	17.4215
VI	62.8570	18.8570	3.7700	2.1673	15.0856
TOTAL:	178.8600	53.6460	10.7297	5.9270	42.9271

TABLE:12

Quantity of nutrients removed and returned to soil

Zones	Nutri-ents	Nutrients removed (from grains/local)	Nutrients removed from other crops	Nutrients returned by agri. waste	Nutrients returned by dung	Nutrients returned by stubbles	Nutrients returned by forest leaves	Nutrients returned by fertilizers
[illegible]	N	[illegible]	[illegible]	850.67	2030.00	2193.29		
	P	[illegible]	[illegible]	358.78	1910.00	2675.09		
	K	[illegible]	[illegible]	1161.66	1910.00	7135.40		
II	N	[illegible]	[illegible]	1660.72	5620.00	69.19		
	P	[illegible]	[illegible]	722.27	5290.00	82.45		
	K	[illegible]	[illegible]	2277.81	5290.00	257.09		
III	N	6725.45	[illegible]	1118.53	3630.00	541.82		
	P	[illegible]	[illegible]	500.35	[illegible]	605.50		
	K	[illegible]	[illegible]	1565.30	3420.00	[illegible]		
[illegible]	N	[illegible]	[illegible]	2161.33	6440.00	410.65		
	P	[illegible]	[illegible]	991.13	6060.00	497.69		
	K	[illegible]	[illegible]	3079.14	6060.00	1509.72		
[illegible]	N	[illegible]	[illegible]	9249.86	[illegible]	[illegible]		
	P	[illegible]	[illegible]	4674.74	[illegible]	[illegible]		
	K	[illegible]	[illegible]	14169.09	[illegible]	92133.34		
[illegible]	N	[illegible]	[illegible]	5580.55	[illegible]	[illegible]		
	P	[illegible]	[illegible]	2504.50	[illegible]	[illegible]		
	K	[illegible]	[illegible]	7827.77	[illegible]	[illegible]		
[illegible]	N	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.56	[illegible]
	P	[illegible]	[illegible]	0.397	[illegible]	[illegible]	0.189	[illegible]
	K	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.647	[illegible]

TABLE:13

Fretch.demand for straw and agricultural wastes (leaves) in Lakh tonnes

Zone	C Sh st	C Sh A	Hh st	Hh A	Total
I	0.0364	0.1109	0.1726	0.2940	0.6138
II	0.0954	0.2999	0.2635	0.4480	1.1106
III	0.0669	0.2040	0.1610	0.2740	0.7056
IV	0.1233	0.3760	0.2940	0.5013	1.2900
V	0.6250	1.9140	0.6350	1.0160	4.1900
VI	0.5168	1.5750	0.4940	0.7935	3.3800
TOTAL:	1.4698	4.4798	2.0221	3.3268	11.2900

C Sh st = Cattle shed straw
C Sh A = Cattle shed agricultural waste (Leaves)
Hh st = Human hut straw
Hh A = Human hut agricultural waste (Leaves).

TABLE:14

Timber requirement for urban houses (Lakh tonnes)

Zones	I	II	III	IV	V	VI	TOTAL
Firewood (Bricks)	39250.47	22256.2	28741.0	36342.4	328402.8	42743.6	8.82
Timber (Door.Windows)	2187.76	1240.5	1401.98	2025.67	18304.7	23826.7	0.4918
Total	41438.23	23496.7	[illegible]	[illegible]	346707.5	451300.3	9.3118

TABLE:15

Timber requirement for rural houses (tonnes)

	I	II	III	IV	V	VI	TOTAL
Firewood for tiles	2590.92	3955.16	2414.64	4418.40	50258.8	39248.50	1.05
Firewood for bricks	12553.03	19162.76	11698.93	21407.02	243503.80	190159.20	4.98
Timber for beams of roof	3824.21	5837.82	3564.01	6521.50	74151.97	57930.80	1.52
Timber for doors and windows	1704.90	2602.60	1588.90	2907.40	33071.52	25826.51	0.67
Poles for thatched houses	[illegible]	2140.60	[illegible]	[illegible]	7324.14	5727.44	0.23
Timber for beams of thatched houses	[illegible]	2598.95	[illegible]	[illegible]	6769.97	5286.87	0.21
Total	[illegible]	37597.50	[illegible]	[illegible]	[illegible]	324179.12	5.66

TABLE:16a

*Source: Office of Indian Plywood Industries.

Sl. No.	Name of the Industry	No.of units	Installed capacity	Quantity of logs required to meet 80% of installed capacity.	Quantity of logs supplied (45-50% of installed capacity.	Produced Plywood
1.	Plywood	21	44000 M^3	70600 M^3	44125 M^3	22000 M^3
2.	Particle Board	2	14500 tonnes	30600	19125 M^3	7250 tonnes

TABLE:16b

Quantity of softwood required and availability to the Industries

Sl. No.	Name of the Industries	Number of Industries	Quantity allotted or (demand)	Quantity actualy available
1.	Plywood	2	21000 M^3	4203.2 M^3
2	Packing case	2	7120 M^3	2781.2 M^3

TABLE:16c

Quantity of Eucalyptus required and availability to the Industries 1983-84 (*)

Sl. No.	Name of the Industries	Installed capacity	Quantity in demand	Quantity available
1.	Kanthar Polyfiber	2.5 metric lash tonnes	2.05 lt	0.59 lt
2.	Mysore Paper Mills		0.58 lt	0.145 lt
3.			0.32 lt	0.013 lt

(* Source: Kanthar Polyfibers)

TABLE:16d

Supply of Bamboo to two paper Mills during the year 1983-84

Sl. No.	Name of the Industries	Quantity in demand	Quantity available
1.	West Coast Paper Mills Ltd. Dandeli	1.58 lt	1.521 lt
2.	Mysore Paper Mills. Bhadravathi	1.26 lt	0.95 lt

TABLE:17

Forest Type	Potential area. 2 (km)	Actual area. 2 (km)	% area of forest type to geo. area.	% area of forest type to total forest	Growing stock/ha M 3	Growing stock/vegn type(M.M 3)	Above ground production t/ha/yr	Total above ground production vegetation (Million tonnes)
Coastal	1075	-	-	-	-	-	-	-
Evergreen+ Montane	13943	1905	[illegible]	7.1	175	33.33	10	1.90
Semi-Evergreen	8992	3438	1.[illegible]	12.83	175	60.16	10	3.44
Moist Deciduous	11009	2350	1.[illegible]	8.85	75	17.85	12-15	3.21
Secondary Deciduous	-	3919	2.[illegible]	14.62	75	29.39	12-15	5.3
Dry Deciduous	37196	3372	1.[illegible]	12.58	75	25.29	12-15	4.55
Scrub	113810	3994	2.[illegible]	14.86	25	9.96	8-12	3.98
Thicket	-	4655	2.[illegible]	17.38	25	11.64	6-8	3.26
Scattered Trees & shrubs	-	3142	1.[illegible]	11.72	-	-	5-[illegible]	2.04
Total forest	191222	26795	13.[illegible]	-	-	187.62	-	27.63

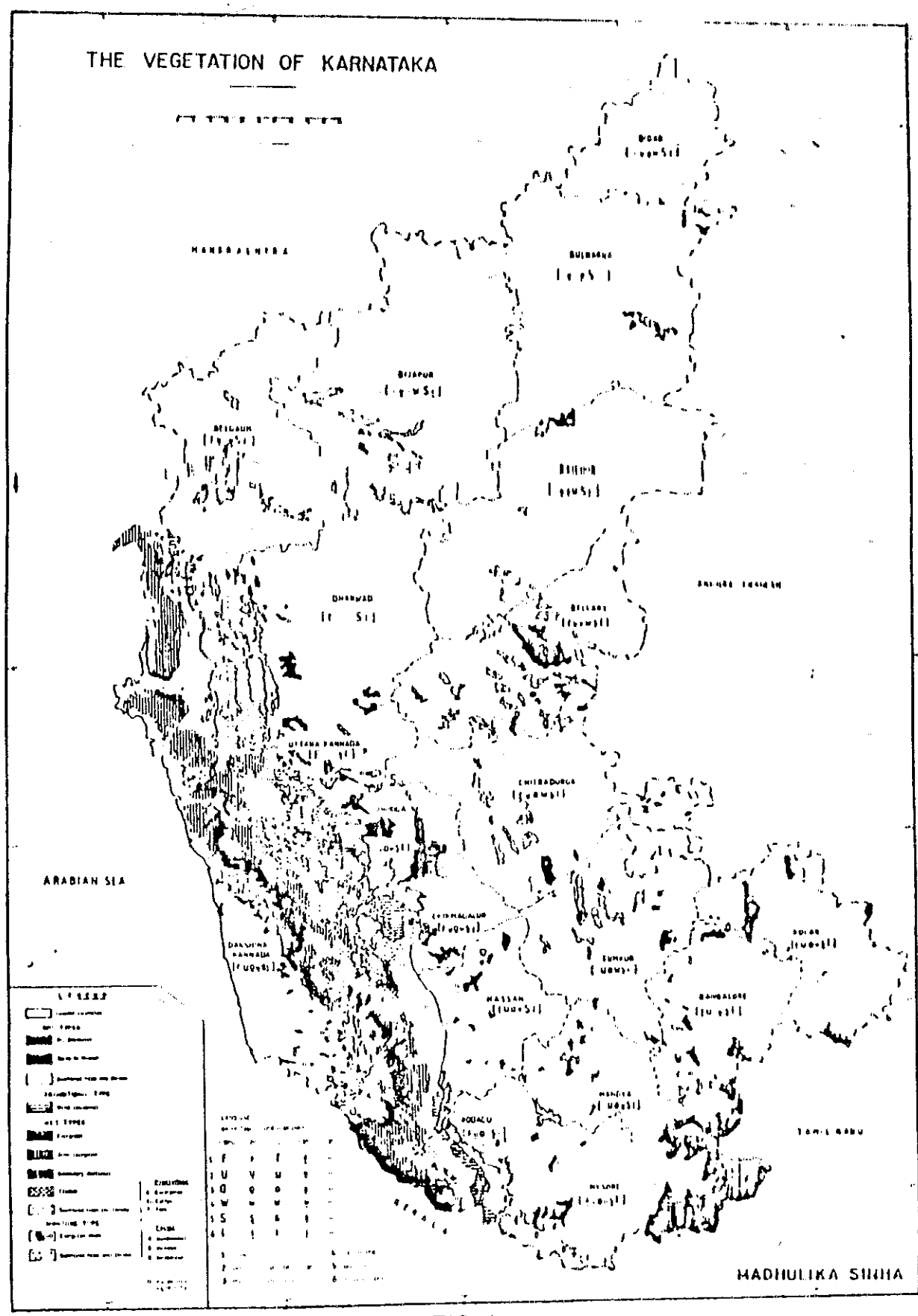


FIG 1

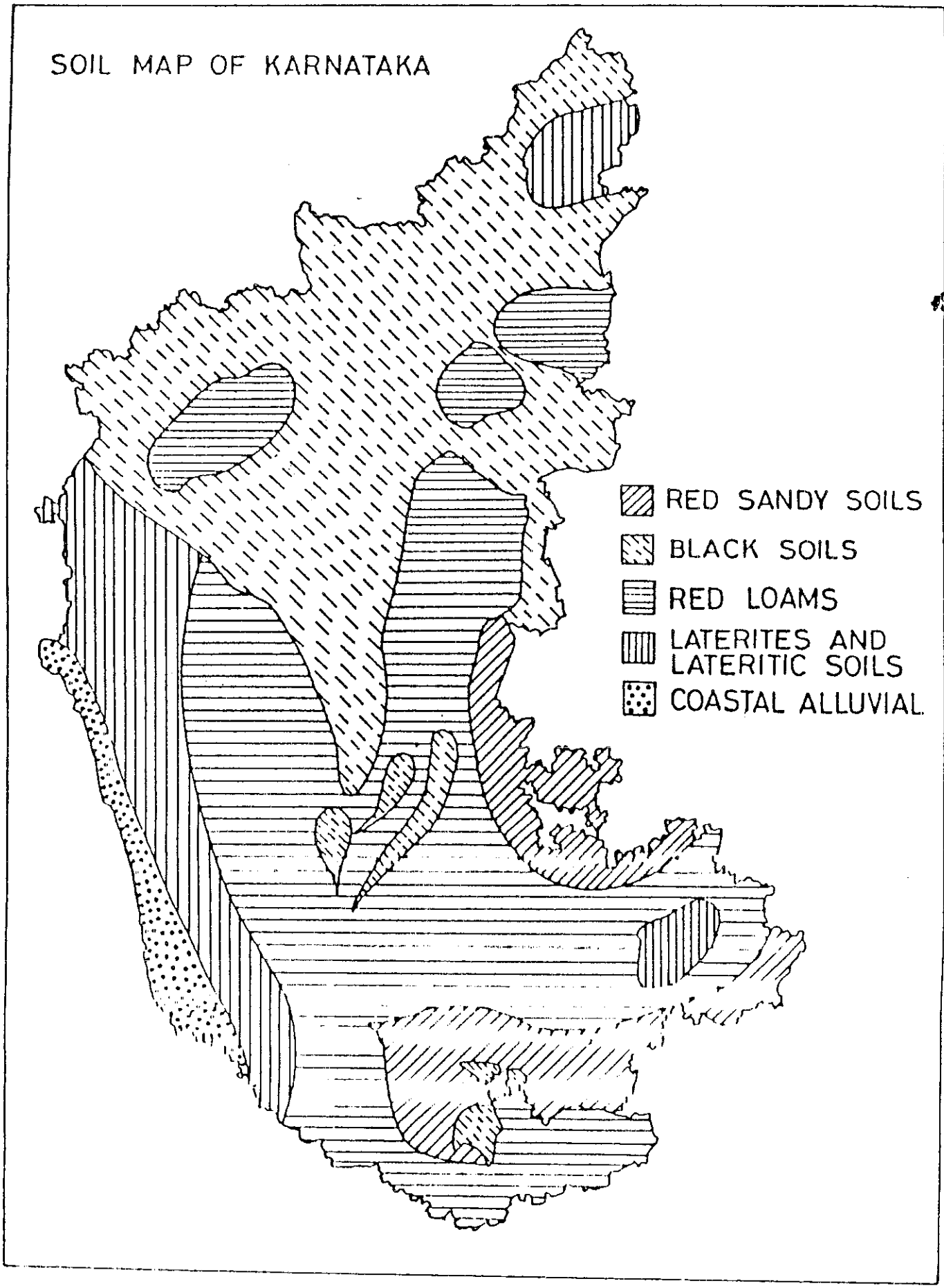

SOIL MAP OF KARNATAKA
RED SANDY SOILS
BLACK SOILS
RED LOAMS
LATERITES AND LATERITIC SOILS
COASTAL ALLUVIAL

FIG 2

TOPOGRAPHY-MAP OF KARNATAKA

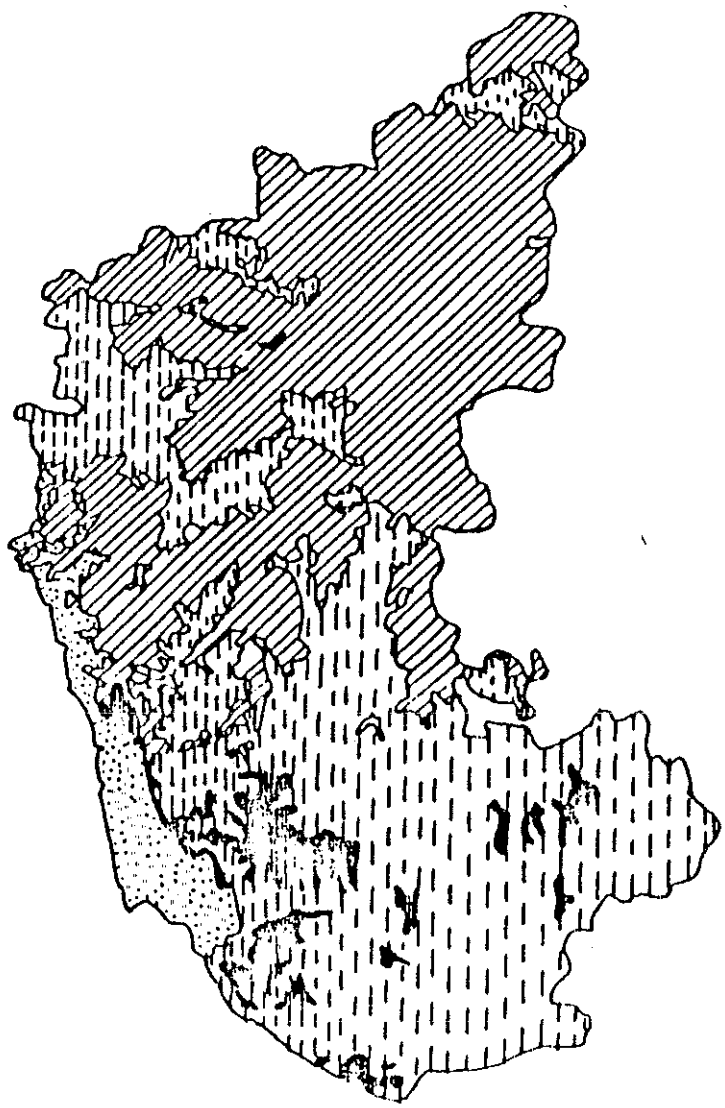


FIG. 3

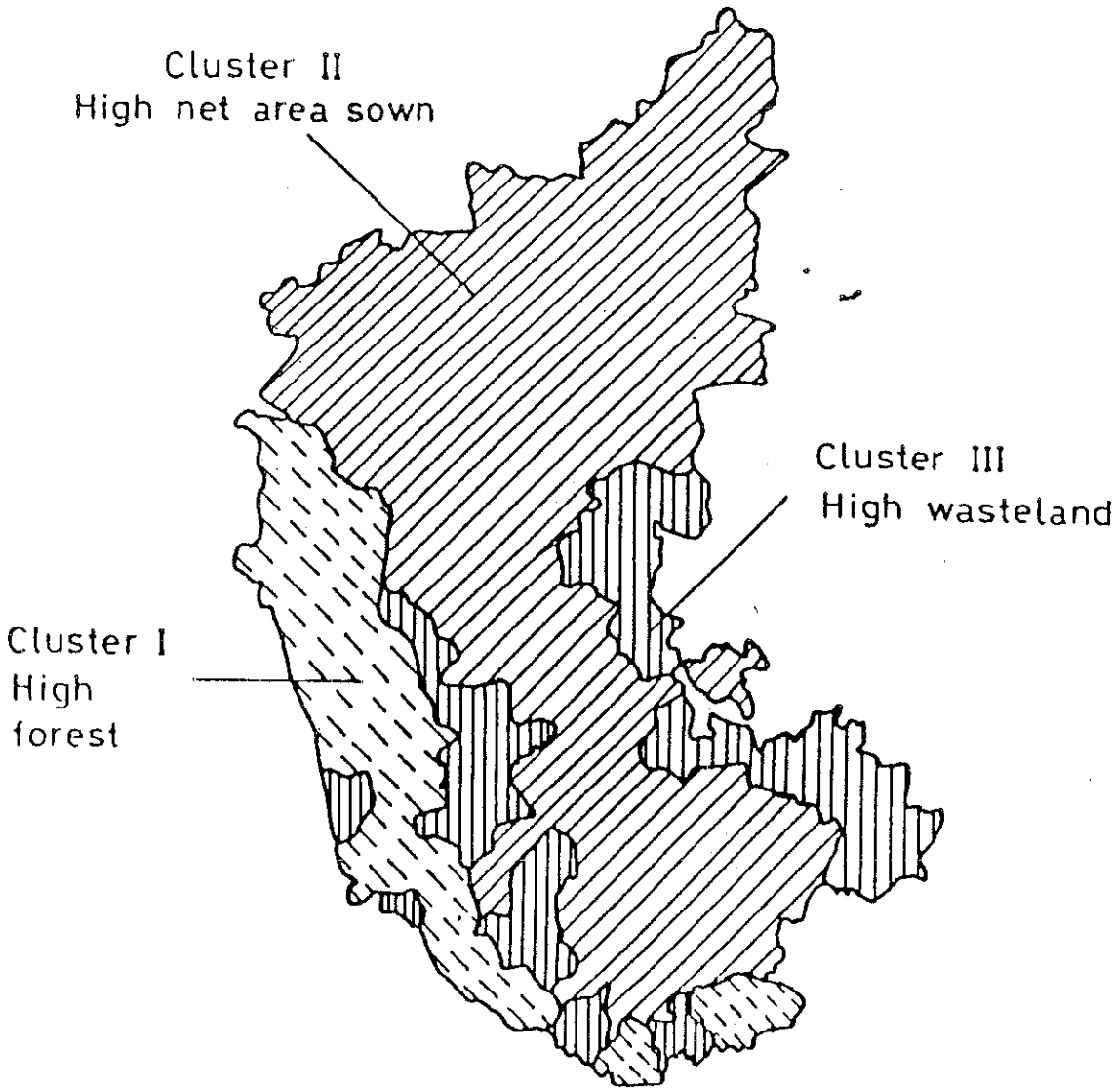


FIG 5 LANDUSE PATTERN

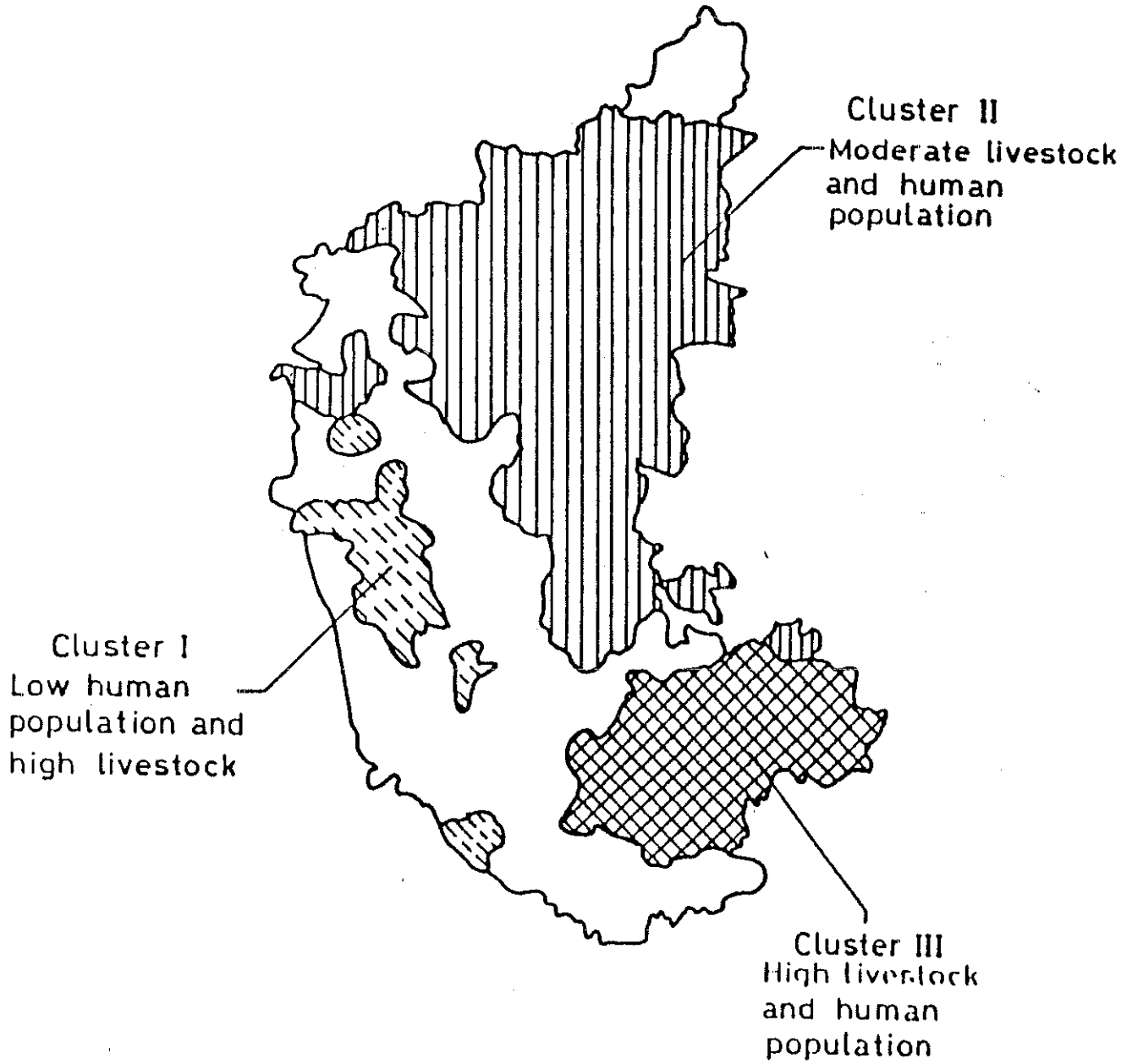


FIG 6 ANIMAL AND HUMAN POPULATION

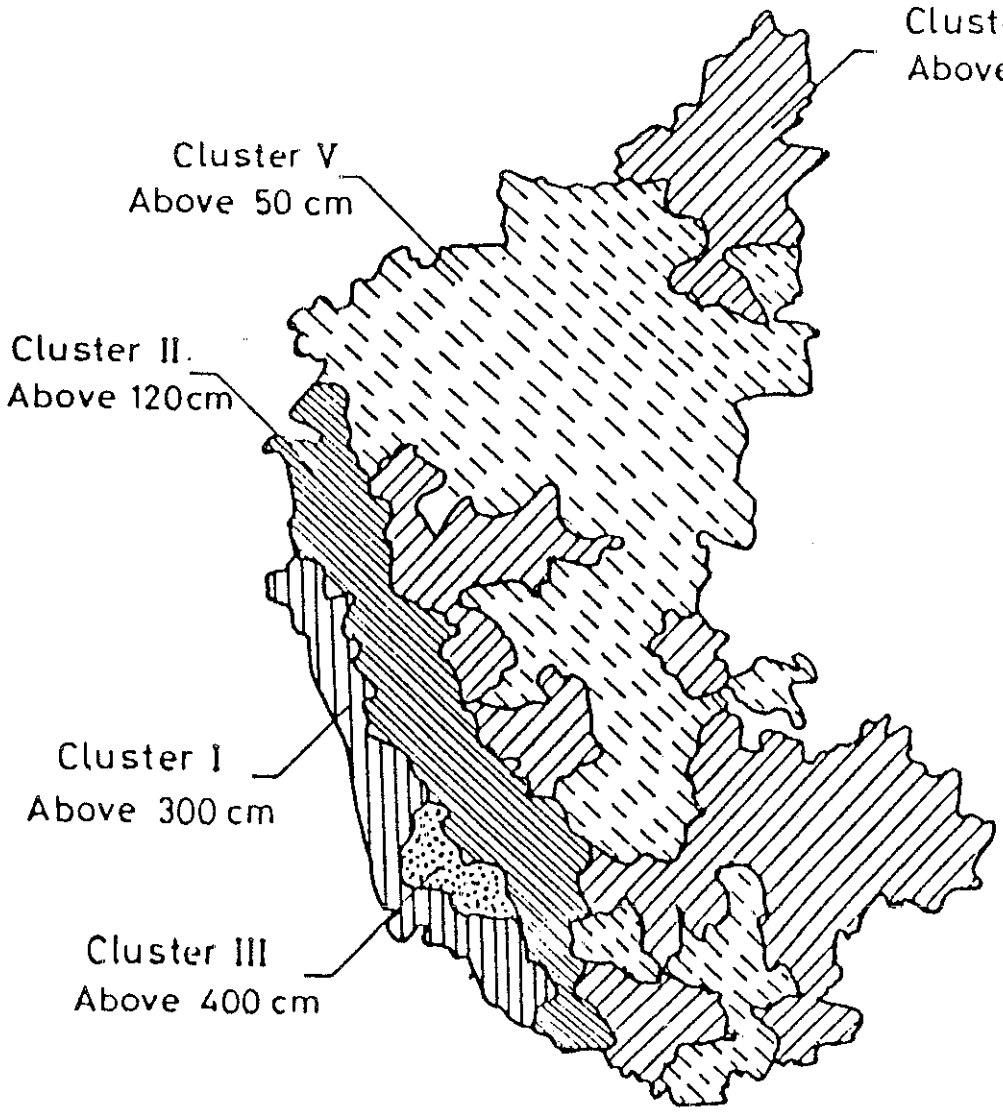


FIG. 7 RAINFALL PATTERN

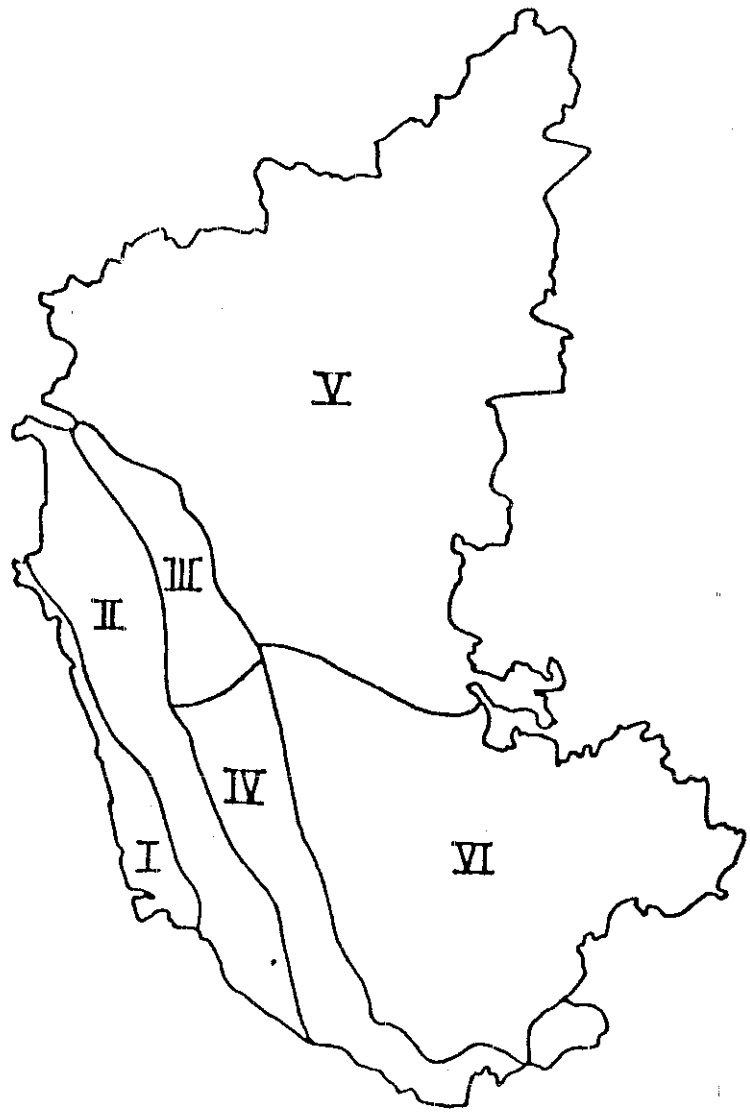


Fig. 8 Different ecological regions of Karnataka.

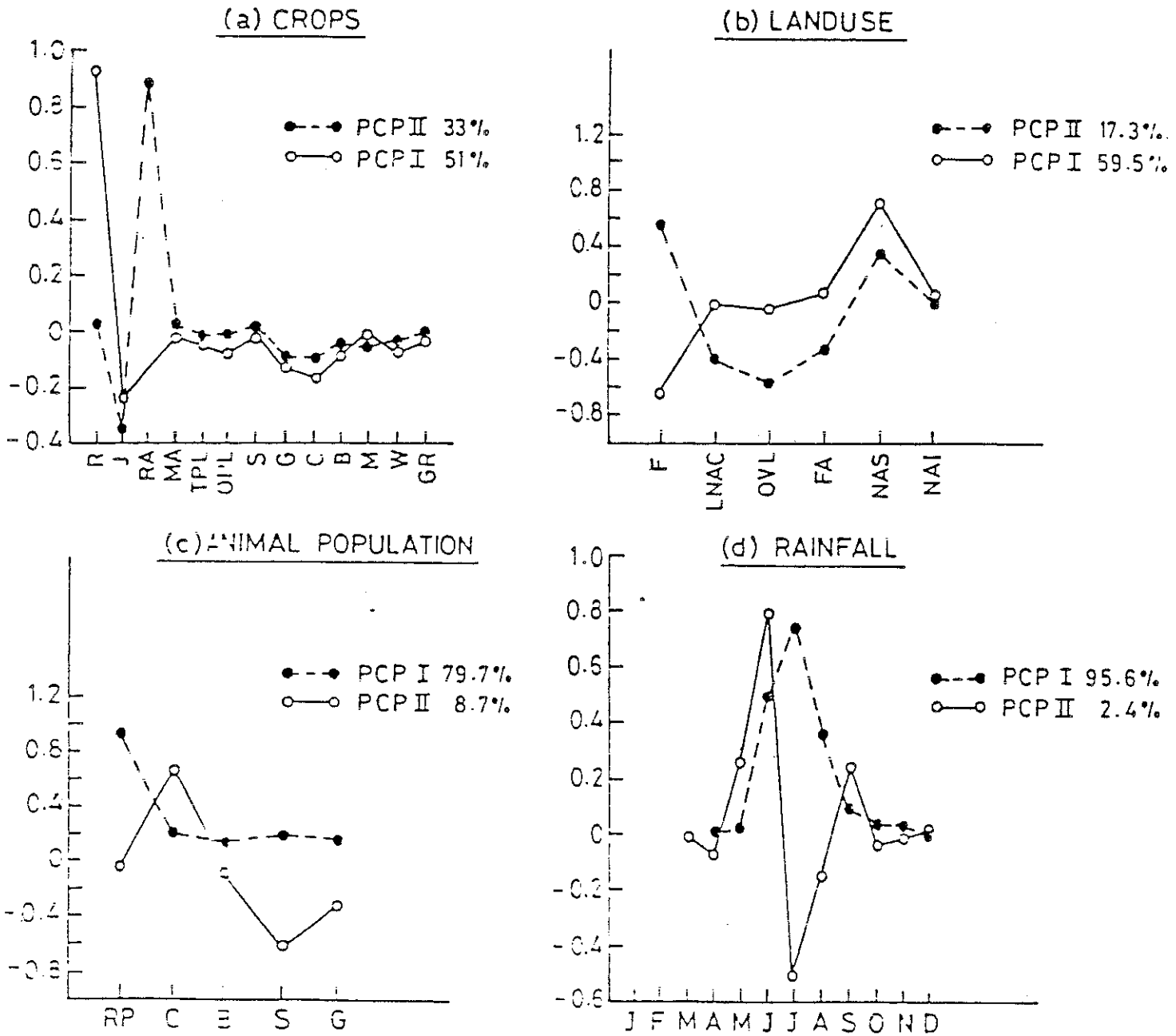

(a) CROPS
PCP II 33%
PCP I 51%
1.0
0.8
0.6
0.4
0.2
0
-0.2
-0.4
R
J
RA
MA
TPL
UPL
S
G
C
B
M
W
GR
(b) LANDUSE
PCP II 17.3%
PCP I 59.5%
1.2
0.8
0.4
0
-0.4
-0.8
F
LNAC
OVL
FA
NAS
NAI
(c) ANIMAL POPULATION
PCP I 79.7%
PCP II 8.7%
1.2
0.8
0.4
0
-0.4
-0.8
RP
C
E
S
G
(d) RAINFALL
PCP I 95.6%
PCP II 2.4%
1.0
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
J F M A M J J A S O N D

FIG. 9

0.75

J F M A M J J A S O N D

FIG. 9

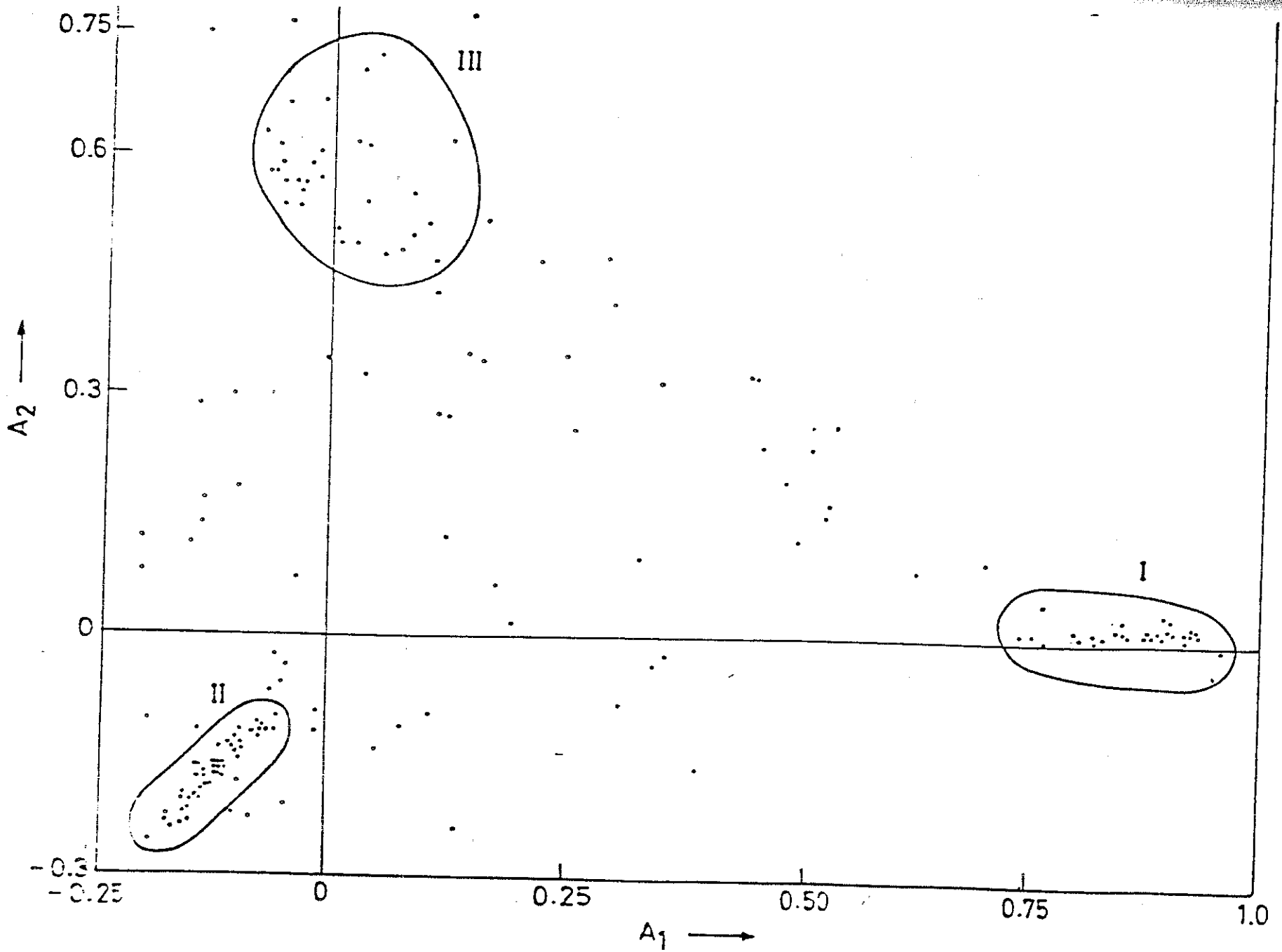
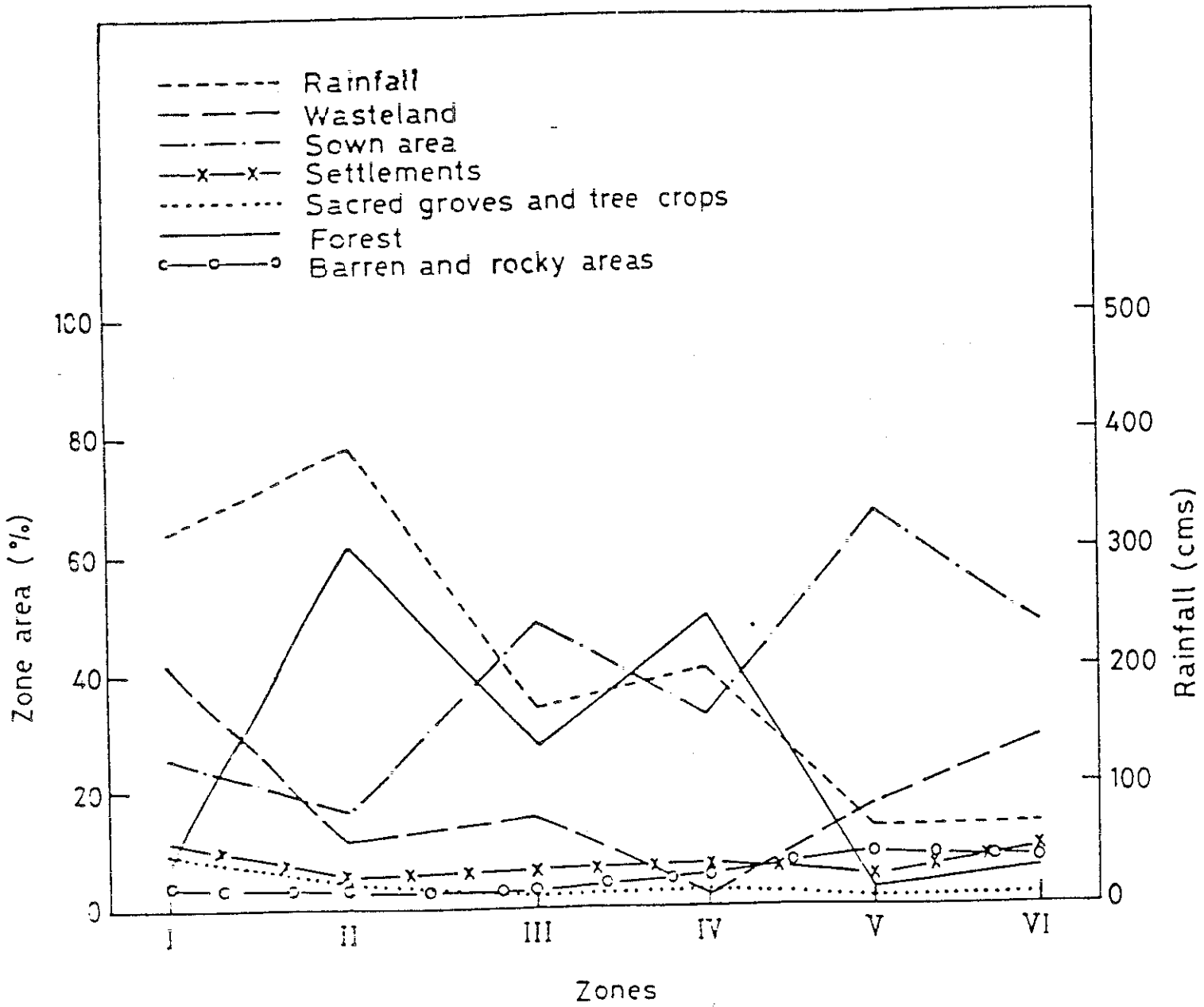
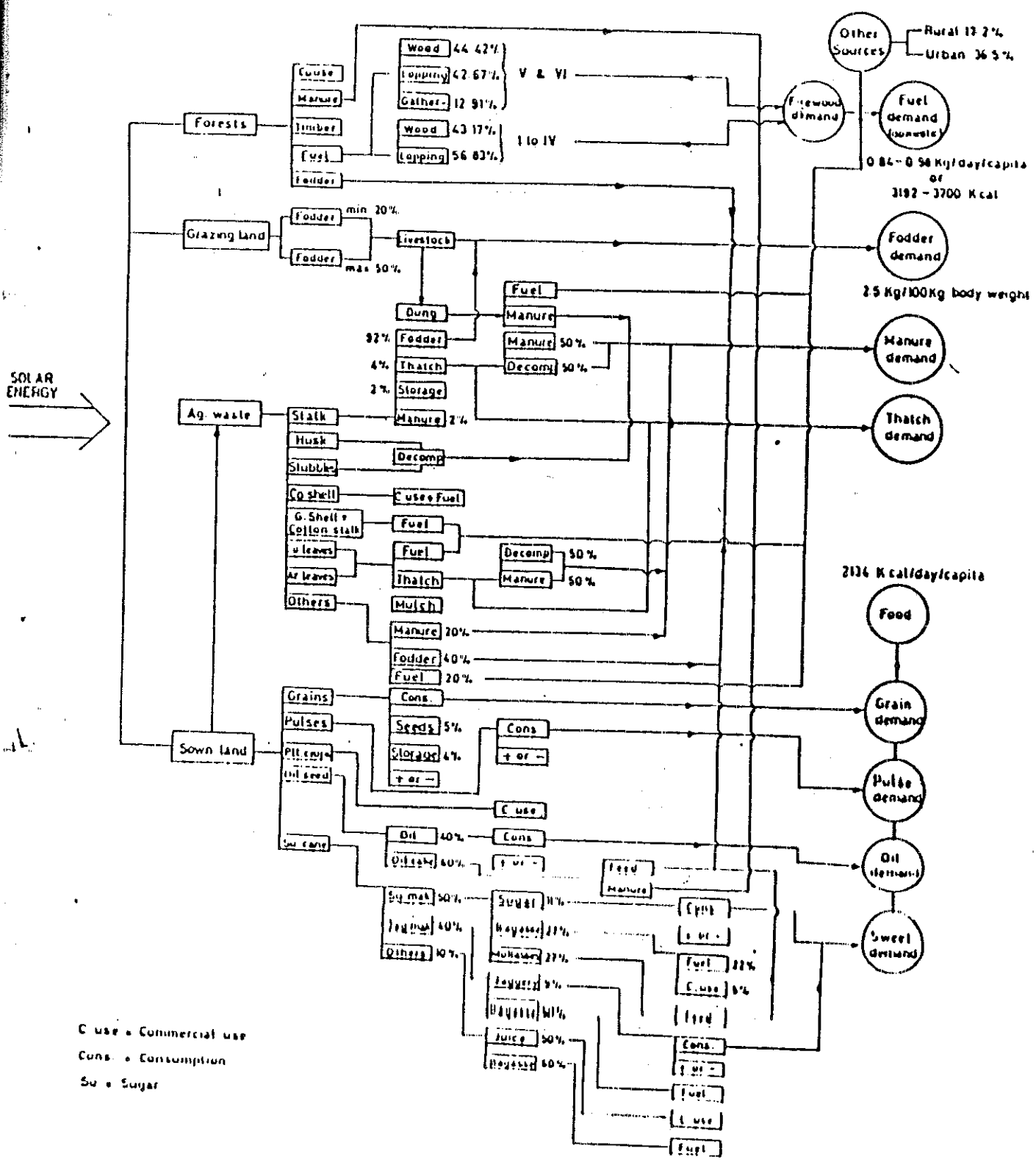


FIG. 10



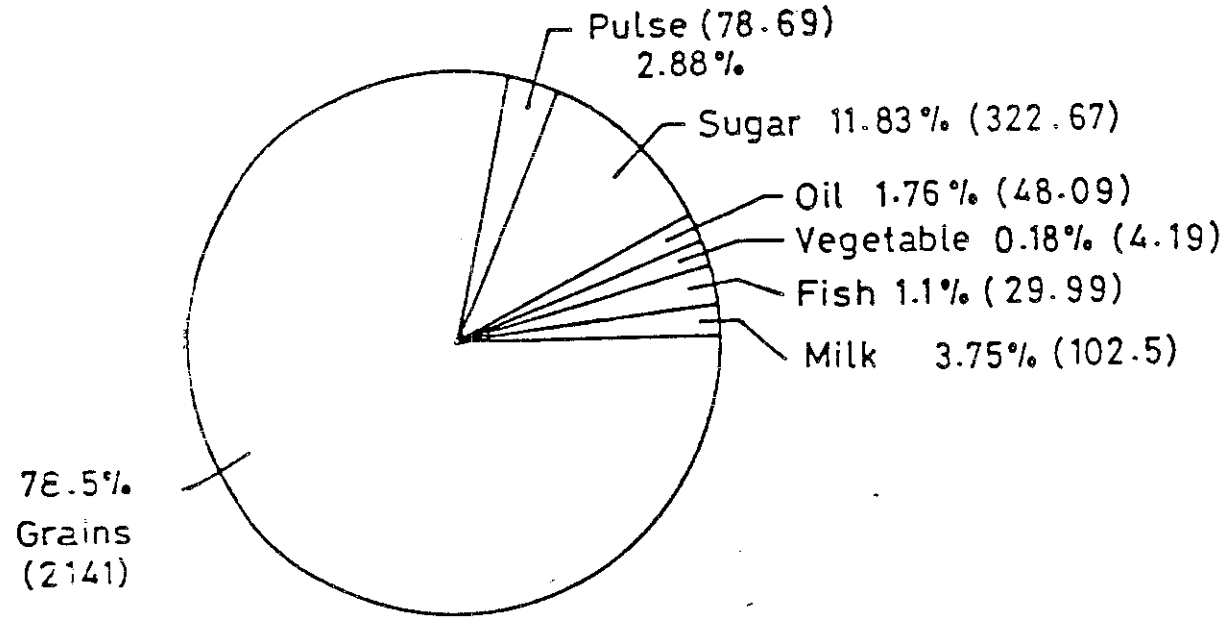
LAND USE OF THE DIFFERENT ECOLOGICAL ZONES

LAND USE OF THE DIFFERENT ECOLOGICAL ZONES



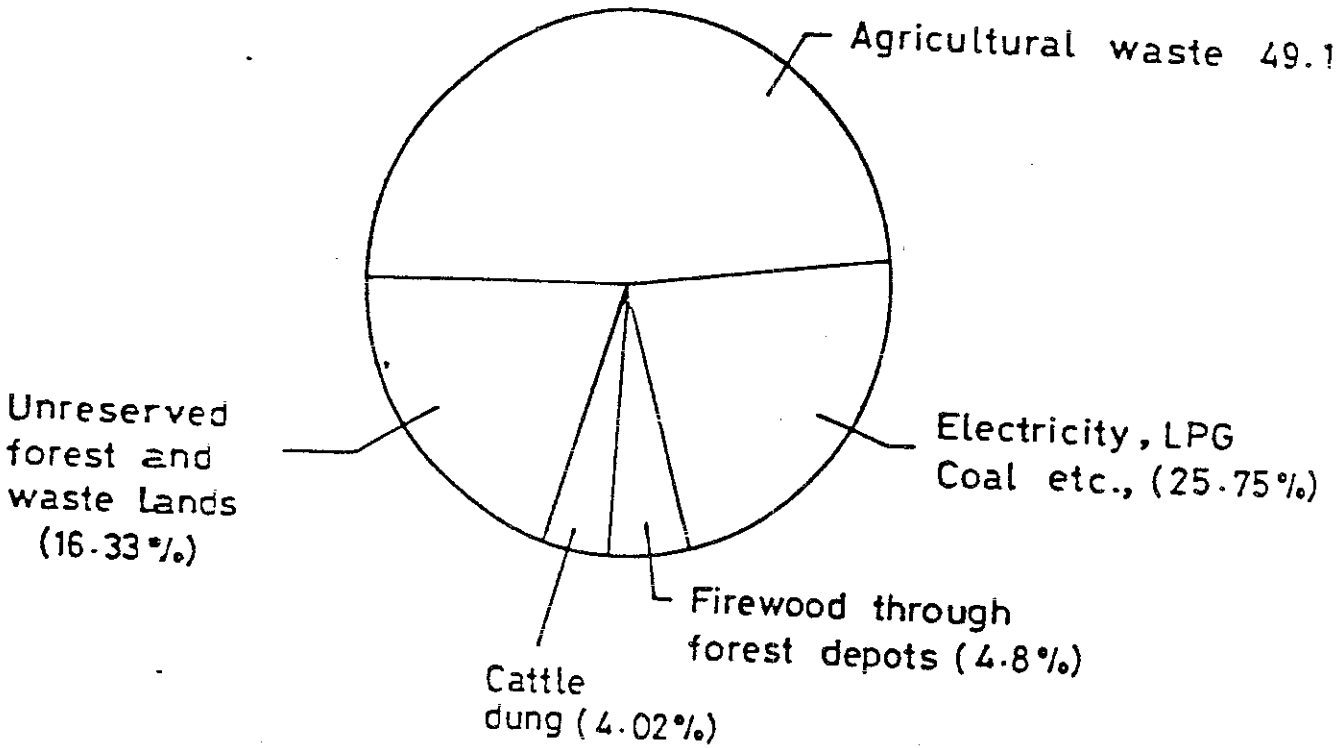
ESTIMATED PRODUCTION AND DEMAND OF BIOMASS

FIG. 12



PER CAPITA AVAILABILITY OF FOOD (K cal) KARNATAKA (1982)

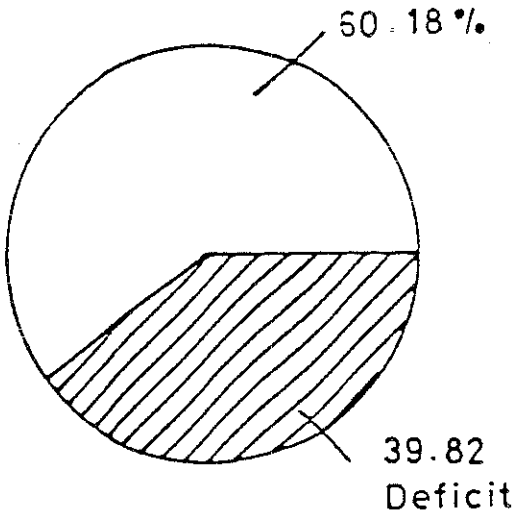
FIG. 13



Domestic fuel requirement = 124.23 lakh tonnes

ESTIMATED FUEL AVAILABILITY IN THE STATE (1982)

FIG. 14

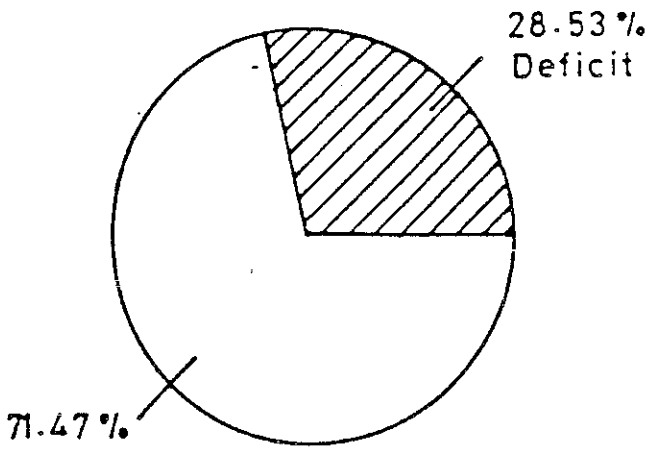


R = 176

S = 105.92

May to October

(Uncultivated lands)



R = 176

S = 125.8

November to April

(Agricultural waste)

FODDER REQUIREMENT (R) AND SUPPLY (S) IN KARNATAKA (1982) IN LAKH TONNES.

FIG. 15