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AN OPERATIONAL RESEARCH PROGRAMME FOR INTEGRATED DEVELOPMENT OF MICROCATCHMENTS IN UTTARA KANNADA DISTRICT : A PROPOSAL

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EXECUTIVE SUMMARY

This proposal for integrated development of two microcatchments of Uttara Kannada district as an operational research project to be co-ordinated by the Karnataka State Council for Science and Technology has been prepared in pursuance of a decision taken at a meeting chaired by the Development Commissioner of Karnataka on 4th June 1987. The two selected microcatchments, Sirsimakki-Mundagesara in Sirsi taluk and Masur-Lukkeri in Kumta taluk represent high rainfall hill tracts located on the Western Ghats and the west coast respectively.. Each of the microcatchments is about 400 ha in extent; the former is thinly and the latter densely populated, with total populations of 724 and 3417 respectively. The plan for integrated development presented here is grounded in a detailed investigation of the dynamics of the resource base of the two microcatchments, followed by extended discussions with the local people as well as Government officials. It documents the high level of underemployment and pinpoints a number of ecological imbalances such as harvest of plant biomass from forest lands exceeding the increment to the growing stock by a large margin, pressure of grazing excluding the possibility of a rabi fodder-cum-manure crop in the paddy lands, siltation of irrigation tanks, incursion of brackish water in the summer season in the wells, Salination of estuarine paddy lands due to inadequate period of drying, and depletion of Pandanus trees used as raw material for mat weaving. It also draws attention to untapped development potential, for instance, of fish culture in irrigation ponds, bee keeping and processing of coir. It presents a development plan phased over three years and including 52 component programmes. These would involve

direct Government investment of Rs. 13.33 lakhs in works such as check dams, planting of minor forest and construction of a solar pond, subsidies to the tune of Rs. 13.01 lakh for items such as construction of fuel efficient chulas, bee hive boxes and a coir processing plant in the co-operative sector, extending credit facilities of Rs. 26.99 lakhs for programmes like the development of fodder tree crops and soil conservation works on private lands, and funding of research, development and monitoring activities to the extent of Rs. 4.81 lakhs. It is our sincere hope that this programme would serve as a possible model of environmentally sound, sustainable and people oriented development process.

1. INTRODUCTION

It is now widely recognized that integrated development of watersheds is the key to sustainable and environmentally sound development. The Government of Karnataka has been at the forefront of this approach through its dryland watershed development project. This project is also notable for the active participation of the scientists through the operational research programme of the University of Agricultural Sciences, Bangalore. This approach, vital for the drought-prone maidan areas of the state is equally relevant to the higher rainfall hill tracts of malanad and kharavali. At a meeting chaired by the Development Commissioner, Karnataka State on 4th June 1987, it was decided that the Karnataka State Council for Science and Technology would formulate an operational research project on two micro-watersheds of about 400 ha in Uttara Kannada district representing these zones (Ref. No. DEE 55 ENV 87 dated 19th June 1987 from the Secretary to Government of Karnataka, Department of Ecology and Environment). This document outlines such a proposal.

2. BACKGROUND AND METHODOLOGY

2.1 Need for a Systems Approach

Our ability to sustain the pace of national development critically depends on the health of our base of renewable resources of soil, water, vegetation, livestock and genetic diversity. Unfortunately our policies of stressing intensification of resource use one at a time and in a short term perspective have led to disastrous consequences. These include large scale soil erosion,

siltation, floods and droughts, waterlogging and salination, lowering of ground water table, gradual depletion of fertility of fields, extensive deforestation and overgrazing by an ever exploding population of cattle and goats.

Amongst the most significant causes of these problems are:

(i) Narrow sectoral approaches of the experts and development administrators. Thus veterinarians have consistently neglected the provision of fodder and irrigation projects the vegetation cover of catchment areas. More complex interactions such as the role of overgrazing by cattle in depleting vegetation in river catchments have of course been totally ignored.

(ii) Neglect of long term considerations, for instance what happens to the fertility of soils under continued application of chemical fertilizers without adequate levels of organic manuring.

(iii) Neglect of side effects, for instance, destruction of fisheries by chemical effluents from industry.

(iv) Neglect of subsistence needs of the local people, for instance fuelwood or even drinking water.

(v) Neglect of traditional knowledge and practices, for instance, use of neem as pesticide or the cultivation of highly nutritious green leafy vegetables.

(vi) Neglect of social forces impinging on resource use, for instance the dependence of many landless families on sale of fuelwood for making a living.

The Science and Technology as well as Managerial inputs now most urgently called for therefore relate not so much to any specific

issue, such as provision of drainage under irrigation or genetic upgrading of livestock, as to the introduction of a systems approach, of understanding and properly dealing with all relevant interactions, including of course the human ones.

2.2 The Spatial Focus

Such an approach requires a spatial focus. The selection of a unit in this context is bound to be somewhat arbitrary for the dynamics of resources in no locality, however chosen, would be free of outside influences. Thus paper mills in Karnataka draw in bamboo from Arunachal Pradesh, and their effluents affect fisheries in Tamilnadu. The choice of the unit will be governed by physical considerations, especially topography and hydrology, by social considerations, especially settlement and land ownership patterns and by administrative considerations such as areas of jurisdiction of mandal panchayats and development blocks. It is desirable that the unit be of a relatively limited size, for an effective systems approach calls for a very detailed microlevel planning. Furthermore, such planning as well as subsequent implementation ought to involve the local people at every stage. For this to happen the local community should be rather homogenous, at most a few hundred households. An area of a few hundred or at most a few thousand hectares with a human population of a few hundred or a few thousand, corresponding to a single microcatchment and falling within the jurisdiction of a single mandal panchayat would therefore be an appropriate choice for a spatial unit for such an exercise.

The suggested exercise of microlevel resource planning with a systems approach would involve several elements; survey and inventory, investigation of resource dynamics, documentation of folk knowledge and traditions of resource use, assessment of problems of resource degradation, identification of causes of resource degradation, identification of corrective as well as preventive technological packages, identification of ways and means of implementation of these packages, communication of identified packages with local people and administrators and actual implementation and concomitant monitoring. Ideally the exercise would be a co-operative endeavour of scientific/technical experts from different disciplines, teachers and students in local educational institutions, local people and their organizations such as yuvak and mahila mandals, mandal panchayats and zilla parishats, and development planners and administrators.

Several excellent beginnings in these directions have already been made, both within and outside Karnataka. Outside of Karnataka, these include the Karimnagar district experiment of the Council for Scientific and Industrial Research, the Sukhomajri experiment of the Central Soil and Water Conservation Research and Training Institute, the Comprehensive Watershed Development Programme of the Government of Maharashtra and the voluntary efforts of Dasholi Gram Swarajya Mandal in the Alakananda valley of Uttara Pradesh. In Karnataka, a most significant initiative has been taken through the Dryland Watershed Development Programmes. This attempt has brought together the agriculture and forest departments along with the University of Agricultural Sciences. Some critical inputs, for instance from the

Animal Husbandry Department, are however still lacking in this experiment.

2.3 Ecodevelopment Action Research

The Planning Commission of the Government of India also began to stress this approach during the 6th Five Year Plan. One of the results of this emphasis was the initiation of a programme of involvement of educational institutions in ecodevelopment action research for the Western Ghats, the Himalayas and the Ganga basin. This programme, established in 1982 is administered by the Department of Environment of the Government of India, and has funded over 70 projects in various educational institutions in the states of Maharashtra, Goa, Karnataka, Kerala and Tamilnadu. The Department of Environment also established in 1983 a Centre for Ecological Sciences at the Indian Institute of Science, Bangalore. This centre has as its focus the ecological problems of the Western Ghats tract.

The Indian Institute of Science has been involved in ecological studies in Western Ghats tract since 1975, well before the establishment of the Centre for Ecological Sciences. To begin with these studies related to wild life conservation and management of bamboo and other forest resources. In 1982 a new step was taken through the initiation of a research programme in collaboration with the Hulgol Group Villages Service Co-operative Society in Sirsi taluk of Uttara Kannada district with a grant from the Department of Environment and Ecology of the Government of Karnataka. This project is aimed at the genetic upgrading of livestock coupled to fodder development, planting of soppinabettas (hilly lands assigned to garden

owners for supply of leaf manure, fuel and fodder), regulation of lopping of soppinabettas and improvement of efficiency of use of fuel, fodder, leaf manure and mulch. The field action in this programme was taken on lands belonging/assigned to 15 volunteer farmers of Yellapur, Sirsi and Siddapur taluks. The programme was overseen by a working group involving technical experts from the University of Agricultural Sciences, Indian Institute of Science and Bharatiya Agro-Industries Foundation, Government officials of Forest, Agriculture, Horticulture, Animal Husbandry and Rural Development Departments and representatives of the farmer's co-operative society. The 3-year programme was quite successful in its limited aim. From the second year of the programme, the Indian Institute of Science also involved 85 more farmers from outside the jurisdiction of Hulgol Group Villages Society to acquire experience on a broader scale for the district. All of this experience clearly showed that the approach of concentrating on a small number of progressive farmers has serious limitations. Firstly, the environmentally more desirable, modern technologies adopted by these better off farmers were not easily diffused to the other, generally smaller landholders. The landless too had quite a different set of problems that needed totally new approaches. Most of all it was evident that real progress was possible only when problems of all strata of the society in a given locality were attacked together. For this the involvement of the people themselves was crucial. One of the felicitous outcomes of this experiment was the establishment of a voluntary agency, Sahyadri Parisara Vardhini, by the local people with its headquarters at a Composite Junior College - High School at Yadahalli in Sirsi taluk. This NGO is dedicated to promoting

ecodevelopment in Uttara Kannada district through a variety of activities.

Meanwhile, the Western Ghats Ecodevelopment Action Research Programme administered by the Department of Environment, Government of India had promoted several projects throughout the Western Ghats tract. These focussed on a number of specific problems in different localities as identified at a Workshop on Western Ghats held in Trivandrum in May 1984. However, the experience of these projects also pointed to the need for developing integrated programmes in a few specific localities to generate a detailed understanding of the situation and to demonstrate successful ecodevelopment action in a few localities. Special encouragement was therefore given to programmes focussing on seven identified focal areas representing the whole range of variation on the Western Ghats. One of the seven localities so identified was the Gangavali and Aghanashini river basins in the Uttara Kannada district of Karnataka.

2.4 K S C S T Programme

Responding to this challenge, the Karnataka State Council for Science and Technology (KSCST) organized in 1986, a three-year programme of ecodevelopment action research in selected microcatchments of Gangavali and Aghanashini river basins with the help of a grant from the Department of Environment, Govt. of India. KSCST oversees its programmes with the help of Working Groups involving a number of Governmental and non-Governmental representatives concerned with the relevant problems. Accordingly the Working Group looking after this programme includes technical people

from the Indian Institute of Science, the University of Agricultural Sciences, and the Bharatiya Agro-Industries Foundation, Government representatives from forest, agriculture, horticulture, animal husbandry and rural development departments, teachers from local educational institutions and representatives from Sahyadri Parisara Vardhini. The Centre for Ecological Sciences at the Indian Institute of Science and the Sahyadri Parisara Vardhini are serving as the nodal agencies for this programme. Two local educational institutions, Vidyodaya Composite Junior College, Yadahalli, Sirsi taluk and Babhrulingeshwara High School, Masur-Lukkeri, Kumta taluk are also very actively associated.

Four microcatchments, each of around 400 ha, and representing different ecological zones of the Gangavali - Aghanashini river basins have been identified as focal localities for this programme. These include the following village clusters: (a) Masur - Lukkeri in Kumta taluk is an island in the estuary of river Aghanashini and represents the coastal ecosystem. (b) Tattikai - Sarkuli lies on the crestline of the Ghats close to where river Aghanashini descends to the plains. It represents the high rainfall zone. (c) Sirsimakki - Mundagesara lies in the Aghanashini basin on the Ghats east of the crestline and represents the zone of moderate rainfall. (d) Malenalli - Belale lies on the Ghats east of the crestline in the Gangavali basin and represents the zone of moderate rainfall (Figs. 2.4.1 and 2.4.2).

Two kinds of activities have been in progress in these microcatchments. The first relates to some on-going ecodevelopment action identified on the basis of earlier experience in relation to

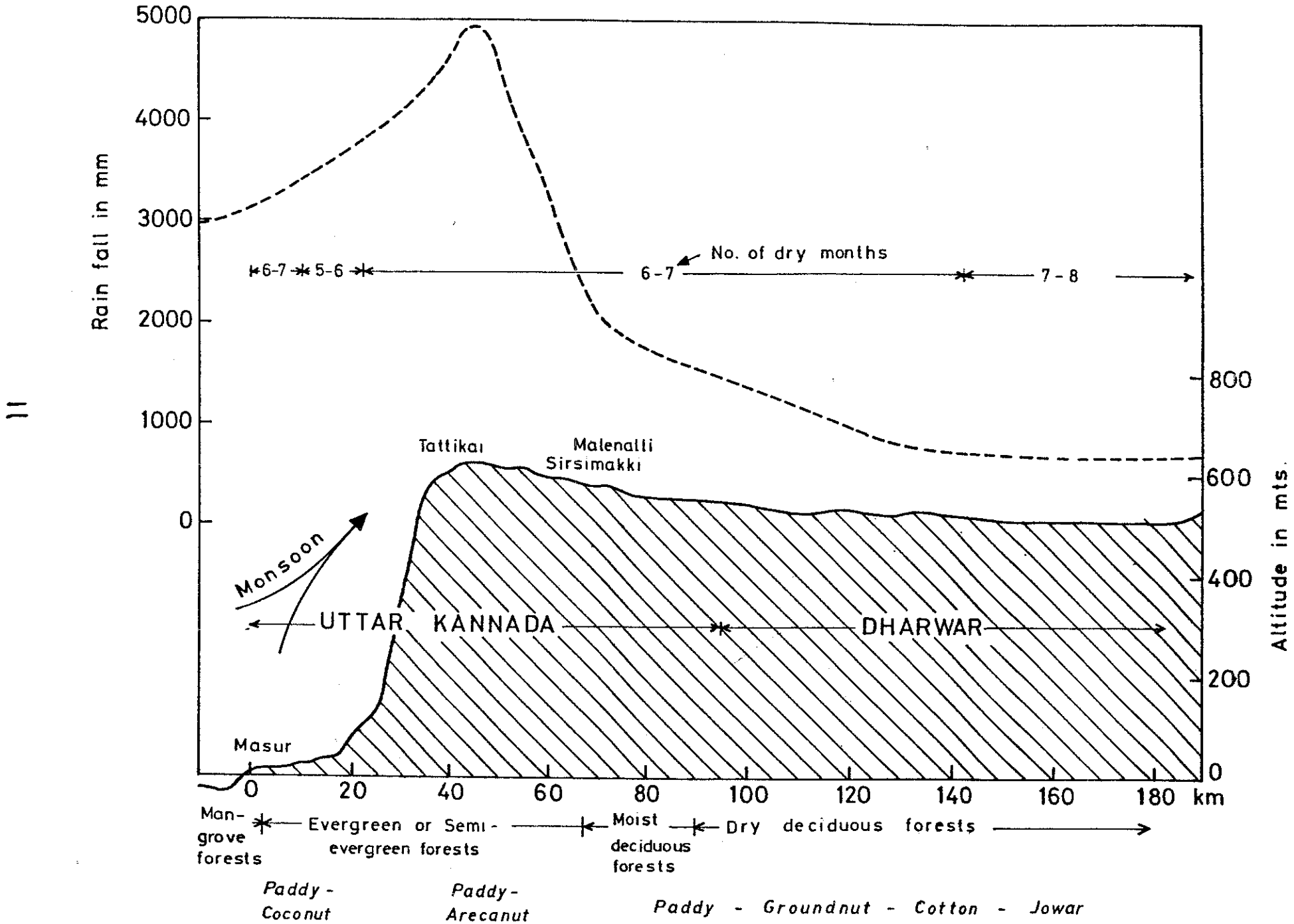


Fig. 2.4.1. A Schematic cross-section through the district of Uttara Kannada.

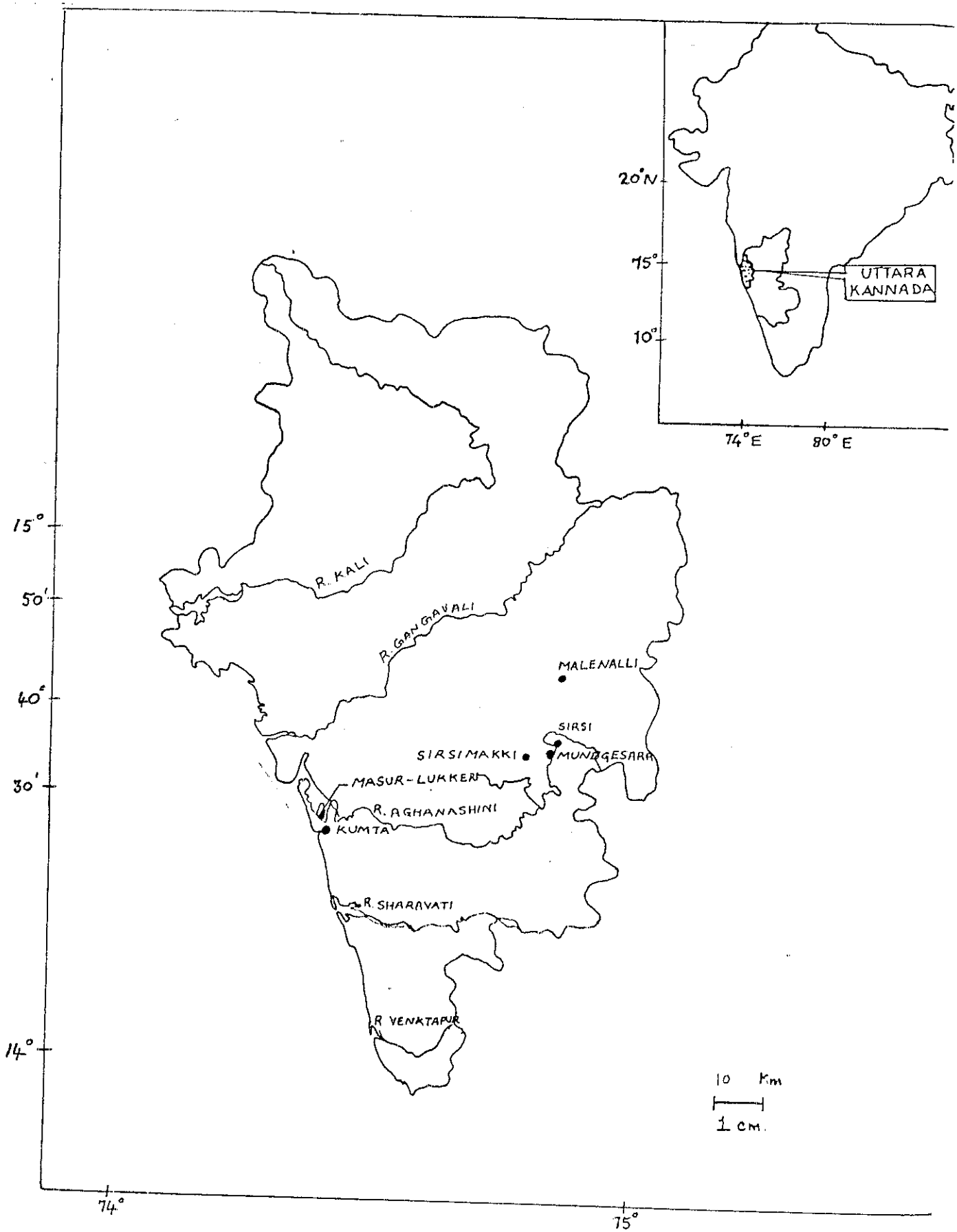


Fig. 2.4.2 MAP OF UTTARA KANNADA SHOWING LOCATION OF SELECTED MICROCATCHMENTS

the Hulgol Society project since 1982. The second concerns the preparation of a microlevel plan for the integrated development of the four selected microcatchments. The first activity has proved vital in gaining contact with and trust of the local population as well as in providing experience of how programmes get implemented under field conditions. However in this document we shall largely confine to the planning activity.

2.5 The Planning Process

The process of planning as well as subsequent implementation and monitoring must be a dynamic one capable of adjusting to the situation as it develops on the ground. It cannot therefore be rigidly programmed. Nevertheless, it might usefully be broken down into nine steps:

(a) Surveying and inventorying the status of resources including land, water, cultivated crops, orchards, livestock, natural plant and animal life as well as the human population. The methods employed include: (i) an interview of head/members of all the households as to their sex, age, education, occupation, land and animal holding, production on own land of all components of biomass, fodder and other requirements of and milk, dung and traction power supplied by livestock, gathering as well as sale and purchase on market of various components of plant and animal biomass, consumption in the household of various components of plant and animal biomass as food, fuel, thatching material etc., consumption of biomass for artisanal activities such as basketry, consumption of biomass for activities relating to agriculture and animal husbandry such as fencing, thatch

for cattle sheds, leaf manure and mulch for the land. (ii) Survey of land and waters within the microcatchment. The Survery of India have specially prepared 1:5000 scale natural environment survey maps for two of the microcatchments, namely, Masur-Lukkeri and Sirsimakki-Mundagesara. These provide details of topography, hydrology, land ownership and vegetation, habitation and roads. Based on these maps we have carried out sample field surveys of soil cover, water courses and water bodies and vegetation cover of cultivated land as well as of natural vegetation. These surveys have been the responsibility of local science/agriculture/arts/commerce graduates working on the project.

(b) Investigation of the dynamics of the resource base: The inventories give a static picture. What is of interest is of course the dynamics of the renewable resources. We have therefore attempted to collect information on increment/harvest from the various resources based on interviews as well as field observations. The field investigations have included measurements of plant production, measurements of consumption of fuelwood, measurements of lopping of trees for leaf manure and so on. These measurements are also carried out by project assistants.

(e) Documentation of folk knowledge and traditions of resource use. We have interviewed selected number of individuals belonging to the different communities to develop a broad picture of how the total human community aportions and regulates resource use. Thus the fact that Masur - Lukkeri villgers have with mutual agreement decided to collect only deadwood and dry leaves from minor forest; they tend to avoid use of Holigarna and Sapium for fuel; they collect substantial amount of fuel from driftwood floating down the river at the time of

flood are all facts of considerable significance from our viewpoint. We however need to carry on this task far more systematically than has been so far possible.

(d) Assessment of problems of resource degradation in light of socioeconomic structures and processes. The picture of resource dynamics as well as social organization of resource use that is thus generated reveals the imbalances in the system. Thus the soppinabetta lands of Sirsimakki are estimated to have an annual above ground production of only 3 tonnes/ha in comparison with harvests of 6 tonnes/ha. Similarly, the sources of supply of fresh soil for the gardens are getting exhausted.

(e) Identification of causes leading to resource degradation: A deeper probe into the imbalances revealed, especially in consultation with knowledgeable local people provides an appreciation of underlying causes. These may be manifold, and at different levels. Thus the irrigation tanks are now considerably silted up. At earlier times they were periodically desilted by communal effort - the last such desilting was in 1944 in Sirsimakki - Mundagesara microcatchment. It is the breakup of communal organization following independence and elective politics and the new attitude of dependence on Government programmes for all developmental activities that are the underlying causes of this degradation. On the other hand, overharvest of soppinabettas can be traced to better prices for arecanut after 2nd World War prompting garden owners to employ labourers to lop. With labourers being paid by bundles of leaves, the restraint on lopping earlier showed by owners has disappeared.

(f) Identification and evaluation of corrective as well as preventive

technological packages which may already be available and clear definition of those which need to be evolved: Following the identification of ecological imbalances and their root causes, we have attempted to identify ways of dealing with them. Thus the number of cattle and buffaloes in Masur - Lukkeri clearly need to be reduced. These animals primarily serve as sources of dung especially as plant biomass is very scarce to serve as organic manure. Now another scarce resource in these villages is poles for fencing. Hence, if Glyrecedia can be used as live fence, it may both reduce the demand for fencing poles and provide leaf manure which can cut down the demand for dung as a manure source and make possible reduction in the number of livestock.

(g) Identification of ways and means of implementing these technological packages within the given social, economic, administrative and legal constraints: This can be achieved only through an extensive dialogue with the local people and concerned Government Officials. We have attempted this in several ways. In each microcatchment we have set up an ecodevelopment task force of youth with whom we regularly discuss all identified problems as well as possible solutions. We have also had wider feedbacks through the circulation of a case-study for the Uttara Kannada district as a whole. The Kannada language version of this case study was read and discussed by a whole cross-section of people from basketweavers, buffalo keepers and fisherman to farmers, orchard owners and traders. The case study was considered in depth on 23rd January 1987 a meeting of state level officials chaired by the Chief Secretary of Karnataka State. We have discussed extensively various possible solutions with Government officials in individual meetings as well as meetings of

KSCST Working Group. We are also making special efforts to work with the newly set up Mandal Panchayat representatives. All of this feedback has been used to decide on what is possible on the ground.

(h) Communication of the identified package of programmes with the local population and administrative machinery: This is an on-going process and the main objective of the present document.

(i) Monitoring of the on-going patterns of resource use, including especially the implementation of the recommended package of programmes. This would be the function of the KSCST Working Group which may be assigned the task of overseeing the implementation as well as monitoring of the recommended package of practices as part of the operational research project.

3. SIRSIMAKKI-MUNDAGESARA MICROCATCHMENT

3.1 Physical Setting

Of the two microcatchments for which we propose the operational research projects, that of Sirsimakki-Mundagesara microcatchment (hereafter referred to as S-M catchment) lies in the Sirsi taluk about 5 km from the town of Sirsi and is bounded on either side by the Sirsi-Kumta and Sirsi-Siddapur roads (Fig. 3.1.1). It is at 14^0 35'N lat. and 74^0 48' E long. with an altitude ranging between 618 m to 545 m. This is an area of transition between the basaltic rocks of Deccan to the north and the archaen crystalline rocks of the peninsula to the south. The soils are lateritic and reddish brown in colour. They are acidic with a pH of 4.5 to 6. This is a region of moderately high rainfall, the annual total fluctuating between a low of 1862 mm in 1986 and 3503 mm in 1982 with an average of 2626 mm. The rains are

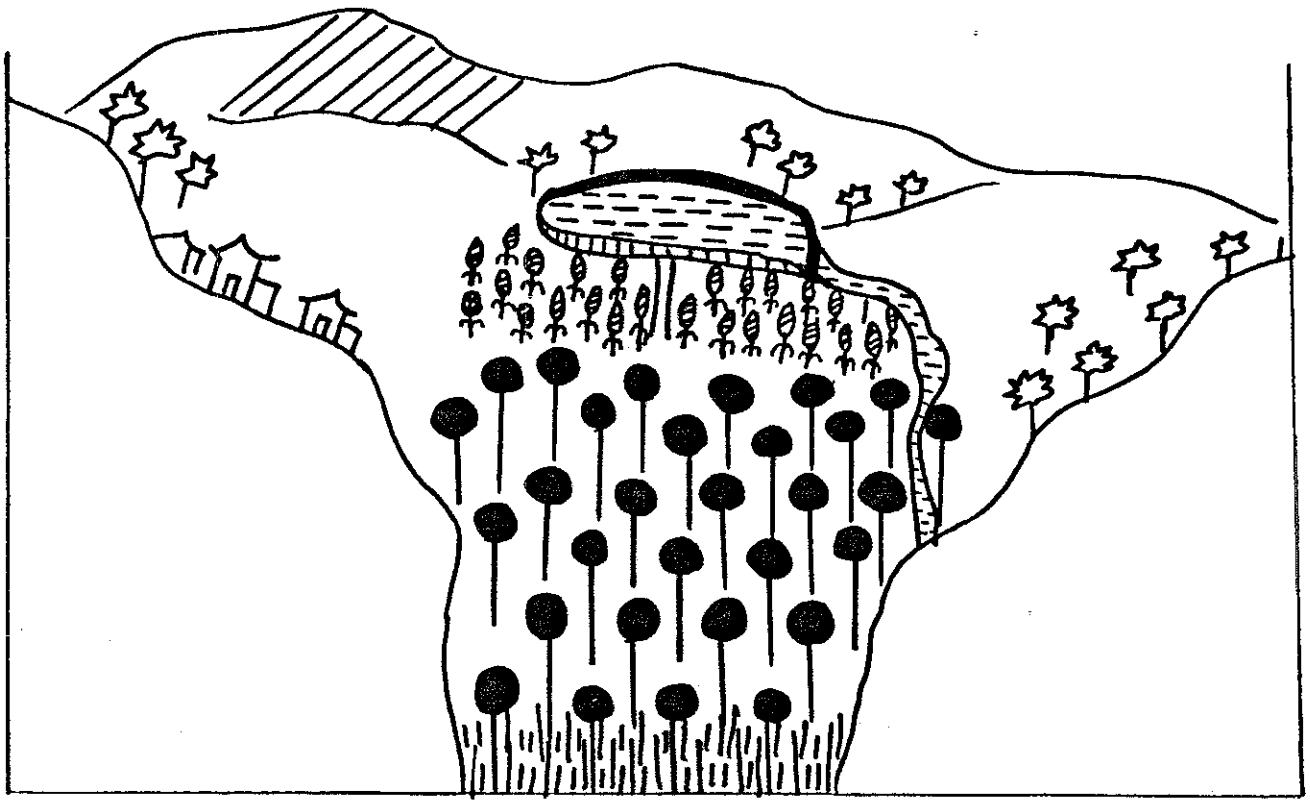


Fig 3.1.2 A SCHEMATIC VIEW OF LAND USE IN THE SIRSIMAKKI - MUNDGESARA MICROCATCHMENT

concentrated in the months of May to November. June, July and August are the rainiest months, with 2586 mm having been recorded during the months of July and August 1982 and 2380 mm in the months of June and July 1980. The months of November to May have been totally dry in some year or the other.

The S-M catchment encompasses an area of 386.5 ha of which 324.5 ha are hills. The whole terrain is gently undulating with 26 hill peaks with an altitude of 584 m to 618 m. Cultivators have broadened the initially narrow valleys by making vertical cuts in the bordering hill slopes and created 65.8 ha of flat lands now under cultivation. The total length of such widened valleys is 5.26 km with a minimum width of 50 m and maximum width of 200 m. The valleys have a gentle gradient of about 1 m per 100 m (Fig. 3.1.2).

The water drains to the river Aghanashini through 3 perennial and 2 seasonal streams. The total length of these is 6.12 km. The streams are narrow, the average width of the main stream being 6.5 m. There are 7 tanks constructed by bunding these streams, 5 of these are perennial. They range in size from 0.1 ha to 0.62 ha. The underground water table is quite high, rising nearly to the surface in the monsoon and dropping to 10 m or so in the summer. There are 62 domestic and 7 irrigation wells.

The 88 households are clustered into four hamlets of Sirsimakki, Vadgeri, Bellikeri and Mundagesara-Abrimane. The total compound area of these hamlets which are located just above the cultivated valleys is 2.96 ha. There is a network of 7 km of motorable roads and many footpaths throughout the microcatchment. The hilly lands are owned by

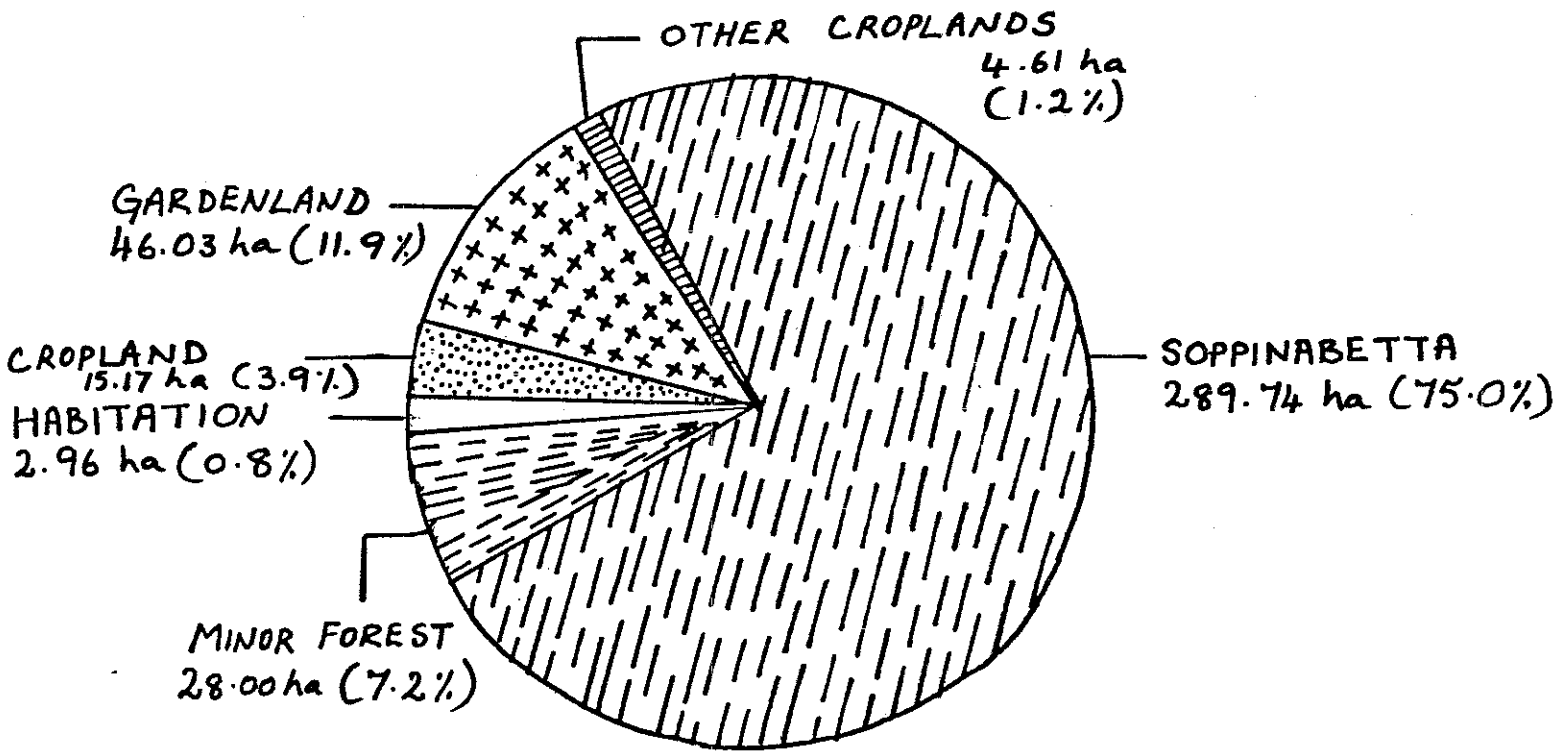


Fig. 3.1.3 PATTERN OF LAND USE IN THE SIRSIMAKKI - MUNDGESARA MICROCATCHMENT

forest department as a minor forest of 28 ha and soppinabetta lands of 289.74 ha. The only cultivated tracts of hill lands include coconut gardens of 3.37 ha and mulberry of 0.49 ha. The croplands extend over 15.92 ha, of which 15.17 ha is devoted to kharif paddy and 0.75 to sugarcane. The multistoreyed areca, pepper, cardamom, cocoa, banana gardens extend over 46.03 ha and are the mainstay of the locality's economy (Fig. 3.1.3).

3.2 Human Habitation

The 88 households of the S-M catchment account for 724 people, of whom 296 are adult males and 304 adult females. There are 140 children below the age of 14 and 39 older people above the age of 60. The main communities are Havik Brahmins who are largely garden-owners and Vakkals who are paddy cultivators or landless labourers. Literacy is very high at 91% and there are 70 degree holders in the population.

Fourteen of the 88 families are landless, 9 families own only paddy land, 47 own only garden lands, while 18 families own both paddy and garden lands. For those owning paddy lands, the median landholding is 0.5 ha, the median garden land for garden land owners is also 0.5 ha. The largest single holding is by one family with 3 ha of paddy and 3 ha of garden land. Of the 74 landowning families 66 maintain livestock, the minimum being 1, median 5 and maximum 31.

How do the 545 adults of the catchment employ their time? Fiftytwo of them are either employed as school teachers etc or have their own shops in Sirsi. That leaves 493 people dependent on land based or domestic employment. Our surveys indicate that the landless

men find farm employment for about 240 days a year and the women 150 days a year. This does not take account of the time spent by landless women in their own domestic chores. Amongst the landholders the men are employed only for about 120 days a year. The women from landholding households have employment equivalent to 220 days a year in taking care of livestock and in domestic work. Amongst the landholders 44 graduates and 51 matriculates are essentially unemployed. The S-M catchment is a relatively prosperous locality. The gardens bring in an annual income of about 14 lakhs, the salaries and wages another 6 lakhs and the paddy fields some 25000 rupees. The per capita annual income of the population is then about Rs. 3000, quite good by standards of rural India.

In terms of plant biomass, the household sector primarily needs food, fuel to cook it with and small timber and thatch to maintain the houses and cattle sheds. Since the mainstay of agriculture of the tract is gardens, the food production is inadequate, totalling some 70 tonnes of paddy, pulses etc. as opposed to the demand of about 130 tonnes.

The per capita fuel consumption in this locality is rather high, about 2.5 kg per day. Of this 1.22 kg goes into bath water heating, 0.88 kg in cooking food, 0.1 kg in drying blankets during the rainy season and the balance of 0.3 kg. in processing of agricultural produce. This implies an annual demand of 686 tonnes of fuel, which is met partly by the waste products from arecanut and coconut trees, but also imposes an excessive pressure on minor forest and soppinabetta lands (Fig. 3.2.1). The annual maintenance of houses and cattlesheds

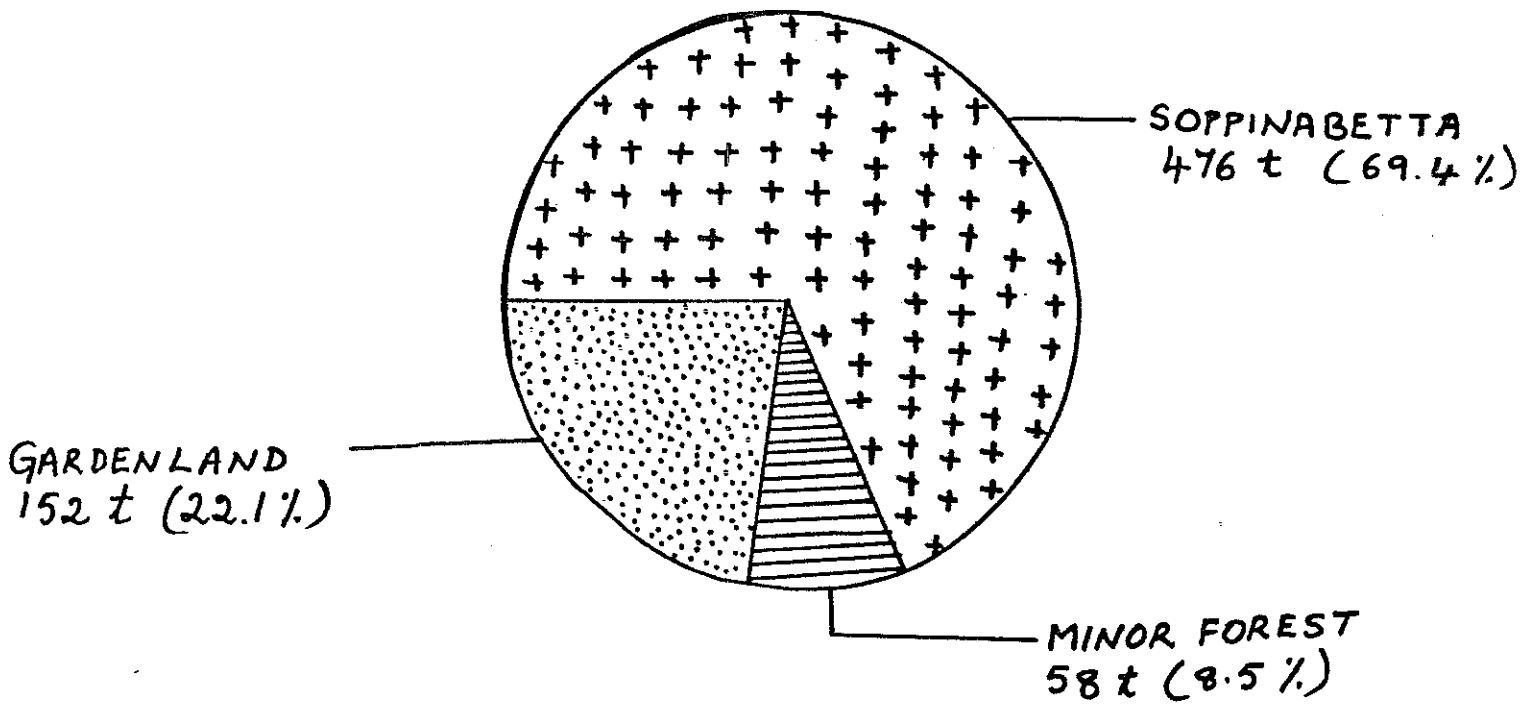


Fig. 3.2.1. SOURCES OF FUEL FOR THE SIRSIMAKKI - MUNDGESARA MICROCATCHMENT

also generates a sustantial demand of about 200 tonnes of thatch and small timber. These too add to the excessive demands on minor forest and soppinabetta areas, especially by the landless families who must entirely depend on the minor forest for their plant biomass needs. There has however been good progress in the installation of fuel efficient cooking and bath water heating stoves, about 40% of the households have modern cooking stoves and 25% modern bath water heating stoves. In fact one of the earliest field tests of Astraole, the fuel efficient cooking stove designed by Chemical Engineers of the Indian Institute of Science was carried out in this catchment. A fuel efficient bath water stove capable of burning arecanut husk, otherwise wasted as a fuel was also first constructed in this locality. There are 8 biogas plants, and 4 families use LPG stoves.

The drinking water comes from open wells for 82 out of 88 households, and this water becomes turbid during the rainy season. Only 21 households have latrines with septic tanks.

3.3 Livestock

Apart from 22 of the landless and very small landholding households, all own between 1 to 31 cattle/buffaloes. The total number of livestock for the catchment is 449, with a mean of 6.8 and median of 5 animals for the 66 animal holding households. There are no goats, sheep or pigs in the catchment; however two farmers have taken to rabbit-keeping. The number of livestock is roughly one per ha of the total land holding, including crop, garden and soppinabetta lands.

TABLE 3.3.1

Composition of the livestock population of S-M catchment. The number of animals in milk is given in brackets against adult females.

	Local cattle	Crossbred cattle	Buffaloes
Calves Male	16	6	14
Female	6	6	2
Heifers (Female)	21	20	11
Adult females	127(40)	52(23)	104(51)
Scrub males	18		11
Castrated males	35		0
Total	307		142

All the 66 animal holding households have cattleshed varying in area from 7.3 to 92 m^2. Only 18 of these have concrete floor, and 50 of them have tiled roof. This reflects the traditional practice of daily preparing a bedding of leaves for the animals and adding this to the manure pit along with the dung. Majority, but not all farmers vaccinate their animals against HS and FM and there have been no serious epidemics in recent years. However the calves carry an excessive load of intestinal parasities. The 52 crossbred cows are mostly inseminated artificially, local cattle and buffaloes enjoy natural service. The Veterinary hospital as also the BAIF Centre at Sirsi, about 8 km away look after the health and insemination needs (Fig. 3.3.1).

A fair amount of labour goes into managing the livestock, including cleaning the shed, feeding, milking etc. On an average each household puts in 4 hours of work or 1/2 man-day every day; this

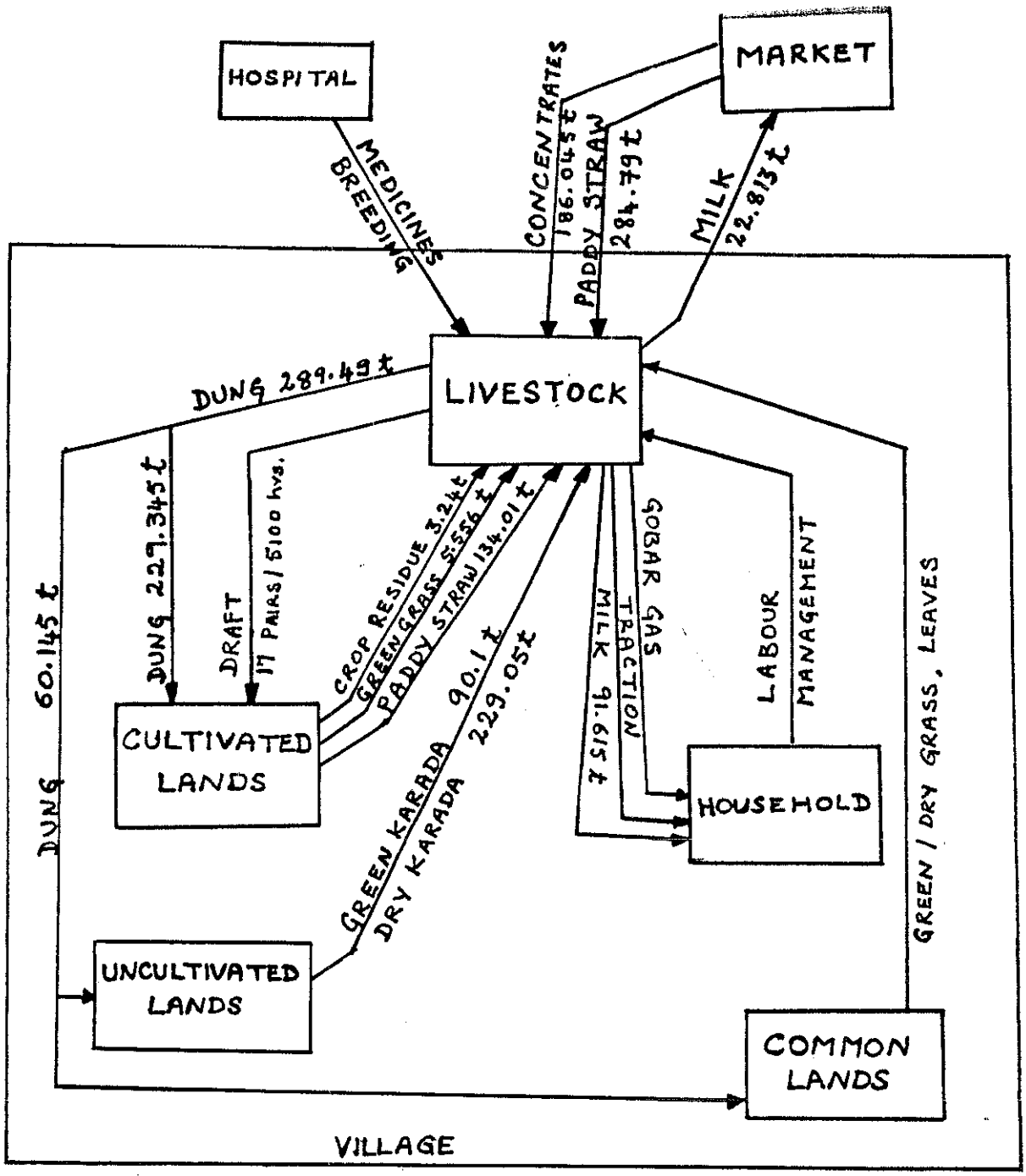
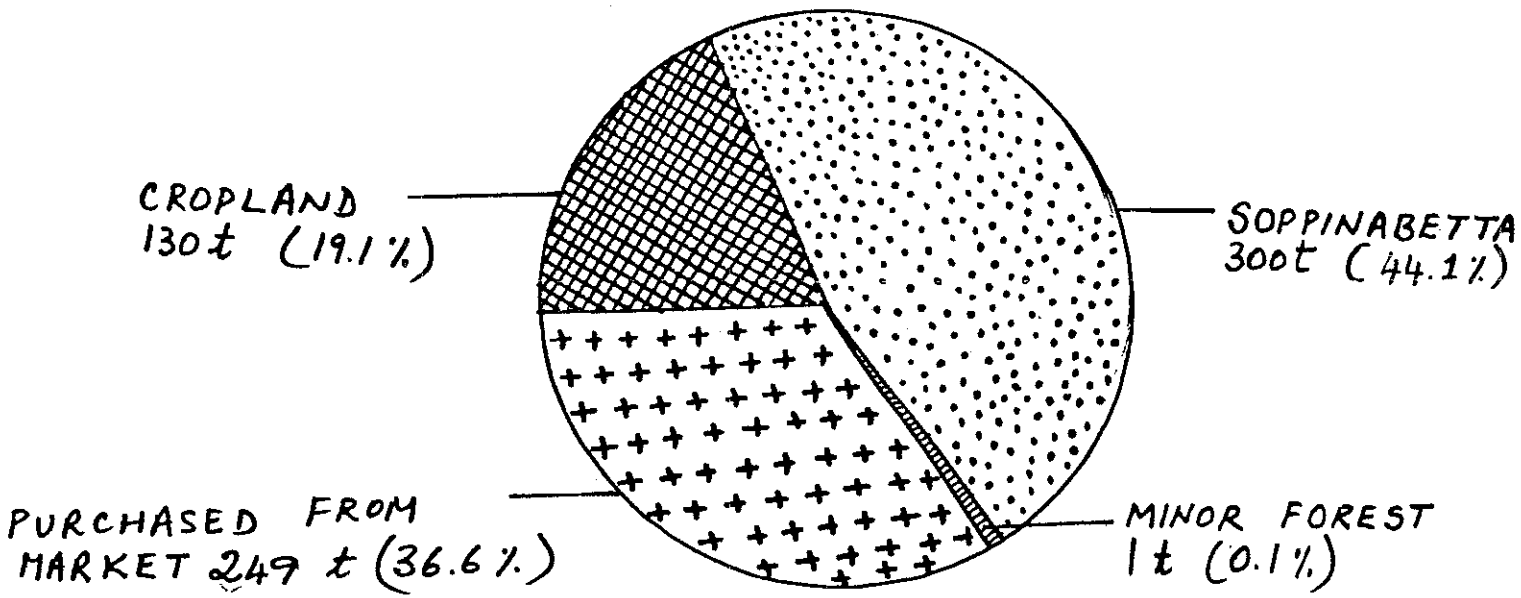


Fig. 3.3.1 FLOWS THROUGH LIVESTOCK SECTOR IN SIRSIMAKKI - MUNDGESARA MICROCATCHMENT



3.3.2. SOURCES OF FODDER FOR THE SIRSIMAKKI - MUNDGESARA MICROCATCHMENT

amounts to over 12,000 man-days of labour per year for the catchment as a whole.

These 449 animals require large quantities of fodder; at 5 kg of dry weight per day per animal this comes to over 800 tonnes of grass. If all the 323 ha of forest and crop land were fully productive, this could be available. However, there is in fact severe shortage of natural grazing, with harvestable grass production from forest lands coming to 300 tonnes and paddy straw to 129 tonnes. The farmers therefore purchase a substantial amount of paddy straw as well as some grass and concentrates. The total quantity of fodder and feeds in dry weight given to the animals is as follows:

Green grass and leaves	95	tonnes
Leguminous crop residues	3.8	,,
Paddy straw	419	,,
Dry grass	229	,,
Concentrate pellets	140	,,
Cotton seeds	16.7	,,
Bran	18.2	,,
Other concentrates	10.9	,,

The farmers of this catchment thus provide a considerable amount of feeding for the livestock in the stall. In all 19 farmers stall feed all of their 194 animals round the year, 12 farmers let out for grazing their entire herd of 77 animals round the year, while 47 farmers let out 178 of their animals for part of the year, primarily from August to January for grazing. In addition, some animals from outside the catchment also come into the catchment for grazing (Figs. 3.3.1 and 3.3.2).

A milking local cow daily yields an average of 1.2 litres, a buffalo 2.6 litres and a crossbreed cow 5.8 litres. Of the total 310

litres of milk produced in the catchment only 62 litres are marketed, primarily through the Karnataka Milk Federation.

Given the low milk yields, less than 0.7 liters per day per head of livestock, it is clear that the animals are not really being maintained for milk. The bullocks and buffaloes do provide vital animal power during the ploughing season. However these work animals are on average engaged for no more than 300 hours in the whole year. The real product of the livestock is therefore the dung. Farmers use dung and urine, mixed with animal bedding for the preparation of manure. There is no definite information on the amount of dung produced by these animals and the proportion collected. Our estimate is that about 1100 tonnes of fresh weight of dung is available and leads to production of about 1276 tonnes of fresh weight of manure. The system of preparation of this manure is quite primitive and leads to substantial loss of nutritive value. There are only eight gobar gas plants amongst the 66 households owning livestock, although more than 50 of them own 4 or more animals.

An estimate of the economics of livestock maintenance in the catchment is then possible. The cost of fodder is 5.6 lakhs and of concentrates 3.6 lakhs, to this we may add 1.2 lakhs towards labour input. The value of dung at Rs. 90 per tonne of fresh weight comes to 1.03 lakhs and of milk at Rs. 4 per liter to 4.57 lakhs. The value of bullock power is about 0.25 lakhs. The returns then come to 5.85 lakhs on an investment of 10.4 lakhs (Fig. 3.3.3).

There is food for thought here. The livestock as maintained currently are obviously not a very effective way of providing power

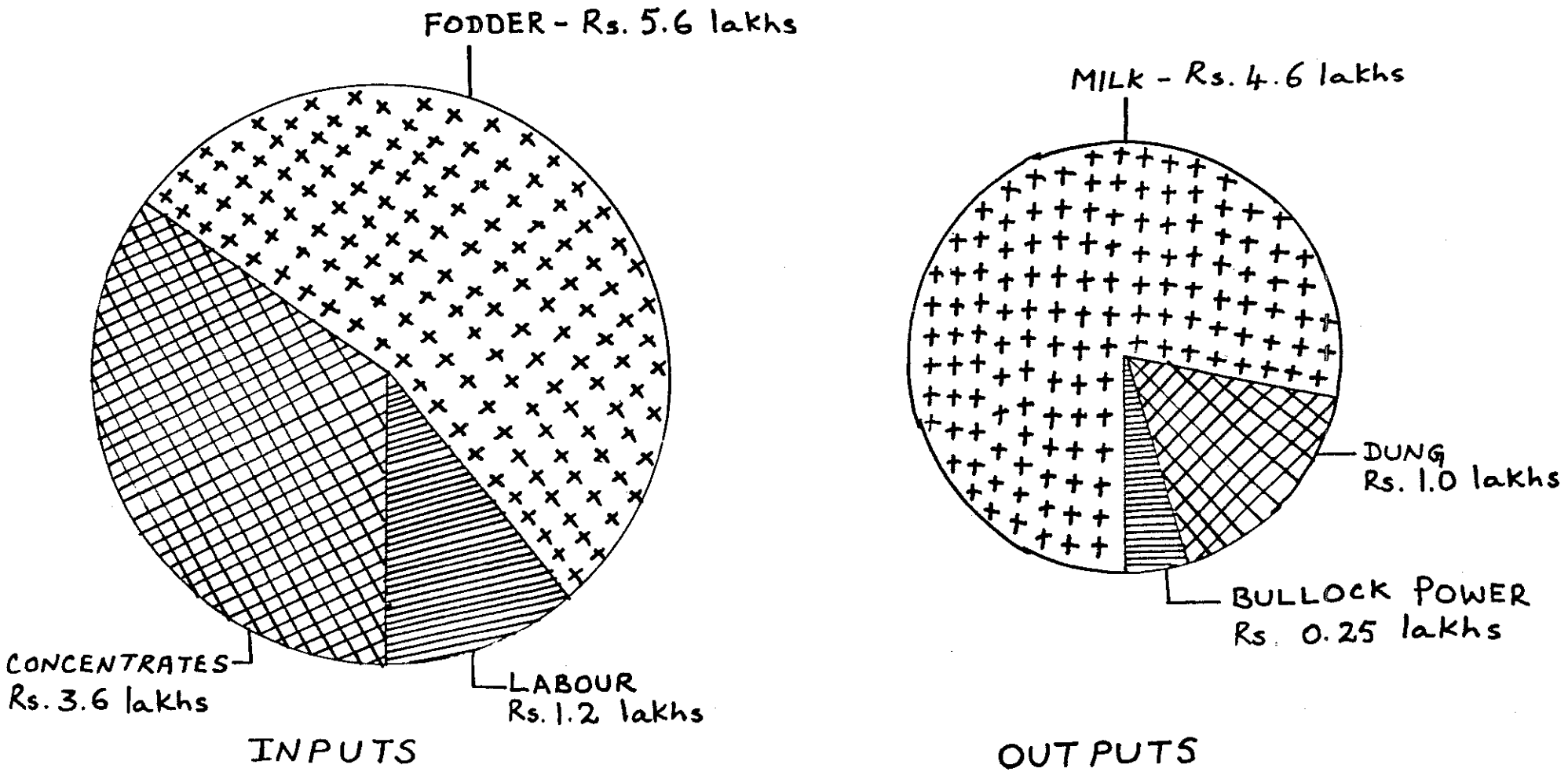


Fig. 3.3.3 ECONOMICS OF LIVESTOCK MANAGEMENT IN THE SIRSIMAKKI - MUNDGESARA MICROCATCHMENT

for farming operations, dung as a method of returning nutrients to cultivated land and milk as a source of protein. While drastic changes in the present practices may be difficult to be brought about, attempts along a number of lines are called for. These include :

(a) Improving cattlesheds especially to reduce the need for leaf bedding and enhance the efficiency of collection of dung and urine

(b) Genetic upgrading of livestock

(c) Better health care especially of calves

(d) Further spread of stall feeding practices

(e) Development of fodder resources including silaging

(f) Better utilization of animal power, particularly in dry season for drip irrigation etc.

(g) Improving methods of manure preparation

(h) Reducing the total number of animals.

Two of the farmers have recently taken to maintaining rabbits. There is also much scope for fish culture in irrigation tanks, bee keeping and perhaps maintaining ducks.

3.4 Water Resources

The S-M catchment with an average annual precipitation of 2626 mm is blessed with abundant water resources. However since the rainfall is concentrated in 3-5 months irrigation is essential during the December-May period. As all the cultivated land is artificially widened stream beds irrigation potential has been created by construction of tanks at the heads of valleys as well as by bunding the streams in the dry season (Fig. 3.4.1). Traditionally these tanks were maintained communally. Since independence however this system has

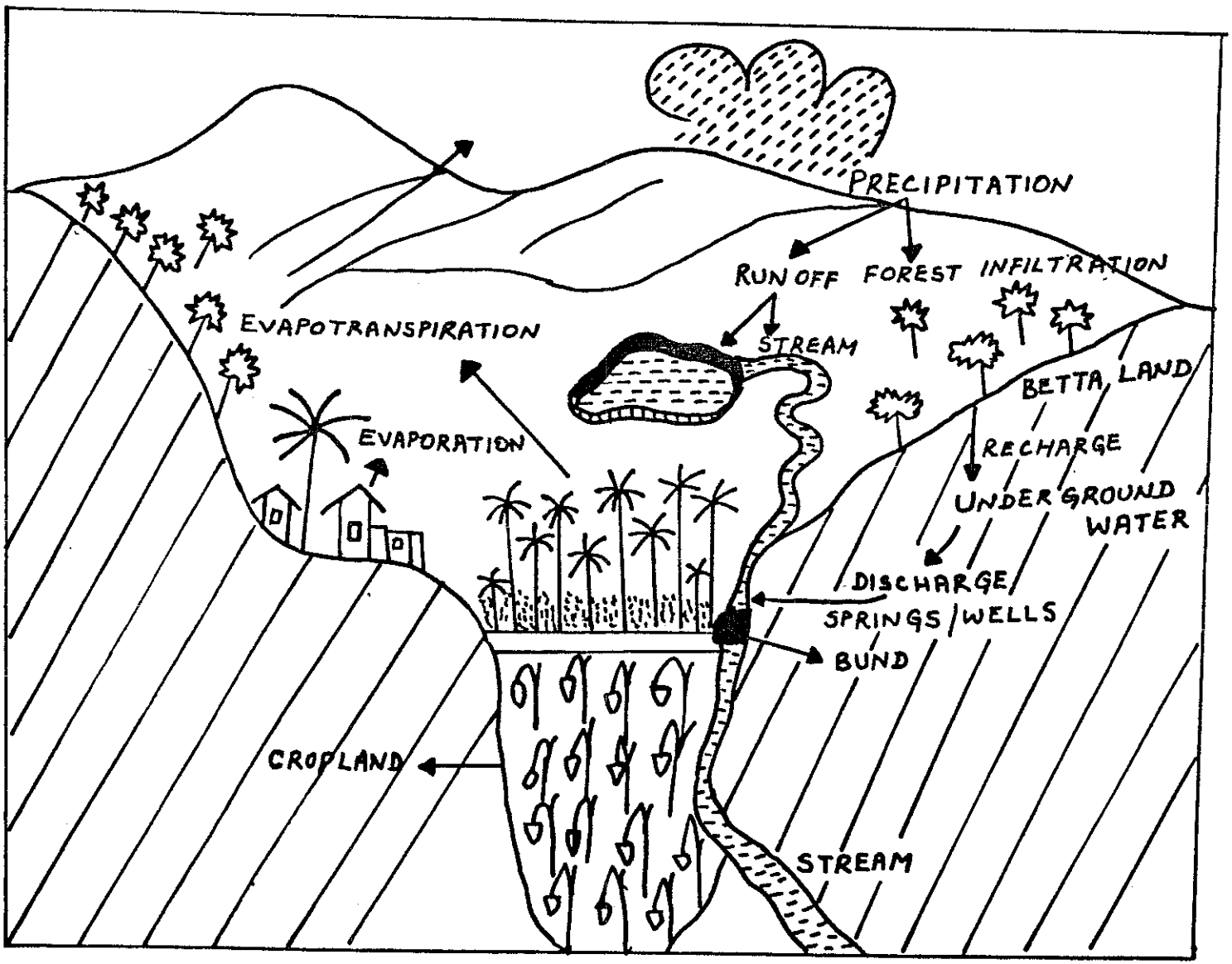


Fig. 3.4.1 THE WATER CYCLE OF SIRSIMAKKI - MUNDGESARA MICROCATCHMENT

collapsed and the tanks are suffering from siltation, overgrowth of vegetation, neglect of bunds, and improper use of land bordering the tanks. The status of the 5 tanks may be summarised as follows (Table 3.4.1).

Table 3.4.1

Status of irrigation tanks of S-M catchment

Name	Status	Potential for irrigation ha.	Currently realized irrigation ha
1. Dhrongere	Fully silted	6	2.2
2. Bellikeri melinakere	Thick weed growth	7	4.1
3. Bellikeri kelaghinakere	Fully silted		
4. Giddamavinakattekere	Partly silted	5	3.0
5. Mundagesara kelaghinakere	fully silted		
Total		18	9.3

It has been estimated that the Dhrongere tank has accumulated 6200 m^3 and Kelaghina Bellikeri tank 3600 m^3 of silt over the last 40 years.

There are 4 major bunds on the streams in which water is impounded during the dry season. Three of these are yearly constructed from mud and plant biomass; and require 408 m^3 of soil 4.36 tonnes of green twigs and 0.3 tonnes of poles of material. A fourth bund is permanent but in need of repairs. The areas irrigated by these bunds are as follows:

Name	Area
1. Sirsimakki melina kattu	5 ha arecanut
2. Sirsimakki kelaghina kattu	3 ha arecanut
3. Vadgere kattu	1.5 ha paddy
4. Mundagesara kattu	1.4 ha paddy

There are 7 irrigation wells, many of them near the streams from which water is lifted by pumping. A few garden owners now use sprinkler irrigation.

Apart from the tanks and bunds, water from streams as also smaller springs is used for irrigation. This water is circulated through channels in gardens that serve both to irrigate and drain. Some of the gardens have been provided with underground drainage channels. There are however areas amounting to 2.4 ha of garden land and 1.8 ha of paddy land which have become waterlogged.

The hilly minor forest and soppinabetta lands serve as catchments for the streams and tanks. Overgrazing, regular fires and sweeping the ground of all leaf litter have however led to erosion as well as compaction of soil. This has reduced the ground water recharge and in recent years led to drying up of springs and tanks. The garden lands are protected from the runoff from these hills by an outer trench. This trench has also fallen into some disrepair.

3.5 Minor Forest

Forest lands of Uttara Kannada are divided into four main categories: reserved (state owned forest primarily dedicated to timber and industrial softwood production), minor (state owned forest land set aside for supply of fuelwood, fodder and small timber for the

local population), soppinabetta/hadi (state owned forest land assigned to garden owners for enjoyment of usufruct provided they maintain a minimum tree density of 100 per ha) and khushki/bena (privately owned forest land often converted to grassland by cutting down tree growth). S-M catchment has 28 ha of minor forest adjoining the Sirsi-Kumta road. The 14 landless households of the catchment are entirely dependent on this land for all their plant biomass requirements; the 74 landowning families also have access to and use these lands despite the much greater extent of soppinabetta lands available to them. Apart from these fuelwood extractors and cattle from outside the catchment also exploit these lands. The result has been a severe degradation of its vegetation. Originally its vegetation should have been a semi-evergreen forest with a standing biomass of 300-450 tonnes/ha and annual above-ground production of 15-25 tonnes/ha. Today the biomass is reduced to just about 8.5 tonnes/ha with a tree density of 144 trees/ha and above-ground annual production to 0.5 tonnes/ha The vegetation is now dominated by thorny and fire resistant species. The dominant trees are Randia spinosa, Eugenia jambolana, Memecylon sp., and Diospyros melanoxylon. The annual harvest from the minor forest, for fuelwood (51%), small timber (37%) and green leaves for manure (12%) is at the rate of 4.2 tonnes/ha, more than 8 times the level of production. A rather rapid liquidation of the capital stock the vegetation is evidently in progress and many portions of the minor forest are totally barren. This production/harvest balance leaves out of account a small amount of grass produced and quickly grazed by the cattle.

In recent years there have been new initiatives to restore the productivity of the minor forests. The forest department has taken up two such programmes in or near this microcatchment. The first is the development of a plot of about 5 ha of fodder grasses plus fodder trees such as Subabul. Secondly, the Vidyodaya Junior College-cum-High School that serves this catchment has been allotted 25 ha of minor forest land including some outside the catchment for the development of a school forest.

Sustainable management of the minor forests is obviously a major challenge. The current open access management pattern is not at all conducive to good use of these lands. It is necessary that either mandal panchayats, primary milk-producers' co-operatives or some specially set up forest panchayats, be made responsible for management of minor forests and be given sufficient authority to keep out non-locals and penalize locals violating the necessary regulations.

3.6 Soppinabetta

The 289.7 ha of soppinabetta lands are hilly lands owned by forest department but assigned to the garden owners to fulfill their requirements of leaf manure by lopping the trees, as well as of fuelwood, small timber and grazing for their animals. While the lands are jointly assigned to the garden owners, the bulk of them has been divided up and assigned to individual households through mutual agreement. These soppinabetta lands are often fenced and properly protected by the owners increasing the chances of more regulated harvests and better maintenance of the growing stock of the vegetation. Despite this, there has been overexploitation of the

soppinabetta lands leading to their degradation, although they are in far better shape than the minor forest.

There are 65 garden owners with soppinabettas assigned to them, with an average ratio of 6.3:1 of soppinabetta to garden land. The soppinabetta land holding range from less than a ha to 16 ha with the median holding being 3 ha. These bettas are lopped of green leaves to produce manure, as well as swept of dry leaves to provide mulch. Traditionally the lopping practice is supposed to have been on a rotation of 4 years, with a lopping of the lower side branches alone. Currently 28 families lop once in 4 years and 4 families once in 5 years. However 27 families lop once in 2 years while 4 lop every year. The lopping is generally total, including the apical shoot. This has resulted in considerable overexploitation and killing of many trees. As a result 18 households have recently completely stopped lopping the trees. The lopped branches and larger twigs are seperated from leaves and are then used as fuel. All the dried and fallen leaves are generally swept clean from the ground for use as mulch. The natural grass growth is grazed upon by cattle; in November-December the dried grass is harvested as fodder. Fires are often set to the soppinabetta lands in the months of February-April. All of this hinders regeneration. It also leads to laying the ground bare, erosion as well as compacting and formation of a surface hard pan.

The soppinabetta lands are much better stocked than the minor forest lands with a tree density of 360/ha and shrub-sapling density of 18550/ha. The standing biomass is 27.9 tonnes/ha, still far below the potential of 300-450 tonnes/ha for such a forest, but three times as large as that of the minor forest. The productivity is estimated at

2.98 tonnes/ha, again much below the potential of 15-20 tonnes/ha. The dominant tree species include Terminalia tomentosa, T. paniculata, Eugenia jambolana, Aporosa lindleyana and Careya arborea. These are mostly species favoured as sources of leaf manure.

The annual harvests from soppinabetta lands come to 6.04 tonnes/ha, which is twice the annual production. They include fuelwood (27%), dry leaves for mulch (25%), green leaves for manure (21.6%), dry grass harvested as fodder (17%) and small timber and poles for agricultural implements, fencing and house repairs (8.4%) and a small quantity of fruits, spices etc. The result of this overexploitation has been the opening up of many patches of soppinabetta lands creating grasslands. This is, however, often considered desirable because it is believed to enhance fodder production of which there is an acute shortage. Unfortunately the grass production is also not sustained in many cases leading to the formation of hard surface pans.

Over the last 4 years many farmers have begun attempts to reverse these trends, largely thanks to new initiatives from the Forest Department and through involvement in the Indian Institute of Science project. The initiatives taken by them include:

(a) Cessation of lopping of trees for leaf manure,

(b) Planting of soppinabetta lands with saplings of a variety of indigenous as well as exotic species,

(c) Planting of soppinabetta lands with fodder grasses,

(d) Halting grazing and setting of fires to soppinabetta lands.

(e) Development of a nursery at the School as well as privately by

kissans for raising seedlings for planting on soppinabetta lands with support of the Forest Department.

Soppinabetta lands constitute nearly three fourths of the S-M catchment, and in fact, cover 2000 ha out of the 10000 ha of the district. Their good management must therefore be a significant element of the development efforts in the Uttara Kannada district. The soppinabetta land assignees are becoming increasingly motivated to plant and take good care of tree crop on these lands. However, they currently have the privilege of enjoying the usurfruct in the form of twigs, leaves, fruits and grass but have no claims over the wood produced. There is a proposal before the State Goverment to give them a share somewhere between 70-90% in the wood produced by them over and above the maintenance of 100 trees per ha. If this proposal is acted upon, there is every possibility that the lands will be brought under good management and used very productively.

3.7 Croplands

Four connected stretches of valley lands, along with some of the bottom lands along the hill sides totalling 15.17 ha serve as the cropland of this microcatchment. A small proportion, 0.75 ha is under sugarcane. Of the rest, 14.42 ha are all under paddy in the kharif season; 11.48 ha out of this is also put under some summer crops, 2.49 ha of summer paddy and 8.99 ha. of pulses.

The soils of croplands are acidic and heavy, mostly clayey or sandy loams with a pH between 5.0 to 6.5. About 2 ha of upland paddy is entirely rainfed and is susceptible to failure of rains as in July

1987; the rest is irrigated from seasonal and perennial streams. The soils in the low lying areas are rather ill drained and 1.87 ha remain waterlogged even during the summer. The summer crops depend on residual soil moisture. The whole of the cropland is divided into very small terraces with drainage water of the higher terraces serving as irrigation water for the lower ones. There is considerable loss of soil during the puddling operations. Rodents are a significant pest of the crops.

There is susbstantial input of organic manure to the croplands, 6.9 tonnes/ha of plant material and 3.47 tonnes/ha of dung every year. This input of 10.37 tonnes/ha is to balance the annual harvest of 12.75 tonnes/ha. The paddy yields come to 9 tonnes/ha for one season crop, the pulse yields to 4.6 tonnes/ha. This is of course the grain as well as straw; the paddy grain yeilds average 3.0 tonnes/ha. There is little use of chemical fertilizers. At the moment, we cannot state with any certainity whether the fertility of croplands is being sustained by this balance of organic matter input and harvest. It is however clear that there is a significant extent of soil erosion.

The whole farm demonstration of Agricultural University in Sirsi taluk has resulted in paddy yields of 4 tonnes/ha in comparison with 3 tonnes/ha in the S-M catchment. There are thus good possibilities of improving the productivity of croplands. The excessive fragmentation of lands owned by an individual leading to creation of small terraces is one of the major problems; extensive depredation by rodents is another. A most vital issue is also the drain on minor forest and soppinabetta lands in connection with the organic manure demands of the croplands (Fig. 3.7.1). A step in correcting this imbalance has

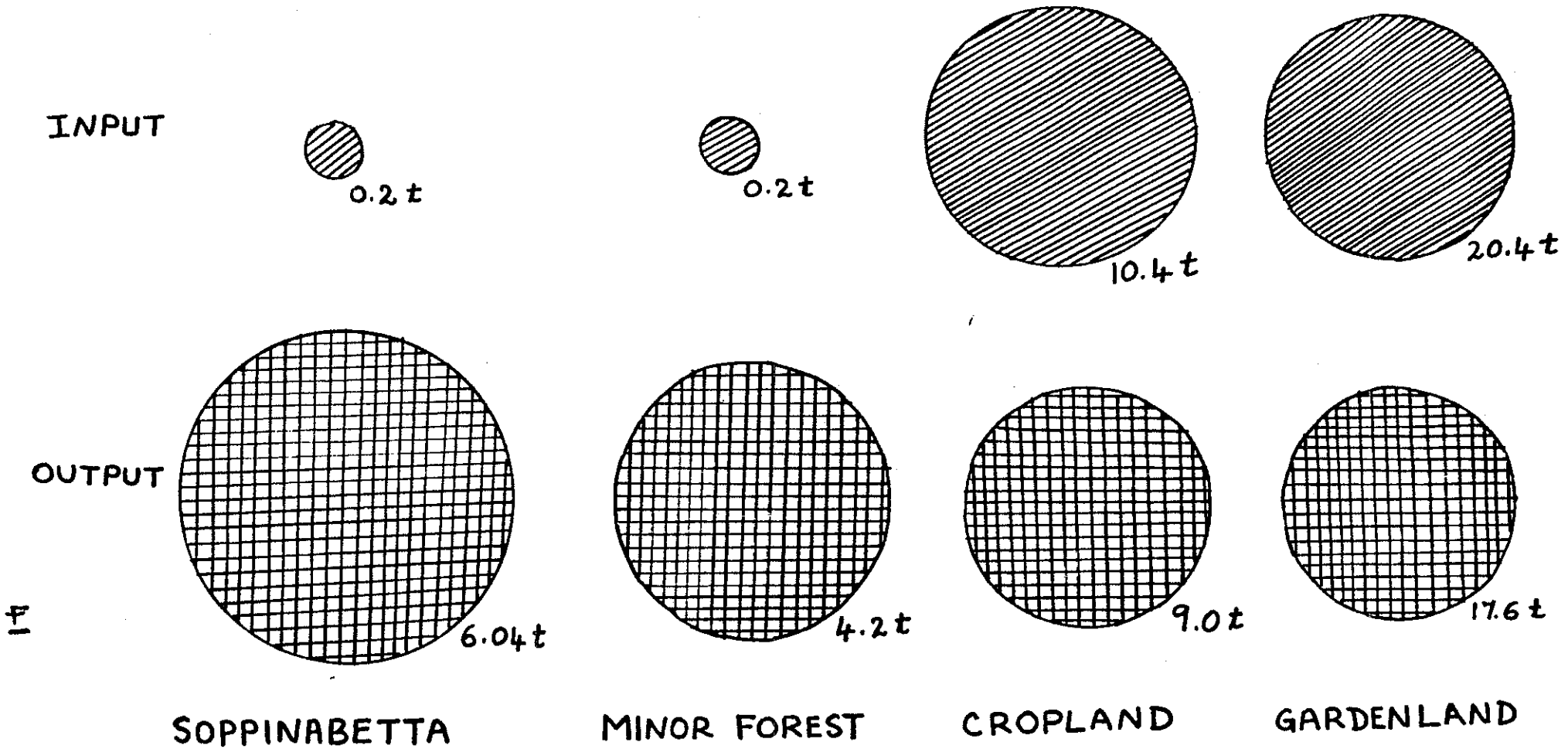


Fig. 3.7.1 INPUT AND OUTPUT OF BIOMASS (tonne/ha/year) FROM MAJOR LAND USES OF SIRSIMAKKI-MUNDGESARA MICROCATCHMENT

been the introduction of sunhemp as a summer crop on residual moisture. Experience of the Hulgol Society project has shown that it can yield 3 or 4 cuts of fodder and then can be ploughed in as green manure. It would be desirable to bring the upland paddy fields under fodder and manure plantations.

3.8 Garden Lands

The gardens of this catchment covering an extent of 46.03 ha occur in three large and one small patch in the bottom of the valleys, generally below an irrigation tank or by the side of a major stream. The gardens are protected from scorching evening sun by a protective belt of jackfruit, mango, coconut trees and by soppinabetta forest. The garden soils are not the original soils of the valley but brought from the hills by the sides of the valleys. They are acidic (pH 4.5 to 6.0) with good water holding capacity. Since the valley lands require good drainage a series of interception, mid- and side-drains are laid out throughout the garden. In recent years these are being supplemented by a more efficient underground tile drainage system. However 2.4 ha of garden lands suffer from year round water logging. The entire garden is protected from ingression of rainwater and silt from surrounding hills by digging an outer trench. The drains also serve for irrigation. In recent years this irrigation is being supplemented by sprinklers.

There is a practice of replenishing the soils of the garden lands by fresh soil dug from sides of valleys or from special mud-quarries. For the whole microcatchment this amounts to 6737 m^3 of soil per year.

The fresh soil is formed as a 75 cm high mound in between rows of arecanut palms and spread at the base of palms every year after application of manure. This operation of bringing fresh soils costs Rs. 5000 per ha and is now becoming difficult as it involves cutting into soppinabetta lands, or because the gardens are touching habitation or roads.

This need to periodically replenish the soil suggests that the garden lands do get depleted of soils and nutrients in spite of the careful shaping, covering of mulch and the very substantial inputs of organic manure. These inputs amount to 16.6 tonnes/ha of dry weight of plant biomass as part of green manure as well as dry leaf mulch plus 3.84 tonnes/ha of dry weight of dung. As against this input of 20.4 tonnes/ha of organic matter, the per ha harvests includes 6.7 tonnes of fruit bunches and 10.9 tonnes of fallen leaves plus some stems from dead trees.

The gardens are multistoreyed and highly productive. They have a ground cover of cardamom of about 4460 shrubs/ha, a middle storey of banana which is especially important in protecting the arecanut trees when the garden is first being raised, but persist till the canopy is closed, and an upper storey of arecanut trees trained with pepper vines. In recent years cocoa is replacing banana. Currently the density of arecanut trees is excessive, 2200 per ha, while the optimum is about 1500/ha. Hence the arecanut tree stemwood increment, estimated at 3.1 tonnes/ha is perhaps excessive and cuts into arecanut yields which are now 2.56 tonnes/ha, while the whole farm demonstration trials of University of Agricultural Sciences suggest a potential of 3.4 tonnes/ha/year. The standing biomass of arecanut

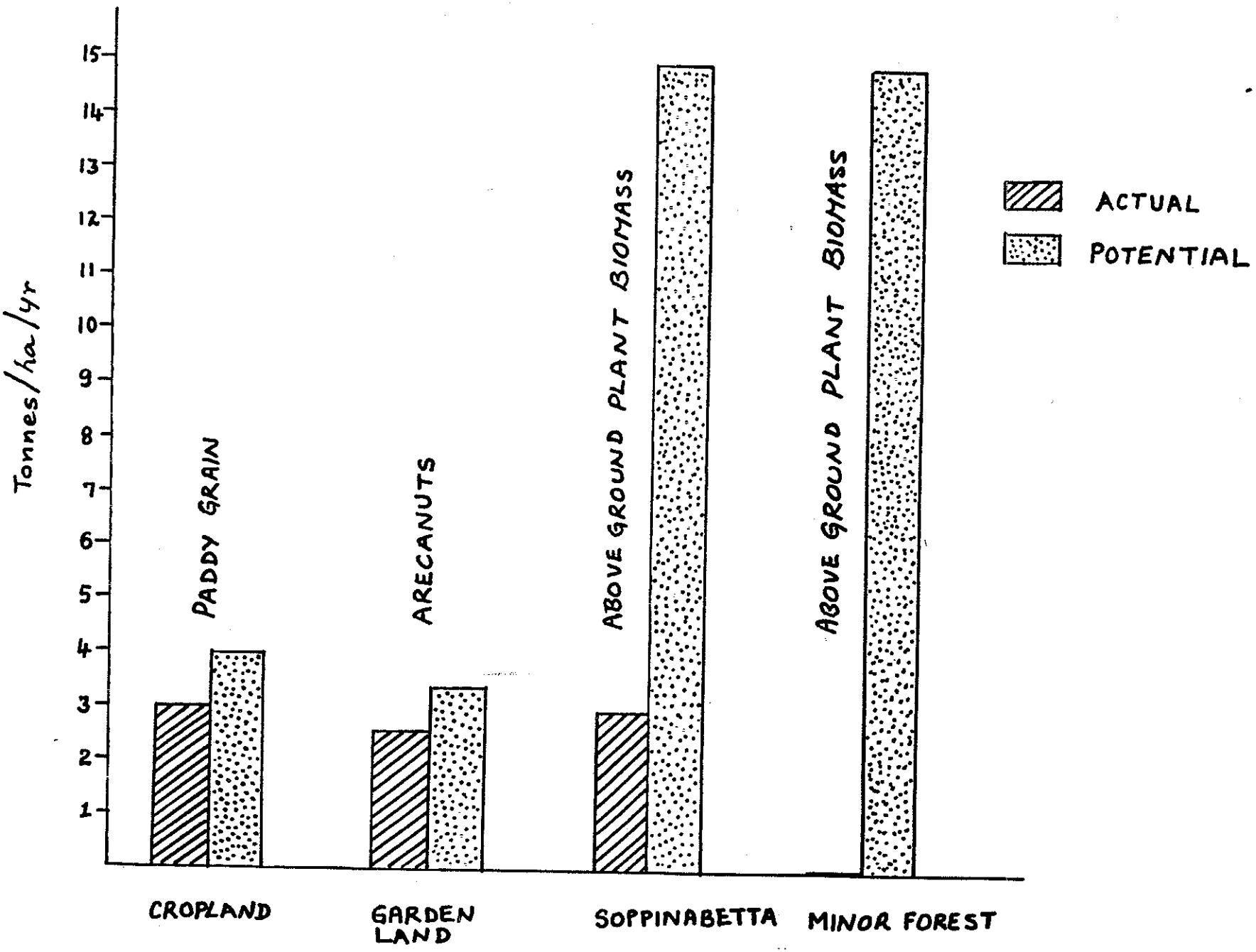


Fig. 3.8.1 ACTUAL AND POTENTIAL PRODUCTIVITY OF LAND IN SIRSIMAKKI - MUNDGESARA MICROCATCHMENT

trees is 170 tonnes/ha; this compares favourably with 300-450 tonnes/ha of the natural semi-evergreen forests that have been replaced. The pepper crop, whose productivity had been pushed up in recent years with introduction of new high yielding strains has been wiped out in recent years by a fungal disease (Fig. 3.8.1).

The gardens are economically highly productive. The gross annual income from arecanuts and cardamom can be as much as Rs. 38000/ha. The labour and material costs are of the order of Rs. 9000/ha. There is thus considerable interest on the part of garden owners in the good management of the garden lands. An important contribution in this connection could come from proper development of sources of organic manure with use of high density planting of species like Glyrecedia; and experiments along these lines have already been initiated. Cover crops like Pueraria, Calapogonium and Mimosa invisa could reduce the need for mulch and trials for their use have also been initiated. Although soil erosion from gardens is not excessive, it nevertheless is significant and shold be further controlled. Careful irrigation with sprinkler or drip systems, plus underground tile drainage are also desirable practices that should be further diffused. Control of diseases, including a co-ordinated effort at getting rid of infected plants would be most helpful. As with cropland, one of the problems in improving the management is the highly fragmented nature of holdings, with some households owning just one or two rows of trees in a large garden.

3.9 Processing Industries

The economy of S-M catchment is entirely based on agriculture and horticulture with the export of arecanut, cardamom, and some pepper,

cocoa and milk being the main sources of income. Apart from some processing of arecanuts to produce chali, there are hardly any major processing activities in the area. The only exception is a small scale spice making industry recently set up. Many raw materials processed elsewhere such as sisal and coir are available here, but not utilized. Other possibilities include production of chemicals like strychnine from fruits of Strychnos nuxvomica. In fact; if a clear decision on granting of ownership rights to tree production on soppinabetta lands is made, these lands could produce many commodities that could stimulate processing activities.

3.10 Social Institutions

The variety of institutions existing at the local level must obviously come to play a vital role in the exercise of planning and implementing an ecologically sound programme of development. At the same time the Government machinery must become more responsive to environmental issues and attempt to reach out to the people. Some promising beginnings in this direction have already been made in the S-M catchment. We review here the various possible agencies that may contribute to this effort.

(i) Kangod Group Multipurpose Co-operative Society: This society serves the people of the catchment in extending credit for and supplying fertilizers, pesticides, spraying pumps etc and in arranging for the sale of commodities such as arecanut, cardamom and pepper. It has appointed an agricultural advisor who visits the farmers and provides technical assistance in activities like improvement of drainage and application of fertilizers. The society could become far

more concerned with natural resource management issues such as soil and water conservation and depletion of the vegetation on soppinabetta lands.

(ii) Milk Producers' Co-operative Society : This society has been recently established with help from the Karnataka Milk Federation. It is also getting involved in supply of cattle feed, fodder seeds, semen etc. It could come to play a vital role in modernising the animal husbandry practices along with a sound base of cultivated fodder.

(iii) Yuvak and Mahila Mandals : the Yuvak mandals of Bellikeri and Sirsimakki have been involved in raising nurseries, planting on minor forest lands, extension activities in relation to agriculture, horticulture and so on. These organizations could take a leading role in the ecodevelopment efforts.

(iv) Vidyodaya Composite Junior College and High School, Yadahalli : This educational institution serving the catchment has taken an active role in local ecodevelopment activities. One of the first school nurseries in the state was established here in 1984; so was one of the first fuel efficient Astraoles, also in 1984. The institution is developing a 25 ha school forest. This institution has also established in 1987 one of the three Technology Demonstration Centres funded by the Karnataka State Government. This Centre has started its programmes with the diffusion of wood gasifiers and a grass cutting machine. The institution has been involved in the publication of a newsletter on Western Ghats environment, Sahyadri Parisara Patra, and is the headquarters of Sahyadri Parisara Vardhini.

(v) Sahyadri Parisara Vardhini: Established in 1984 this voluntary agency is primarily involved with environmental education and

ecodevelopment action in the Western Ghats areas. The environmental education activities have included workshops for school and college teachers, college students, local farmers and youth, as well as state-wide performances of a dance drama on environmental theme, Nisarga Sandhana. The action programmes initiated in 1985 have focussed on fodder development and related animal husbandry activities, as well as forestry programmes. These activities have centred on the four microcatchments identified by the KSCST project. The Sahyadri Parisara Vardhini plays a nodal role in the KSCST project and would continue to be involved in the operational research project being proposed.

In addition, of course, organizations such as the Indian Institute of Science, University of Agricultural Sciences, and Bharatiya Agro-industries foundation, Khadi and Village Industries Commission and Government Departments including Forest, Animal Husbandry Agriculture, Horticulture and Rural Development would have to play a significant role in the programme. Finally the S-M catchment falls within the jurisdiction of two Mandal Panchayats, Itguli and Kangod. Dialogue has already been initiated to involve these mandal panchayats in this programme.

4. MASUR-LUKKERI MICROCATCHMENT

4.1 Physical Setting

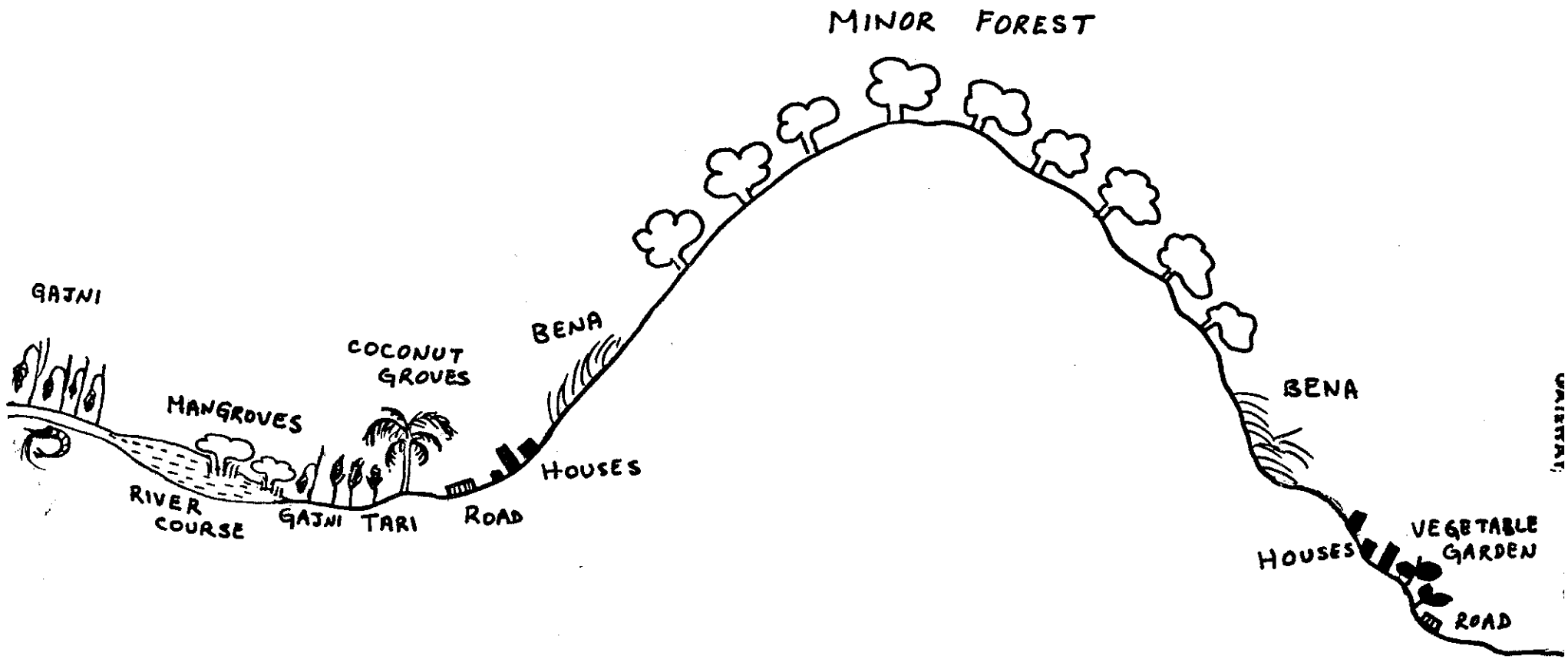
The Masur-Lukkeri microcatchment (hereafter referred to as M-L catchment) lies in the Kumta taluk 4 km from the town of Kumta at 14^{o} 28' N lat 74^{o} 23' E long. It is a cluster of 9 settlements on an island in the estuary of the river Aghanashini (Fig. 4.1.1). A westward spur of the Western Ghats runs right upto the sea

near the mouth of Aghanashini, and one of the hillocks of this spur, rising to an altitude of 75 m constitutes this island. The island is surrounded on all sides by brackish water which is subject to the tidal influence since the mouth of the river Aghanashini lies just 5 km to the north. The soils are lateritic, acidic and reddish brown in colour. This is a region of good rainfall, the mean annual precipitation being 3200 mm. The rains are concentrated in the months of May to November, with June, July and August being the rainiest months.

Table 4.1.1

Land use in the M-L catchment

Zone I Hillock	
Minor Forest	103.0 ha
Private grasslands/bena	23.4 ha
Zone II Base of hillock	
Area under settlement including some upland paddy (*makki gadde*), coconut groves and vegetable gardens	22.3 ha
Roads	2.2 ha
Zone III Low lying lands	
Fresh water paddy fields (*tari*)	55.3 ha
Arecanut gardens	2.0 ha
Zone IV Estuarine lands	
Brackish water paddy fields (*gajni*)	87.6 ha
Zone V	
River course	62.5 ha
Total area of catchment	358.3 ha
Land owned by residents just outside catchment.	
Tari lands	58.5 ha
Gajni lands	155.4 ha



4.1.2. A SCHEMATIC VIEW OF LAND USE IN MASUR - LUKKERI MICROCATCHMENT

The M-L catchment with an area of 358.3 ha may be divided into 5 zones (Fig. 4.1.2). The hilly area accounting for 126.4 ha comprises a small hillock of 2 ha with an elevation of 42 m at the southern end of the island and a larger central hillock of 124 ha with an elevation of 75 m. The central hillock rises steeply on the eastern side but is indented and has a gentler slope to the west. The five major streams on the island therefore lie to the west, while there are three much smaller and faster running brooks on the east. All the streams are seasonal and dry up soon after the monsoons.

The second zone of the catchment is a broad belt with an altitude of 10 to 4 m at the base of the hill. A circular road of a little over 4 km in length runs along the centre of this belt with houses on either side. There are coconut and cashew nut trees and some upland paddy fields (makki gadde) in this zone which occupies 24.5 ha. Between the river and the contour of 4 m elevation is the third zone of low lying paddy fields (tari) of 55.3 ha and garden lands of 2 ha. At the sea level lies the shallow bed of the estuary subject to the tidal influence. The waters here are relatively fresh during the monsoon when the river is in spate. A series of bunds bordering 87.6 ha of this fourth zone control the flow of river and tidal water. These are the khar or gajni lands which support a crop of brackish water paddy in the monsoon and serve as prawn farms in the dry season. The fifth zone of the catchment is the deeper river bed and accounts for 62.5 ha. Farmers of the catchment own 58.5 ha of tari and 755.4 ha of gajni lands just outside this catchment.

The 404 households of this catchment are clustered into 9 hamlets of Lukkeri, Hoskeri, Masur, Sannakuli, Kalbhavi, Halasamavu,

Keregajni, Devarabole and Ambigakeri. The circular road, only a small section of which has been tarred, is connected to Kumta by a bridge near Lukkeri. A road formed by the bunds in the river connects the island to the village of Hegde near Keregajni.

4.2 Human Habitation

The coastal tract is quite thickly settled and this island has a population of 3417 which comes to a density of 949 per km^2. Males constitute 50.4% of the population and children below the age of 14, 38.5%. There are as many as 15 different endogamous communities living on the island. The numerically largest is the community of Gam Vakkals or Patgars (210 households) living in Hoskeri, Masur, Sannakuli and Kalbhavi. The second largest community is the Halakki Vakkals or Gowdas (62 households) living in Lukkeri. Numerically the third and fourth largest community are Ambigas (43 households) and Madivals (26 households) who live in Ambigakeri and Devarabole respectively. There are two scheduled caste families, and 18 Brahmin families as well. Eighty six of the families are landless and the remaining 328 families own between themselves 144.9 ha of cultivated land within the microcatchment and another 213.9 ha of paddy land just outside the microcatchment. Thus the average landholding per family is 1.1 ha. This is split into several fragments, in some cases as many as 40, so that each individually owned piece of land is only between 0.05 to 0.1 ha in any one place. Of the landholders, 200 families own only paddy lands while the others own some coconut or arecanut gardens as well. Two hundred of the landowning families maintain a total of 734 cattle and buffaloes. A number of families also maintain poultry, 1332 chicken in all.

The different communities tend to follow their traditional occupations. The Gam Vakkals are primarily cultivators; many of them also migrate upghat to work as labourers in arecanut gardens. The Halakki Vakkals are paddy cultivators. Their women cultivate vegetables and weave mats, while the men also work as masons. Both these communities indulge extensively in fishing and shellfishing for their own consumption. The Madivals too are cultivators, while the Ambigas are fisherfolk. Many Brahmin families are horticulturists. There are also artisans such as Achari (carpenter and blacksmith), Shet (goldsmith) and service castes like Kodeya (barber).

The household sector needs food, fuel to cook it with and small timber and thatch for the houses and cattle sheds. Rice is the staple food but the paddy production on their own land is inadequate, coming to 0.33 kg/day/head as compared to the average consumption of 0.5 kg/day/head. Of the 470 tonnes of rice consumed every year 161 tonnes has to be purchased from the market. 96% of the 13 tonnes of pulses produced are also purchased. A good deal of fish, crabs and shellfish is also consumed, much of it collected personally from the waters around the island. The overall fuel consumption is much lower than in the S-M catchment considered above coming to only 1.48 kg/day/head. Of this 0.98 kg goes into cooking food and the rest in heating bath water. Of the total annual requirement of 1850 tonnes of fuel, 123 tonnes is produced within the catchment, 115 tonnes as by products of coconut, 4 tonnes as dry leaves and 4 tonnes as dung cakes. Another 180 tonnes is collected in the form of driftwood at the time of floods of the river Aghanashini. The rest has either to be brought from the Mirzan Minor Forest on the other side of the river (1072 tonnes) or purchased from the Government fuel depots (475 tonnes). It is notable

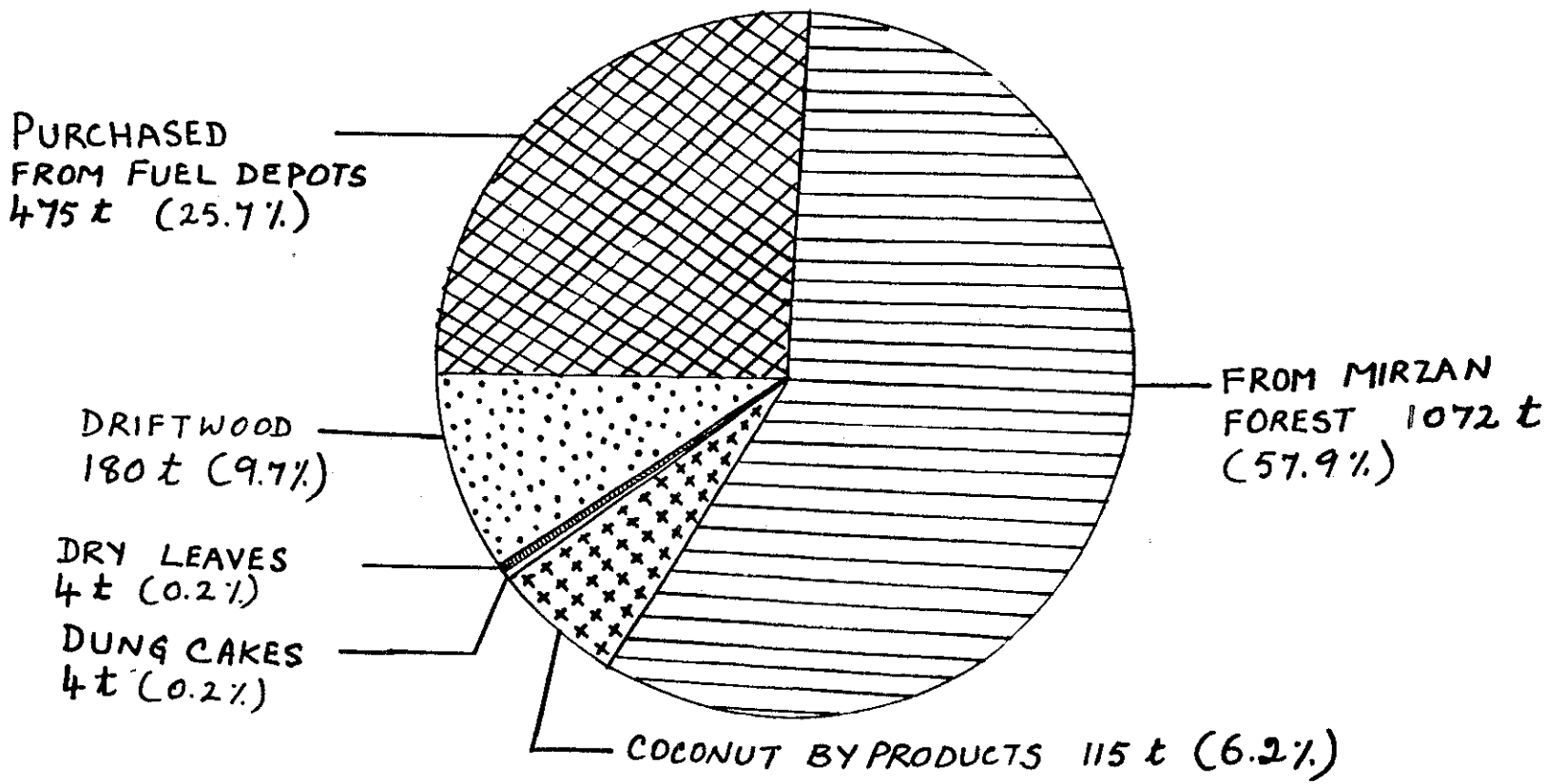


Fig. 4.2.1 SOURCES OF FUEL FOR THE MASUR-LUKKERI MICROCATCHMENT

that a small quantity of dung is used as fuel (Fig. 4.2.1). Since dung is prized as manure this is indicative of the severe shortage of fuel. Sixty of the households now have fuel efficient cooking stoves, Astraole and two have new bath water heating stoves. There is just one biogas unit in the area. Of the 9.2 tonnes of thatching material required, 4.2 tonnes is in the form of paddy straw and 5.0 tonnes in the form of coconut leaves.

An interesting new possibility that may be explored with great advantage in M-L catchment is the use of a solar pond to provide hot water for bathing. Based on the pilot project at the Indian Institute of Science, such a pond of 200 m^2 surface area has been designed for this locality and would require an initial capital investment of around Rs. 40,000. It would also require a recurring expenditure of Rs. 10,000 per year. These costs, especially the recurring cost could be cut down substantially if we utilize the brine discarded at the salt pans of the Caustic Soda factory close by. Such pond can provide 1700 tonnes of hot water at 40 ^{o}c every year, thus saving around 68 tonnes of fuelwood. A suitable location for this pond has already been identified within the microcatchment.

Of the 404 households, 160 have electric lights, but only 4 have septic tanks.

The older people of this area are essentially all illiterate. On the other hand, younger generation is all literate with two primary and one high school serving them. However, very few of them, apart from the 18 Brahmin families have employment outside of cultivation. There is therefore a tremendous level of underemployment especially in the two major communities of Gam Vakkals and Madivals. Consequently,

many of the Gam Vakkals migrate upghat as garden labourers, and some have permanently settled there. The Halakki Vakkals do not face as serious a problem since the men are also skilled masons and women engage themselves in mat -weaving and vegetable cultivation in the dry season. The fishing community of Ambigas is affected by the recently introduced system of auctioning gajni land for prawn capture in the dry season. Earlier they used to freely fish in these waters, but are now restricted to only catching crabs.

4.3 Livestock

In M-L less than half of the households, 200 of the landholders maintain cattle or buffaloes. There are no pigs, sheep or goat but most households other than the few vegetarians maintain 3 or 4 chicken. Three farmers have recently taken up rabbit farming. The total number of livestock for the catchment is 734 with a mean of 3.6 per animal holding household. The range varies from 1 to 19. Table 4.3.1 gives the composition of the livestock.

TABLE 4.3.1

Composition of the livestock population of M-L catchment

	Local cattle	Crossbreed cattle	Buffaloes
Calves	42	0	15
Heifers	30	0	6
Adult	321	1	100
Scrub/Breeding Males	37	0	29
Castrated Males	153	0	0
TOTAL	583	1	150

The 200 animal holding households share 198 cattlesheds. These are rather poorly constructed with only 17% having a concrete flooring and 53% permanent roofing of tiles. In the 163 sheds with mud flooring a bedding of dry leaves fetched from the Minor Forest, straw from the brackish water paddy crop of gajni lands and some reeds gets mixed up with dung and urine and are later converted into manure. Although there is a veterinary hospital at Kumta 5 km away, no farmers vaccinate their calves and only 4 have recently taken to artificial insemination. Each household puts in an average of 2.66 hours of labour in managing the livestock. This amounts to 24270 man days of labour per year.

These 734 animals require a fair quantity of fodder; for a minimal adequate diet of 5 kg of dry weight per day per animal, this comes to 1340 tonnes of dry weight of grass. The fodder must come primarily from straw and grass from 113.8 ha of tari, the 23.4 ha of bena and the 103 ha of minor forest lands. If all this 240.2 ha of land were highly productive, the requirement might have been met. However, in practice there are serious shortfalls with the 214 tonnes of paddy straw, 63.1 tonnes of pulse crop residues and 20 tonnes of dry grasss from bena lands along with 70 tonnes of dry weight of green grass from bena and gajni lands providing less than a quarter of the requirements. In consequence, the 103 ha of minor forest is severely overgrazed. It has short stubble of green grass during the monsoon, but this largely disappears after November. The animals are therefore half-starved for at least half the year from December to May (Fig. 4.3.2).

The farmers supplement the scanty natural grazing and fodder harvested on their own lands by purchasing 13.9 tonnes of dry karada

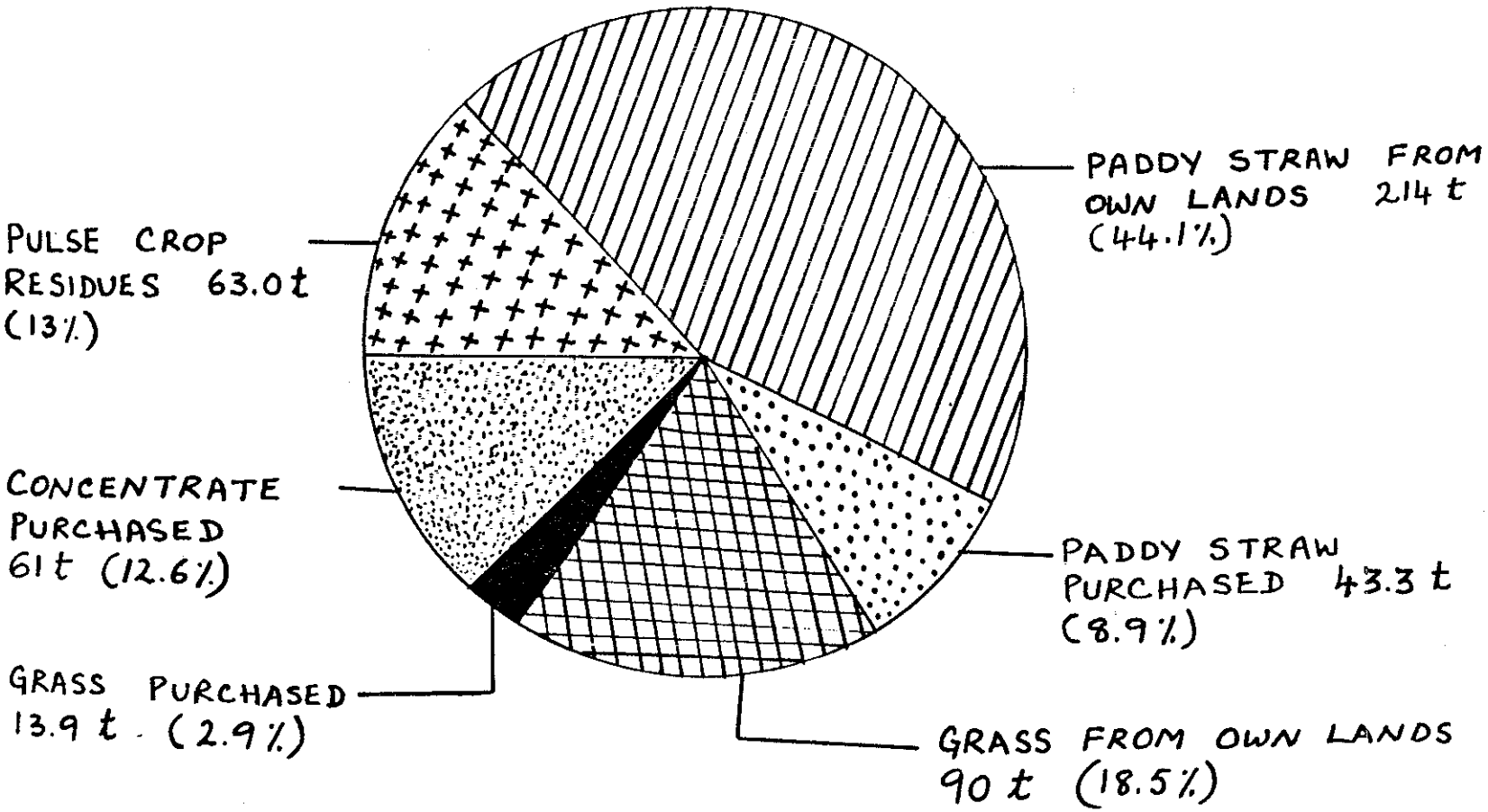


Fig. 4.3.2 SOURCES OF FODDER FOR MASUR-LUKKERI MICROCATCHMENT

grass, 43.3 tonnes of paddy straw and 61 tonnes of concentrates. The total amount of feed and fodder given to the livestock in tonnes of dry weight then comes to :

Green grass	69.6
Dry grass	34.3
Paddy straw	257.0
Pulse crop residues	63.1
Concentrate pellets	30.7
Cotton seed	4.93
Rice bran	19.75
Groundnut cake	3.78
Other feeds	1.82

This is a mere 1.8 Kg/day/cattlehead.

Of the 734 animals only 57 calves and 59 adults are stall fed. Of the rest 85 animals are let out for grazing from November to May while the majority, i.e., 531 animals graze free round the year. Of these, the buffaloes tend to swim across the river and graze on grass by streamside, while the cattle all converge on the minor forest, as well as on the stubble in the paddy fields after harvest. This grazing pressure essentially rules out taking a second crop during the dry season even though there are excellent possibilities of cultivation of pulses, groundnut, fodder legumes or green manure-cum-fodder crops such as sunhemp on the residual moisture. In fact, considerable difficulties are experienced by people in protecting their paddy crop against grazing even during the monsoon season. Till the bus route started a few years ago protection was ensured by erecting a series of cattle gates during the monsoon. However these can no longer be constructed, and there has to be extensive fencing of about 2 km in length all along the roadside. As fencing poles are very scarce, this poses a real problem. People are afraid that the fencing poles would be stolen outside of the monsoon and hence remove them and use them as

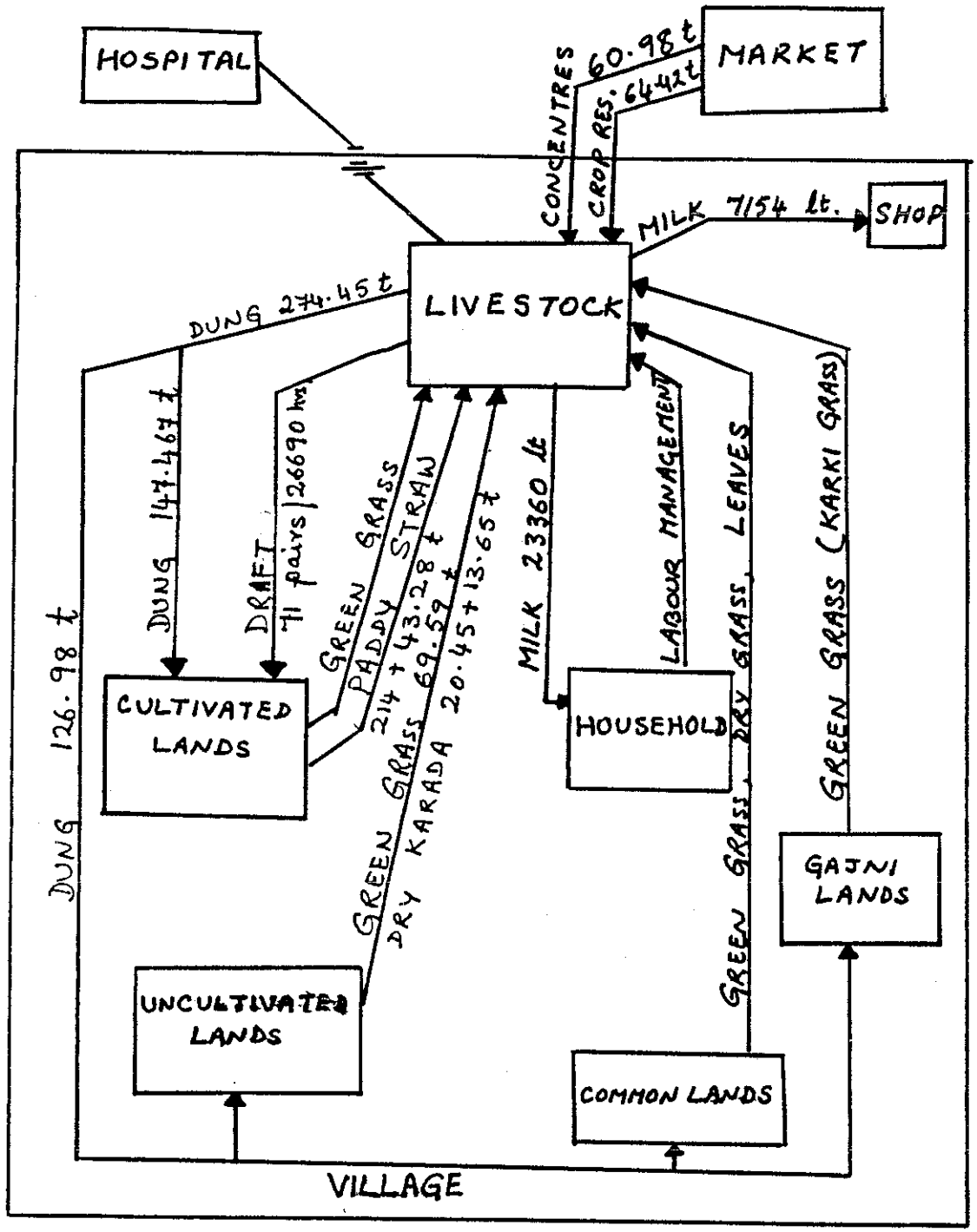


Fig. 4.3.1 FLOWS THROUGH LIVESTOCK SECTOR IN MASUR - LUKKERI MICROCATCHMENT

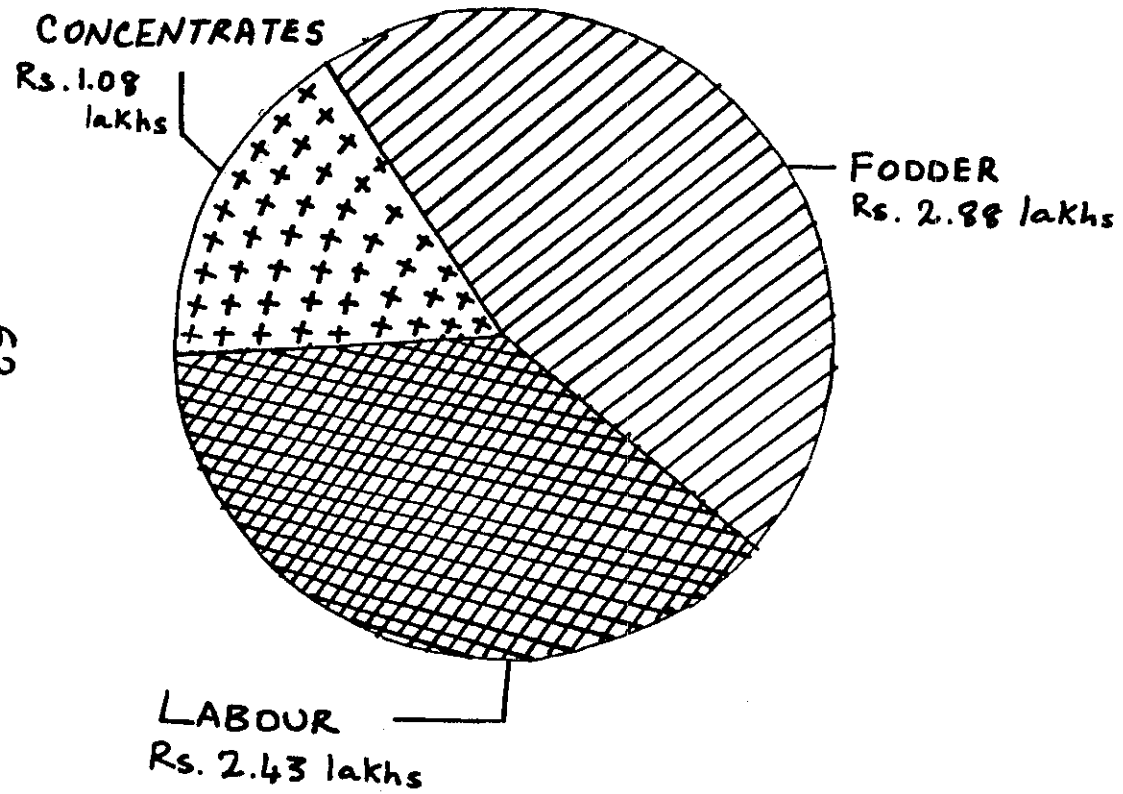
fuel after harvesting paddy. It would be best if live hedges are developed all along the fields to overcome this problem; some experiments in this direction using Glyrecedia have been initiated in 1987.

The gajni lands of today must all have been mangrove swamps earlier, and even now there is a fair amount of mangrove growth, especially by the bunds. One of the mangrove species of the genus Avicennia is palatable to the animals and could serve a very useful role in development of fodder resources. We have initiated some experiments in this connection. However, the protection of the seedlings against grazing is a difficult problem.

The ill nourished animals produce little milk. Only 105 out of 734 are lactating. Of these, 66 cows yield 33 litres a day and 38 buffaloes 51 litres. The annual milk production is thus 30514 litres, which for the population comes to only 0.025 litres per head per day. This is grossly inadequate, and not only is there no marketing of milk, but purchase of milk powder to make tea.

There are 71 pairs of draft animals, both bullocks and buffaloes in the carchment and they are important for agricultural operations in June-July as well as December-January. Each bullock works for about 390 hours every year. The bullock power is thus quite underutilized.

It is the dung that appears to be the main reason for the interest of farmers for maintaining livestock. Unfortunately, there are no reliable estimates of dung production. We estimate that 0.55 kg of dry weight per day per animal is actually collected. This comes to



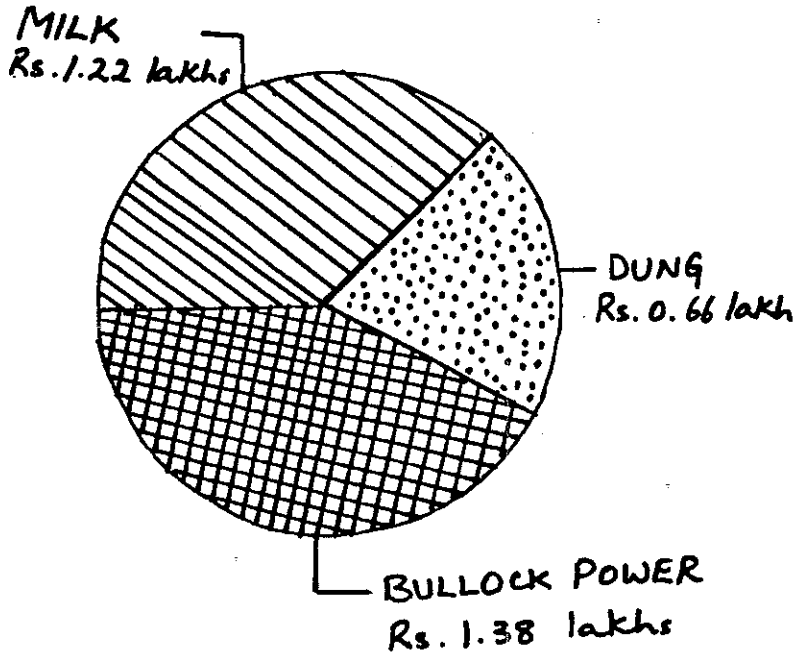


Fig. 4.3.3 ECONOMICS OF LIVESTOCK MANAGEMENT IN MASUR-LUKKERI MICROCATCHMENT

147 tonnes of dung per year that is utilized towards manure production. The method of manure production is very primitive and must lead to substantial losses of value of nutrients that are so precious for the agricultural land.

We may then summarize the information on the economics of livestock management as follows :

Inputs :

Concentrates	60.9 tonnes costing Rs. 108015
Fodder	483 tonnes costing Rs. 288450
Labour	24272 man days valued at Rs. 242720
Total	Rs. 639185

Outputs :

Milk	30514 litres	valued at Rs. 122056
Dung	147 tonnes	valued at Rs. 66360
Bullockpower		valued at Rs. 138450
TOTAL		Rs. 326068

The benefit : cost ratio, which does not take many substantial costs such as fencing and soil erosion on the hillock into account is thus a most discouraging 0.51 (Fig. 4.3.1).

Obviously a revolution is needed in the management of livestock in M-L catchment. This will have to include (a) development of plant biomass based manure resources to reduce the need for dung as manure, (b) development of live hedges all along the fields to make possible growing of a second crop that would lead to an enhancement of fodder resources, (c) development of fodder resources on the bunds in

estuarine lands, on minor forest land, on bena lands and in house yards, (d) concrete flooring of cattle sheds, (e) initiation of good health care of animals, (f) introduction of stall feeding of genetically improved stock, and finally (g) reduction in the total number of animals. We should also attempt to (h)improve on the methods of preparation of manure, and consider how (i) bullock power could be utilized more effectively or replaced by small power tillers.

There are other, excellent possibilities of development of animal resources in this catchment. Rabbit farming is already becoming popular, and could be supplemented by duck keeping. The estuarine fisheries are of course a vital resource and should be protected especially by guarding against water pollution. There are also possibilities of developing fresh water fisheries in the tanks. We shall consider below a programme for conversion of gajni lands into coconut orchards coupled to enhanced prawn production. There is also excellent potential for culturing mussels on floating rafts.

4.4 Water Resources

In spite of over 3000 mm of rain and the close vicinity of the perennial river Aghanashini, the M-L catchment lives under serious water stress for seven months of the year from November to May. This is in part, of course, because the rainfall is restricted to the five months of June to October, but much more so because the core of the catchment, the central hillock of 120 ha from which all streams originate has been totally denuded of tree growth. This has led to laterization, compounded by soil erosion and soil compaction because of overgrazing. There are four tanks on the streams, all of these have

fallen into partial or total disrepair. Two of them however still remain as perennial water sources. In early 1987 one of these tanks, at Lukkeri has been desilted through the initiative of the Lukkeri Yuvak Mandal and the Sahyadri Parisara Vardhini.

There are 104 open lined wells, 22 open, unlined wells and 11 tube wells in the catchments. 10 of the tube wells have handpumps, but only 8 have been functioning recently. Of these open wells only 22 retain drinkable water in the summber. The others either go dry or become brackish. Furthermore, 10 of the 12 wells that retain water are in the Halasamavu area which has both a good tree growth in bena lands and arecanut gardens on cultivated lands. Of the 114 open wells outside of Halasamavu only 12 retain fresh water during the summer. There is a tremendous resultant pressure on the 8 borewells with functioning handpumps and considerable hardship for the two thousand or so people dependent on it. The difficulies for livestock are equally serious.

It is clearly imperative to (a) revegetate the hillocks coupling this with water conservation measures (b) form a series of small checkdams along the streams, (c) desilt and repair the four tanks, (d) augment the storage capacity of the tanks, and (e) develop ways of effective use of such irrigation water as will become available from these tanks.

4.5 Minor Forest

The single most important land use in the M-L catchment is the minor forest of 103 ha on the central hillock. Reportedly once this

had excellent tree growth and even sheltered a leopard for a few days some thirty years ago. Recent years have seen its near total denudation, so that the whole area has just one Ficus tree preserved on grounds of religious sentiments and a few small Sapium trees left intact because of their poisonous latex. For the rest, there is some shrub growth of Holorrhena and Plectronia. The total standing biomass is estimated at around 0.2 tonnes/ha; consequently the tree/shrub annual productivity is only around 0.05 tonnes/ha. The herb layer is very thin, being continually under heavy grazing pressure, its annual productivity must be of the order of 0.2 tonnes/ha. The present productivity level of the minor forest lands must then be of the order of 0.25 tonnes/ha/year at the best; only about 2% of the potential.

The minor forest is land under the control of forest department, but open to all villagers for collection of fuelwood, leaf manure and for grazing the animals. There is no formal management structure at all, although the residents of M-L catchment have been attempting to impose some self-discipline. Thus about ten years ago, they reportedly got together, resolved to cut no more tree or shrub growth and appointed a watchman with their own funds to enforce these regulations. Apparently this attempt failed. Nevertheless, they have again agreed only to collect dry leaves and graze their animals on minor forest land in the catchment. This is currently largely, though not totally enforced.

In 1983, the Indian Institute of Science initiated attempts to work with the villagers and Government agencies to revegetate the minor forest. At the local level, the Head Master of the local High

School took lead in the matter. After several discussions with the villagers, a programme of afforestation of minor forest has been launched by the Forest Department with 2 ha being planted in 1984, 2 ha in 1985 and 25 ha in 1987. A mixture of species has been used to this end; however Acacia auriculiformis is the dominant component. The villagers have so far been entirely co-operative in protecting this plantation. A plan has been prepared to afforest the remaining area in phases over the next three years. Part of this would be developed as a "Pavitravana" and would serve to protect a broader spectrum of plant species diversity. What is now necessary is clear cut Government policy decision as to how the usufruct of the minor forest will be managed and shared by the village community as these plantations mature. No such decision has as yet been made, but needs to be taken urgently.

With the minor forest of the catchment throughly degraded, the bulk of the biomass demands of the villagers are met from the larger Mirzan forest of over 1000 ha across the river. This minor forest has a somewhat better standing biomass of around 50 tones/ha, although the composition has shifted towards thorny and latex bearing species because of the intense hacking pressure. Residents of the M-L catchment bring in some 1072 tonnes of fuelwood and 70 tonnes of dry leaves from this locality. People from several other localities also utilize this minor forest, so that we are not in a position to estimate the total pressure on the Mirzan M.F. However the preponderance of thorny and latex bearing species is a clear indication of substantial degree of overexploitation of this minor forest as well. Its good management would be an all the more difficult

problem because of a very large number of households from widely scattered localities depend on it. To bring all these together to agree on good management of Mirzan MF would be a major challenge.

Residents of M-L catchment not only need fuelwood and dry leaves, they also need poles for fencing. These are not readily available in the degraded Mirzan M.F. and are fetched from further away, from the Marakkal M.F. The more remote, hilly area of Marakkal thus serves an even larger and more scattered population. Its good management would be an even stiffer challenge. Nevertheless, these isues need to be faced and dealt with urgently if the current pace of degradation of minor forests is to be halted.

4.6 Bena lands

Bena lands are privately owned hilly lands, generally lying just adjacent to the houses and the road at the base of the hill. These 23.4 ha of benas are all enclosed by stone walls and are much better managed than the open access minor forest. Some of the benas, especially those belonging to arecanut garden owners of Halasamavu possess good tree cover of mango, jack and of species belonging to genera Eugenia, Callophyllum, Careya, Terminalia and Garcinia. They also have shrub growth of Memecylon, Carissa etc. Other benas have been totally shorn of the tree and shrub cover to convert them into grasslands. These sustain fairly good growth of Themeda and other grasses which are harvested around November and yield some 80 tonnes of dry weight of fodder for the livestock. A large bena near Lukkeri is the joint property of some 20 households, who profess difficulty in investing in the land. However, it should be possible to plant up and manage these bena lands well. Experiments have already been initiated

in planting them with fodder trees such as subabul, and fruit trees such as cashew and mango.

4.7 Base of the Hillock

At the base of the hillock below the benas and above the tari paddy fields lies a zone bisected by the road and including the house compounds, upland paddy or makkigadde and small coconut groves. The rainfed upland paddy is an uncertain crop, and this whole zone would best be maintained under tree and fodder crops. There are already some 3087 coconut trees, plus several hundred mango, jackfruit, breadfruit, drumstick and other trees in and around the house yards. There is scope for introducing others and experiments have already been initiated with planting subabul, sapota, guava etc. There is also tremendous scope for improving the yields of coconut trees, which are planted too close, some times only 2m apart.

The womenfolk of Halakki vakkal community of the hamlet of Lukkeri are engaged in growing vegetable and flower crops in 2 ha of this zone. Their lady's finger, gourds and many other vegetables are in fact locally very famous. These are provided irrigation by hand lifting of water from wells in the dry season. Each such plot is tiny, of the order of a few m^2 and is intensively looked after. There are many interesting possibilities of developing this activity further, especially with some simple irrigation such as with the use of a handpump.

4.8 Garden lands

The hamlet of Halasamavu has two ha of arecanut gardens with a very dense stand of nearly 3000 trees/ha. This is also the locality

with bena lands with good tree growth, and some 10 wells, all of them perennial and partly used for irrigation. The livestock are also better maintained and produce more dung. The gardens therefore annually receive 18 tonnes per ha of organic manure; 9 tonnes of leaves and 9 tonnes of dung. Their productivity is however well below the optimal; only 0.75 tonnes/ha of nuts as compared to 2.56 tonnes of nuts in the S-M catchment. This is in good part due to excessive tree densities being maintained.

4.9 Freshwater Paddy lands

Just above the estuaries lie the fresh water paddy or tari fields of the M-L catchment, 55.3 within the catchment. Residents of the catchment also own tari lands on the other side of the river in the hamlets of Masurkurve, Manikatta, Tannirkuli, Taribagilu, Madguni, Tudbele, Hanagal and Hasala of an extent of 58.5 ha. The individual paddy fields are in the form of small terraces and the holdings of each household are scattered over several localities, often far apart. The most popular variety used is Arya, and the cultivation practices are highly traditional with little mechanization or use of chemical fertilizers or pesticides. The paddy fields recieve organic manure in the form of dung at the rate of 1 tonne/ha and plant biomass, especially stalks of the brackish water paddy at the rate of 2 tonne/ha. The productivity levels are of the same order, 1 tonne/ha of grain and 1.9 tonne/ha of straw. This straw is a major component of the fodder for livestock. Both the inputs and yields are thus substantially lower than those reported above for the S-M catchment.

This points to the need for further development of organic manure sources. The livestock are in fact primarily maintained with this purpose, but in turn result in serious difficulties in control of grazing. Before the beginning of the bus route a series of gates used to be put up all along the road to control grazing during the monsoon. This is no longer possible and farmers have to erect fences of some 2 km of extent all along the road/paddy field boundaries. There is a severe shortage of poles for such fencing that are brought from Marakkal M.F. The poles are used as fuel following the harvest and since there is no fencing, there is no possibility of raising a second crop. It is essential to solve this problem by raising live hedges all along. Such a live hedge could itself be a good source of leaf manure, and some experiments of using Glyrecidia for this purpose have already been initiated. Unfortunately, it is difficult to protect the hedge plants against cattle in initial stages. It would therefore be necessary to provide a barbed wire fence for a three year initial period to raise a live hedge. It would then be possible to bring these lands under a second crop such as pulses, or a green manure-cum-fodder crop such as sunhemp or fodder cowpea. This could substantially enhance the organic manure as well as fodder production and would be a key step in bringing abut a new pattern of sustainable resource use.

4.10 Estuarine lands

In the estuary of the river Aghanashini lie extensive lands cultivated during the monsoon with a variety of salt-resistant paddy called kagga which also are a rich source of prawn fisheries in the dry season. These are the so-called khar or gajni lands that extend

over several thousand ha of Uttara Kannada district. There are 87.6 ha of such lands within the catchment and another 155.4 ha owned by residents of the catchment just outside in the hamlets of Masurkurve, Manikatta, Tannirkuli, Taribagilu, Madguni, Tudbele, Hanagal and Hasala. The gajni land soils are of lateritic origin and yellowish-grey in colour with a pH of 5.5 to 6.0 and conductivity of 1.4 to 1.46 m.m ho/cm. These soils are high in organic carbon and phosphorus but poor in potash. The sodium/potassium ratio is very high around 100, indicating the influence of salt water.

These estuarine lands lie between the high and low tide levels and would thus be subject to periodic inundation under the brackish water all round the year. During the monsoon when the river is in floods, the salinity of this water would be much lower; the land would also remain more continually under water. The lands receive silt rich in organic matter when the rivers are in flood, and are therefore naturally fertile. The brackish nature of water discourages weed growth as well. All of this renders these lands productive with little labour input necessary, provided that they are protected from salt water incursion in the April-June period and allowed to dry. For this purpose a series of bunds are constructed; and these lands have been traditionally producing kagga, a special paddy variety perhaps for many centuries. In the November-April period the same lands supported fisheries.

Around 1968 the Government constructed in this area a series of permanent bunds provided with sluice gates. These permitted regulation of water ingress so that waters rich in fish and prawn fry could be let in and then impounded to permit further growth and excellent

catches. This was linked to the development of canning of fish and prawns and consequently much higher prices for them. The gajni lands are therefore now auctioned to contractors who then have the exclusive rights to all fish and prawns from these land. This has led to some disputes with local fishermen who earlier had free access to fishing in these waters in the dry season. The contractors now permit them only to catch crabs.

As mentioned above, the gajni lands are fertilized naturally by the river flow and receive no other manure or fertilizer inputs. Their total per ha production is of the order of 1.25 tones of paddy grain and 2.75 tonnes of straw; i.e. 4 tonnes/ha in all. About a third of the straw is harvested along with the grain and being unsuitable as fodder, is used as animal bedding which then goes to make the manure. Some 220 tonnes of straw and 305 tonnes of paddy is thus the output of gajni lands used by the population of M-L catchment.

This low input-output, naturally fertile system is under stress because of the high price, of the order of Rs. 7000/ha that the fish and prawn auctions now fetch for the landowners. The temptation therefore is to keep the land longer under water. It is suspected that this is now leading to increasing deposition of salt and decrease in the paddy yields during the monsoon. It is also likely that it is leading to problems of brackish water incursion into the wells. These issues ought to be gone into carefully.

Repairs of the gajni land bunds require sustaintial amount of wood, and this has led to the destruction of mangrove plants naturally growing in the area. This mangrove growth is also very important for

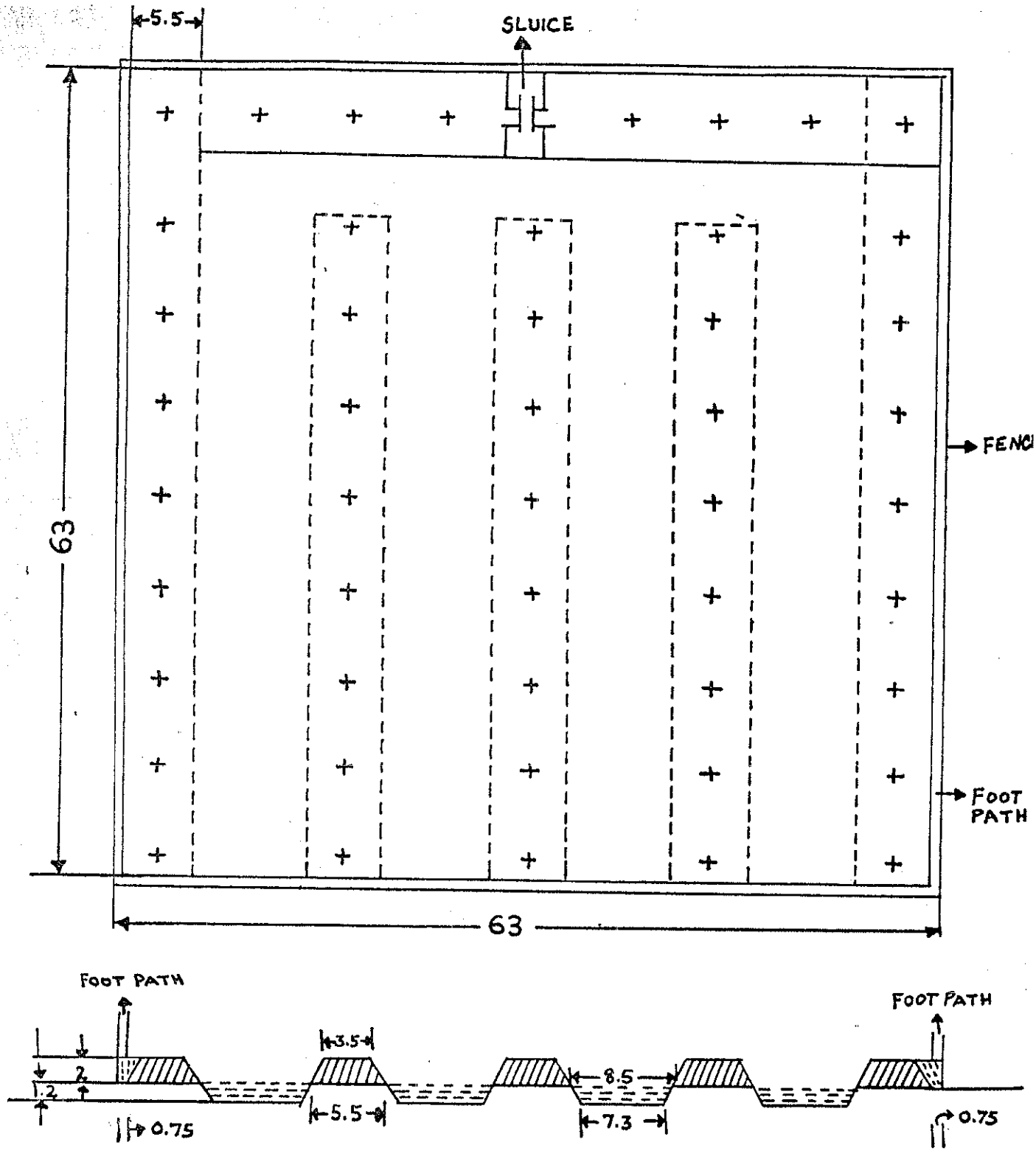


Fig. 4.10.1 INTEGRATED SCHEME FOR LAND RECLAMATION

COCONUT CULTIVATION AND PRAWN CULTURING

the health of fish and prawn populations and needs to be protected and augumented. A programme has been initiated in 1987 to replant the bunds with mangrove species, especially those suitable as fodder. For this experiment to be successful, the plants need to be protected against grazing in the early stages.

Experts from the Central Plantation Crops Research Institute of ICAR have recommended that these gajni lands could be utilized for coconut-cum-prawn culture (Fig. 4.10.1). This would involve planting coconuts at a density of 125/ha on bunds 5.5 m at base, 3.5 m at top and of a height of 3.2 ms at intervals of 8 m. Bananas and vegetables could also be raised along with coconuts on these bunds. Prawns (Penaeus monodon, P. merguiensis and P. indicus) would be stocked at densities of 50 to 60 thousand/ha in the intervening channels. The investment called for is of the order of Rs. 70.000 per ha; and is expected to yield a return of 18% per year. However, as much of the expenses are on labour intensive earth work, the farmers could implement the plan on their own land much more economically. We have been exploring these possibilities in the M-L catchment. However, a major hurdle has been the fragmentation of gajni land holdings, with no single household owning any large piece.

4.11 River Course

The main course of river Aghanashini occupies 62.5 ha of the M-L catchment and is vital in providing substantial quantity of fish, crustaceans and bivalves for local consumption by the population, as well as marketing by fisherfolk. We have however no exact estimate of

the quantity so utilized. It is vital to maintain the health of this component of the ecosystem by protecting it from pollution.

The people report that the course of Aghanashini is becoming shallower due to increasing rates of siltation and that this is leading to greater threats of flood damage. While this is plausible, no clear cut information is available.

4.12 Processing Industries

The economy of M-L catchment is almost totally dependent on agriculture and fisheries; the animal husbandry merely being an adjunct of agriculture and now a likely drain. The catchment has a carpenter-blacksmith and a goldsmith who serve local needs. The Halakki Vakkal women are experts at weaving mats from leaves of Pandanus. They have to bring most of the raw material on foot from Alvekodi some 15 km away, and we have initiated Pandanus plantation on an experimental scale in 1987.

Traditionally the locality had many handlooms in operation. These are however gradually being abandoned the wages earned are exceedingly low. There are two rice mills. There is undoubtedly excellent scope for developing coir production and processing of coir in this area. It would be worthwhile to explore this possibility further perhaps as a co-operative activity of the Yuvati Mandal.

4.13 Social Institutions

The Masur-Lukkeri island is a typically poor rural community with no strong institutions capable of looking after the long range

developmental interests of the community. Fortunately however new initiatives are building up and there are possiblities of building up such institutions in coming years.

(i) The village co-operative society runs a fair price shop with the help of Yuvak Mandalis. It has as yet taken no other lead, but could potentially become involved in the ecodevelopment programme.

(ii) Yuvak Mandals: The Lukkeri Yuvak Mandal has recently involved itself in desilting of a tank in collaborates with Sahyadri Parisara Vardhini, and is becoming more and more involved in ecodevelopment programmes.

(iii) Babhrulingeshwara High School: This High School along with the Headmaster and teachers has been at the forefront of ecodevelopment activities. Its students were involved in the first plantation in minor forest, as well as in nursery activities. It has played an active role in getting together a local ecodevelopment task force to chalk out the on-going programmes.

(iv) Sahyadri Parisara Vardhini: This voluntary agency described above in (section 3.10) has been active in promoting several activities in the M-L catchment. These have included: kissan nurseries, subabul plantation, planting of fruit trees in house yards, development of live hedge of Glyrecedia, planting of fodder grasses, raising mangrove plantations along estuarine bunds and rabbit rearing; as well as educational and training programmes.

(v) Banks: Syndicate Bank, Varada Grameena Bank and Kanara District Central Co-operative Bank have all been involved in extending credit facilities to the farmers, as well as supply of raw material and marketing of products of handloom industry.

(vi) Government departments: A number of Government agencies have been active in M-L catchment. Most notable amongst these are the Forest Department that has raised extensive plantations in the minor forest and supported nurseries and the District Rural Development Society which has supported the propogation of fuel efficient chulas.

(vii) Mandal Panchayat: M-L catchment is part of the Hegde mandal panchayat. The panchayat members are taking special interest in the ecodevelopment activities.

5. The Action Programme

It is thus imperative that we attempt now to orient the development programmes in such a fashion that they would tend to rebuild the ecological capital of soil, water and vegetation that is currently being liquidated. This rebuilt capital could then serve as a basis for other developments, especially agro-based processing industries.

To bring development onto this path a number of initiatives are called for, and their rationale has been discussed above. These programmes could involve either the public domain, that is land such as minor forest or waters such as tanks on public land, or privately assigned or owned lands or waters. They could require either actual works such as construction of bunds across streams or demonstration of technologies such as coconut-cum-prawn culture on gajni lands or growing suitable fodder species on soppinabetta lands which are then expected to be applied more widely through individual efforts. They could require (i) public investment on public lands such as for protecting roads against erosion, (ii) public subsidies or credit for

local institutions such as providing a bore well for a High School to develop nurseries or to Yuvati Mandal to set up a co-operative coir processing unit, (iii) public subsidies for private investments such as in gobar gas plants, or (iv) making available credit for private investments such as bank loans for laying underground tile drainage systems in gardens. We also need to make innovations in the institutional framework, for instance to motivate good management of minor forest and soppinabetta lands. Finally we need scientific research as well as monitoring activities, eg. in enhancing the efficiency of production and utilization of sources of organic manure.

The programme sketched below spells out the necesary Government investment either for actual works (W), or as subsidy (S), as also support required for scientific/technical investigations and monitoring (R). It also indicates the amount that might need to be advanced on credit for private investment (C). The proposed public investment on private land for demonstration purposes would be restricted to the landless or small land holders. In addition, of course, we expect private investment and a variety of voluntary efforts which would be vital. These have been indicated above and are only briefly mentioned below. The proposals are based on detailed discussions held in the chambers of the Deputy Commissioner, Karwar on 31st January, 1987 with the District level officials as well as representatives of Banks and on an on-going dialogue with the local people. We have provided below the year by year breakup of requirements for a 3-year programme. S-M refers to Sirsimakki - Mundagesara catchment and M-L to Masur - Lukkeri catchment. All the amounts are rupees in thousands.

PROGRAMME: a. Human habitation sector. This will have eleven components:

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1	3.0	69.7	10.0	35.2	40.0	151.7	28.0	106.7
Year 2		30.0	10.0	20.0	10.0	30.0	28.0	20.0
Year 3		30.0	10.0	20.0	10.0	30.0	25.0	20.0
Total	3.0	129.7	30.0	75.2	60.0	211.7	81.0	146.7

PROGRAMME: a-1. Fuel efficient cooking stoves of Astraole design will be constructed in all house which currently do not have such stoves under supervision of the scientific staff of the Indian Institute of Science by local youth who have already been trained.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1		3.2		3.2		25.5		25.5
Year 2								
Year 3								
Total		3.2		3.2		25.5		25.5

PROGRAMME: a-2. Fuel efficient bath water heating stoves will be constructed in all houses based on a new design developed by Chemical Engineers of the Indian Institute of Science. Two local masons have already been trained to undertake this construction. The construction will be supervised, the performance monitored, and the design further improved by the scientific staff of the Indian Institute of Science. The design will utilize vessels already being employed for this purpose.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1		12.0		12.0		60.0	3.0	60.0
Year 2							3.0	
Year 3								
Total		12.0		12.0		60.0	6.0	60.0

PROGRAMME: a-3. Fuel efficient chulas for local tea shops: These based on a new design developed by Chemical Engineers of Indian Institute of Science will be constructed in the two tea shops at Masur-Lukkeri by masons already trained in the technique. Their performance will be monitored by scientific staff of Indian Institute of Science.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1						1.2		1.2
Year 2								
Year 3								
Total						1.2		1.2

PROGRAMME: a-4. Gobar gas plants based on the new design employing polythene tubes in place of metal/masonry drum developed by TEXACO, Bangalore will be set up with the help of designers. The performance will be monitored by Indian Institute of Science.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1		30		20		30		20
Year 2		30		20		30		20
Year 3		30		20		30		20
Total		90		60		90		60

PROGRAMME: a-5. Biogas plants using plant biomas such as Eupatorium weeds is being developed by the Indian Institute of Science. This will be field tested and further refined.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1			8.0					
Year 2			8.0					
Year 3			8.0					
Total			24.0					

PROGRAMME: a-6. One fuel efficient jaggery unit based on the design developed by the Indian Institute of Science will be constructed for communal use.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1	3.0							
Year 2								
Year 3								
Total	3.0							

PROGRAMME: a-7. Solar pond for heating bath water. A 200 m^2 solar pond delivering 17 lakh liters of hot water at 40 ^{o}c annually, i.e. sufficient for bathing about 250 people daily will be set up on an experimental basis with the help of technology developed by the Indian Institute of Science.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1					40.0		20.0	
Year 2					10.0		20.0	
Year 3					10.0		20.0	
Total					60.0		60.0	

PROGRAMME: a-8. Fire and decay resistant thatching: Five demonstration units will be set up in each catchment for huts of landless or cattlesheds of small landholders based on the technology developed at the Indian Institute of Science.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1		15.0				15.0		
Year 2								
Year 3								
Total		15.0				15.0		

PROGRAMME: a-9. Low cost latrines with septic tanks: Based on a design of the Indian Institute of Science, schools and landless will be provided with 5 demonstration units in S-M and 10 demonstration units in M-L catchment.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1		7.5				15.0		
Year 2								
Year 3								
Total		7.5				15.0		

PROGRAMME: a-10. Low cost devices for purifying drinking water, developed by the Central Food Technological Research Institute would be set up at schools/landless families as demonstration units. There will be two such in S-M catchment and five in M-L catchment.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1		2.0				5.0		
Year 2								
Year 3								
Total		2.0				5.0		

PROGRAMME: a-11. Extension programmes relating to human habitation sector, including domestic energy conservation, housing and sanitation will be an on-going part of the project co-ordinated by the Indian Institute of Science.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1			2.0				5.0	
Year 2			2.0				5.0	
Year 3			2.0				5.0	
Total			6.0				15.0	

PROGRAMME: b. Programmes in relation to animal resources sector will have 16 components.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1		27.4	15	88.9		52.5	25	116
Year 2		53.4	5	57.9	25	105.5	25	134
Year 3		25.9	5	48.9		50	25	116
Total		106.7	25	195.7	125	208	75	366

PROGRAMME: b-1. Concrete flooring for cattlesheds combined with demonstration of scientific method of manure preperation. Five demonstration units in S-M catchment and ten in M-L catchment for small landholders.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1								
Year 2		9.0		9.0		18.0		18.0
Year 3								
Total		9.0		9.0		18.0		18.0

PROGRAMME: b-2. Demonstration of the package of calf-rearing practices for five small landholders of S-M catchment and ten small landholders of M-L catchment.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1								
Year 2		15.0				30.0		
Year 3								
Total		15.0				30.0		

PROGRAMME: b-3. Deworming of all livestock twice year.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1		4.5		4.5		10.0		10.0
Year 2		4.5		4.5		10.0		10.0
Year 3		4.5		4.5		10.0		10.0
Total		13.5		13.5		30.0		30.0

PROGRAMME: b-4. Eradication of ticks and other ectoparasites from all livestock and poultry.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1		0.4		0.4		1.0		1.0
Year 2		0.4		0.4		1.0		1.0
Year 3		0.4		0.4		1.0		1.0
Total		1.2		1.2		3.0		3.0

PROGRAMME: b-5. Vaccination of all livestock and poultry.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1		4.0		4.0		10.0		10.0
Year 2		4.0		4.0		10.0		10.0
Year 3		4.0		4.0		10.0		10.0
Total		12.0		12.0		30.0		30.0

PROGRAMME: b-6. Experiments on using oestrous synchronization to promote artificial insemination of livestock.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1							10.0	
Year 2							10.0	
Year 3							10.0	
Total							30.0	

PROGRAMME: b-7. Development of Subabul, other fodder trees and fodder grass and legume nurseries under guidance of the Agricultural University at Dharwar. This programme will be on lines of school nursery and kissan nursery programmes of forest department.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1		15.0				25.0		
Year 2		15.0				25.0		
Year 3		15.0				25.0		
Total		45.0				75.0		

PROGRAMME: b-8. Development of plantations of fodder species on soppinabetta and bena lands and along field bunds.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1				25.0				15.0
Year 2				25.0				15.0
Year 3				25.0				15.0
Total				75.0				45.0

PROGRAMME: b-9. Development of fodder-cum-manure crops in the dry season in paddy lands.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1				15.0				80.0
Year 2				15.0				80.0
Year 3				15.0				80.0
Total				45.0				240.0

PROGRAMME: b-10. Demonstration of silaging of green grass under guidance of Agricultural University, Dharwar.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1			10.0	40.0				
Year 2								
Year 3								
Total			10.0	40.0				

PROGRAMME: b-11. Development of fish culture using carp seed supplied by State Fishereis Department in three irrigation ponds in S-M catchment and eight tanks in M-L catchment.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1		2.0				2.0		
Year 2		2.0				2.0		
Year 3		2.0				2.0		
Total		6.0				6.0		

PROGRAMME: b-12. Providing a cage and technical training for rabbit rearing for five landless families of S-M catchment and 25 landless families of M-L catchment.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1		0.5				2.5		
Year 2								
Year 3								
Total		0.5				2.5		

PROGRAMME: b-13. Duck keeping: Four demonstration units of 50 birds each for landless families; one in S-M catchment and three in M-L catchment.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1								
Year 2		2.5				7.5		
Year 3								
Total		2.5				7.5		

PROGRAMME: b-14. Bee keeping: Twenty demonstration units (five in S-M catchment, fifteen in M-L catchment) for landless families.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1		1.0				2.0		
Year 2		1.0				2.0		
Year 3						2.0		
Total		2.0				6.0		

PROGRAMME: b-15. Demonstration of mussel culture on a floating raft under guidance from National Institute of Oceanography, Goa.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1								
Year 2				25.0				
Year 3								
Total				125.0				

PROGRAMME: b-16. Extension and monitoring activities in relation to the animal resources programmes.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1		5.0				15.0		
Year 2		5.0				15.0		
Year 3		5.0				15.0		
Total		15.0				45.0		

PROGRAMME: c. Management of water resources. This has five components.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1	60.0		10.0		90.0		10.0	
Year 2	260.0		10.0		95.0		10.0	
Year 3	175.0		10.0		95.0		10.0	
Total	495.0		30.0		280.0		30.0	

PROGRAMME: c-1. Desilting of the five tanks in S-M catchment and four smaller tanks in M-L catchment. The programme will be carried out by youth clubs with voluntary labour contribution; the youth clubs will also take responsibility for further maintenance of the tanks.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1	60				10			
Year 2	60				10			
Year 3	60				10			
Total	180				30			

PROGRAMME:c-2. Gully plugging and formation of small check dams over the entire course of eleven small and three larger streams in M-L catchment. This programme will be co-ordinated by youth club and high school students who will assume the responsibility for further maintenance.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1					70.0			
Year 2					70.0			
Year 3					70.0			
Total					210.0			

PROGRAMME: c-3. Construction of three additional tanks in M-L catchments for irrigation and water supply for cattle.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1					10.0			
Year 2					15.0			
Year 3					15.0			
Total					40.0			

PROGRAMME: c-4. Construction of a bandhara across the main stream in S-M catchment to create irrigation potential.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1								
Year 2	200							
Year 3	115							
Total	315							

PROGRAMME: c-5. Monitoring of the water budget of the microcatchments.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1			10.0				10.0	
Year 2			10.0				10.0	
Year 3			10.0				10.0	
Total			30.0				30.0	

PROGRAMME: d. Development of minor forest areas. This has three components.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1					100	90	10	
Year 2					100	60	10	
Year 3					100	60	10	
Total					300	210	30	

PROGRAMME: d-1. Plantation of the remaining 72 ha of minor forest of M-L catchment coupled with development of staggered trenches and saucers by the Forest Department employing local labour with the help of the youth club. The seedlings will be locally raised in school and kissan nurseries.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1					100			
Year 2					100			
Year 3					100			
Total					300			

PROGRAMME: d-2. Development of seedlings for planting on minor forest areas through school and kissan nurseries, including provision of a bore well each to the two primary and one high school for developing the necessary irrigation facilities.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1						90		
Year 2						60		
Year 3						60		
Total						210		

PROGRAMME: d-3. Monitoring school/kissan nurseries and minor forest plantations.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1							10	
Year 2							10	
Year 3							10	
Total							30	

PROGRAMME: e. Development of soppinabetta lands of S-M catchment and bena lands of M-L catchment. Subsidy for the nurseries to raise seedlings and credit for planting to be taken up by individual farmers plus monitoring are the main components of this programme.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1		95	10	335		15	5	5
Year 2		95	10	335		15	5	5
Year 3		95	10	335		15	5	5
Total		285	30	1005		45	15	15

PROGRAMME: e-1. Soil and water conservation works plus planting of the soppinabetta lands.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1				330				
Year 2				330				
Year 3				330				
Total				990				

PROGRAMME: e-2. Demonstration of high density fodder, fuel, manure, bamboo, agave and pandanus plantation techniques on 5 plots of 1 ha each in each of the two catchments.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1		5		5		5		5
Year 2		5		5		5		5
Year 3		5		5		5		5
Total		15		15		15		15

PROGRAMME: e-3. Kissan and school nurseries to supply free seedlings for soppinabetta/bena land plantings.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1		90				10		
Year 2		90				10		
Year 3		90				10		
Total		270				30		

PROGRAMME: e-4. Monitoring of soppinabetta/bena management.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1			10				5	
Year 2			10				5	
Year 3			10				5	
Total			30				15	

PROGRAMME: f. Paddylands of S-M catchment and tari lands of M-L catchment. Our main emphasis is on soil and water conservation, biofertilizers and the development of fodder-cum-manure crops in the dry season.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1			5	12		25	5	40
Year 2			5	12		25	5	40
Year 3			5	12		10	5	40
Total			15	36		60	15	120

PROGRAMME: f-1. Soil and water conservtion works on paddylands.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1				10				30
Year 2				10				30
Year 3				10				30
Total				30				90

PROGRAMME: f-2. Development and demonstration of use of blue green algae as fertilizers by the Agricultural University.

	S-M					M-L			
	W	S	R	C	W	S	R	C
Year 1			5				5		
Year 2			5				5		
Year 3			5				5		
Total			15				15		

PROGRAMME: f-3. Development of a live hedge of 2 km extent along the tari lands of M-L catchment. This needs subsidy for a barbed wire fencing in the initial period plus supply of planting material which would be developed in local nurseries.

	S-M					M-L			
	W	S	R	C	W	S	R	C
Year 1						25			
Year 2						25			
Year 3						10			
Total						60			

PROGRAMME: f-4. Supply of seed material of fodder-cum-manure species for raising as a second crop on paddy lands.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1				2				10
Year 2				2				10
Year 3				2				10
Total				6				30

PROGRAMME: g. Gardenlands. This programme has five components.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1			5	240		11	5	3
Year 2	70		5	230		2	5	3
Year 3	70		5	230		2		3
Total	140		15	700		15	10	9

PROGRAMME: g1. Development and demonstration of bullock driven pump plus drip irrigation system under guidance of Indian Institute of Science and Agricultural University.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1				10		8	5	2
Year 2							5	
Year 3								
Total				10		8	10	2

PROGRAMME: g-2. Supply of handpump and improved flower and vegetable seeds.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1						3		
Year 2						2		
Year 3						2		
Total						7		

PROGRAMME: g-3. Soil, water conservation and drainage works in arecanut gardens.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1				230				3
Year 2				230				3
Year 3				230				3
Total				690				9

PROGRAMME: g-4. Digging an outer trench to protect the arecanut gardens of S-M catchment.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1								
Year 2	70							
Year 3	70							
Total	140							

PROGRAMME: g-5. Monitoring the garden land ecosystem, including the use of leaf manure, development of cover crops etc.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1			5					
Year 2			5					
Year 3			5					
Total			15					

PROGRAMME: h. Developmet of gajni lands. This programme has two components.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1					10		40	
Year 2					10		30	
Year 3					10		10	
Total					30		80	

PROGRAMME: h-1. Demonstration of composite coconut-cum-prawn farming under guidance from Central Plantation Crops Research Institute.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1						40		
Year 2						30		
Year 3						10		
Total						80		

PROGRAMME: h-2. Development of fodder mangrove plantations on gajni land bunds, along with mangrove nursery.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1					10			
Year 2					10			
Year 3					10			
Total					30			

PROGRAMME: i. Processing industries: Promotion of coir processing and shell lime making as co-operative industries.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1						10		10
Year 2						20		20
Year 3								
Total						30		30

PROGRAMME: i-1. Setting up of a shell lime unit with the help of Indian Institute of Science.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1						10		10
Year 2								
Year 3								
Total						10		10

PROGRAMME: i-2. Provision of a coir processing unit to a women's co-operative.

	S-M				M-L			
	W	S	R	C	W	S	R	C
Year 1								
Year 2					20		20	
Year 3								
Total					20		20	

THE TOTAL BUDGET IS :

	S-M				M-L				Total
	W	S	R	C	W	S	R	C	
Year 1	63	192.1	55	711.1	240	355.2	128	280.7	2025.1
Year 2	330	178.4	45	654.9	240	257.5	118	222	2045.8
Year 3	245	150.9	45	645.9	215	167	90	184	1742.8
Total	638	521.4	145	2011.9	695	779.7	336	686.7	5813.7

The programme shall require the involvment of many Institutions and Government department, a list of which is given below:

1. Indian Institute of Science.
2. Karnataka State Council for Science and Technology.
3. University of Agricultural Sciences, Dharwad.
4. Bharatiya Agro Industries Foundation.
5. Central Plantation Crops Research Institute.
6. Central Food Technological Research Institute.
7. National Institute of Oceanography.

8. Sahyadri Parisara Vardhini, Yadahalli.

9. Babrulingeshwara High School, Masur.

10. Vidyodaya Junior College, Yadahalli.

11. Department for Rural Development.

12. Zilla Parishad, Uttara Kannada.

13. Department of Forests.

14. Department of Animal Husbandry and Veterinary Services.

15. Department of Agriculture.

16. Department of Horticulture.

17. Department of Fisheries.

18. Coconut Development Board.

19. Small Industries Development Corporation.

ACKNOWLEDGEMENTS

Such a large number of people, ranging from local fisherman, farmers and teachers to scientists and engineers and Government officials at all levels from village accountants and range forest officers to secretaries to the Government have willingly helped in this exercise that it is an impossible task to personally name and acknowledge all of them. We shall therefore attempt only to indicate the main agencies concerned. These include the village ecodevelopment task-forces of local people, the Mandal Panchayats, the local High Schools and Colleges, Sahyadri Parisara Vardhini, Bharatiya Agro-industries foundation, Agricultural Universities at Dharwad and Bangalore, Indian Institute of Science, Karnataka State Council for Science and Technology, Karnataka State departments of Rural Development, Forest, Animal Husbandry and Veterinary Services, Agriculture, Horticulture, Fisheries, Ecology and Environment, Science and Technology and the Department of Environment of the Government of India. We are grateful to all these individuals and agencies for their willing help and advice.