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DEPLETING RENEWABLE RESOURCES: A CASE STUDY FROM KARNATAKA WESTERN GHATS*

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I

INTRODUCTION

"Impact of agricultural development on ecology" is indeed a broad theme for agriculture encompasses not only cultivation of annual crops, but also horticulture and plantation crops, animal husbandry and fish culture. The notion of environment and ecology is even broader and covers everything from temperature balance of the earth to earthworm populations in paddy fields. One may however classify the ecological issues of interest under three broad categories:

(*a*) Non-sustainable utilisation of renewable resources, for instance, lowering of groundwater table due to overdrawal of water for irrigation, exhaustion of micro-nutrients from agricultural soils and over-grazing on pasture lands.

(*b*) Loss of genetic resources, for instance, disappearance of traditional varieties of paddy as they are replaced by high-yielding varieties (HYVs), or of wild strains of mango because of pressures of plywood industry.

(*c*) Pollution of environment, for instance, through improper use of pesticides or fertilisers in the fields as well as by effluents during production of agro-chemicals.

Any one scholar would face serious limitation in doing full justice to the wide variety of issues concerned. In this paper we confine our observations to lessons learnt from a micro level action study. The experience of the experiment throws up rich material for serious deliberations on vital issues.

II

THE SETTING

The Locality

The paper presents a case study of one micro-catchment, Sirsimakki, on the hill range of Western Ghats to bring out the problems of over-harvest of renewable resources, of how the social dynamics of access to these resources shapes the patterns of resource use and to narrate our own attempts at in-

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I wish to place on record my deep sense of gratitude to the people of Sirsi taluka who over the last seven years have taught me so much about their agro-ecosystem and of how to work with live issues in the field. I particularly appreciate the friendship and help of K. M. Hegde, Bhairumbe, R. S. Hegde, Billikeri and R. V. Bhagwat, Sirsimakki. I would also like to thank our research staff, especially D. M. Bhat, H. G. Hegde, P. R. Bhat, C. M. Shastri and N. S. Hegde who have made possible this project with their sincere efforts.

volvement with the people to understand how the problems could be resolved. This micro-catchment, covering 386.5 hectares (ha.) lies at an altitude of 550 m to 618 m above sea level at 14° 35'N latitude and 74° 48'E longitude in the Sirsi taluk of the Uttara Kannada district of the State of Karnataka. The terrain is undulating with 26 small hillocks accounting for 84 per cent of the area. It is a region of good rainfall, the recorded annual precipitation ranging over 1,863 mm to 3,584 mm with an average of 2,580 mm for the years 1976 to 1986 at the town of Sirsi just 5 km. away. The valleys in between the hills carry streams, three of which are perennial and ultimately join the west flowing river Aghanashini.

Land Use Pattern

Originally the valleys were narrow, there being hardly any flat land in the whole tract. Over more than a century of occupation, the farmers have broadened them by cutting into adjoining hills and spreading the soil to create terraces. The process in fact still continues with vertical cuts being made yearly in the hill slopes bordering cultivation which is restricted to the valley terraces. The bigger streams are dammed to create seven small irrigation ponds ranging in size from 0.1 to 0.6 ha. at the head of the valleys. The valleys ranging in breadth from 50 to 200 m run for a total length of 5.25 km. and cover an area of 62 hectares. Towards the head of the valleys, often below the irrigation tanks are 46 hectares of arecanut orchards, further downstream where the valleys tend to be broader are 16 hectares of paddy and sugarcane fields. The houses are at the foot of the hills. Coconut plantation covers 3.4 ha. and mulberry cultivation on the hills is carried on 0.5 ha. The rest of the hills, 318 hectares, are covered by trees and grasses.

Human Population

The Sirsimakki micro-catchment harbours four hamlets of Sirsimakki, Vadgeri, Mundgesara-Abrimane and Bellikeri with a population of 724 comprising 88 households. Of these, 11 own no land and eight own only paddy lands less than 0.5 ha. each. There are 15 families owning both paddy lands and arecanut orchards and 56 families owning only arecanut orchards. For these 71 families the median holding of arecanut orchards is 0.5 ha., the maximum being 3.0 ha., while the median paddy land holding is only about 0.2 ha., the maximum being 2 ha. None of these holdings is in a single unit, each being fragmented in several pieces. Sometimes one person owns just a few trees in an arecanut orchard.

Soppinabetta Lands

The grass and tree covered hill lands are classified into 290 hectares of soppinabetta and 28 hectares of minor forest lands. Both these are lands owned by the Government, controlled by the forest department, but not reserved. These categories were created at the time of land settlement by

the British in the late 19th century as forest lands assigned to the local population to meet their needs of fuel, fodder, leaf manure and small timber. The soppinabetta lands are accessible only to arecanut orchard owners primarily for collection of leafy matter (*soppu* = leaf and *betta* = hill in Kannada). The regulations called for maintenance of a minimum tree density of 100 per hectare on these lands, with orchard owners having rights to lop the trees for leaves and twigs, extract small timber for poles and to graze their animals. The origin of this forest category lies in the claims of arecanut orchard owners that these hill lands belonged to them just as the orchard lands and were essential for the supply of leaf manure and mulch to their orchards. The British Government disallowed this claim, and took over the lands, but continued to allow the privileges to the arecanut orchard owners and their right to exclude others. The orchard owners have further divided up the soppinabetta lands among individual households through mutual understanding, in proportion to the orchard land holding, the ratio of orchard to soppinabetta land being around 6.3.

Minor Forest

The 28 hectares of minor forest are lands set aside for fuel, fodder, leafy matter and small timber needs of all villagers. Thus, the 11 landless families as well as six owning only paddy lands, *i.e.*, 19 per cent of all households exclusively depend on nine per cent of the non-reserved forest land. In addition, the 71 orchard owners also have access to and harvest leafy matter and graze their livestock on this land. Furthermore, unlike soppinabetta lands, the local community has no right to exclude others from this land and many including fuel wood sellers of Sirsi town and cattle from other villages depend on it.

Educational Institutions

Just outside the micro-catchment is the Vidyodaya Composite Junior College and High School, Yadahalli, serving the locality. It so happens that the arecanut orchard owners belong to a Brahmin community called Haviks. Hence, there are 44 college graduates and 51 matriculates in a population of 724. With this level of education, the Vidyodaya college and schools are run by highly qualified teachers, quite an exception for rural India. Our research group has been interacting with this institution for the last five years, and has been involved in setting up a tree and grass nursery, planting up of the soppinabetta lands and holding training programmes on eco-development. Over the last two years, we have carried out a detailed survey of this micro-catchment with a view to identifying the ecological imbalances and have attempted to organise a grass-root programme to overcome the problems. We present here the main findings, together with our experiences in the implementation of the programme.

III

RESOURCE USE PATTERNS

Renewable Resources

Our interest lies in the pattern of utilisation of renewable resources, *i.e.*, of resources whose capital stock can increase as well as decrease through natural processes. Such resources are, for instance, (*i*) soil which is generated by weathering of the rocks as well as decomposition of organic material, and lost through erosion, and (*ii*) plant biomass which may be enhanced through photosynthesis and diminished through respiration and grazing by animals. Soil itself is made up of a number of components, such as minerals or humus each of which is a renewable resource. The capital stock of such resources may be continuously increased or depleted at different points in space and at different times in various ways. Thus, erosion may decrease the capital stock of soil on hill slopes, but may increase that of soil in a lake at the base of the hill. Both these processes may be viewed as ecological imbalances, for we would like the hill slopes to retain the soil to support plant production, while we want the lakes to retain their depth to hold as much water as possible. In general, we think of ecological imbalances whenever the rate of diminution differs significantly from the rate at which the resource stock is growing. Thus, if the annual increment to the stock of timber in a forest is 20 tonnes per ha., while the annual harvest is 50 tonnes per ha., then the stock would be progressively diminished. On the other hand, if the input of water to a field through irrigation exceeds its removal through utilisation by the plants, evaporation and drainage, the stock of water in that area of land may go on increasing leading to waterlogging.

Ecological Imbalances

Our studies have revealed a variety of imbalances in the agro-ecosystem of the Sirsimakki micro-catchment. These are best considered in terms of four different categories of land, namely, crop lands, orchards, soppinabetta and minor forest and two different categories of waterbodies, namely, streams and ponds. For each of these, we can think of resources of soil, surface water, underground water, and plant biomass. We then have the following picture (Table I).

TABLE I. BALANCE OF INCREMENT VERSUS REMOVAL FROM THE STOCK OF VARIOUS RENEWABLE RESOURCES

Categories of land	Soil	Surface water	Ground-water	Plant biomass
Crop lands	—(?)	B	B	B
Orchards	B (?)	B	+	B
Soppinabetta	—	+	—	—
Minor forest	—	+	—	—
Streams	+	—	—	B
Ponds	+	—	—	+

Note:— (+) indicates that increments exceed removals, B that they are roughly balanced, and (—) that removals exceed increments.

It is evident that the imbalances increase in crop land, orchards, streams, soppinabetta, minor forest and ponds in that order. This immediately suggests that the imbalances relate to patterns of ownership; the privately owned crop lands and orchards are doing better than the streams, soppinabetta, minor forest and ponds in the public domain. In fact, the balance for the privately owned lands is being maintained at the cost of the public or common property resources.

Crop Lands

The 15-hectare of crop lands are broader valley lands converted into a honeycomb of numerous small rectangular terraces. Water drained off from upper plots serves to irrigate the lower plots in this system and entails considerable loss of soil in the process of puddling operations. This loss, plus the removal of nutrients from the soil due to harvest of the crop, primarily paddy, is at least in part made up by addition of organic manure to the fields; chemical fertilisers being used but little in this tract. The per hectare average (above-ground) production and therefore output from land of the paddy crop is 6.08 tonnes of straw and 3.06 tonnes of grain. The per hectare input to the land amounts to 4.9 tonnes of plant matter from soppinabetta and minor forest lands plus 2.5 tonnes of dung. In addition, the roots and stubble left in the fields bring in some additional organic matter. We do not have sufficient data to state whether the removal of minerals and organic matter from the crop lands is properly balanced by the returns. This issue of possible depletion of nutrient capital of agricultural lands is one of broad interest on which little information exists in India. This vital lacuna needs to be filled through a well planned programme of monitoring the situation.

Arecanut Orchards

The 46 hectares of arecanut orchards are economically far more productive than the paddy lands. The 2.56 tonnes per ha. of arecanuts fetch an income of around Rs. 38,000, while the cost of cultivation in terms of recurring inputs and labour (but excluding supervision and interest on capital investment) is about Rs. 9,000 per hectare. The three tonnes of paddy plus 6 tonnes of straw fetch only around Rs. 8,500 per ha., while the cost of cultivation is about Rs. 7,000. The orchard owners therefore invest much in terms of inputs of soil, organic matter and water as well as disease and pest control for the arecanut crop. As mentioned above, the land for arecanut cultivation is prepared by cutting into the hills and adding the soil to orchards as they gradually expand out. The soil addition operation is carried out once every eight years and involves new soil equivalent to 12 cm depth over the orchard land. For the whole micro-catchment, this amounts to 6,737 m^3 of soil per year. The fresh soil is formed as 75 cm high mound in between rows of arecanut palms and spread at the base of palms every year after the application of farmyard manure. The amount of organic matter added to

the arecanut orchard every year is very substantial, being of the order of 16.6 tonnes per ha. of plant matter from soppinabetta and minor forest lands and 3.84 tonnes per ha. of dung. A fraction of the plant matter is used to form the farmyard manure; the rest is used in the form of dry leaves forming mulch. This mulch serves to conserve moisture as well as reduce soil erosion. Nevertheless, a certain amount of soil erosion does take place. The per hectare amount of organic matter harvest from the arecanut orchard includes 6.7 tonnes of fruit bunches and 10.9 tonnes of fallen leaves, totalling 17.6 tonnes, less than the 20.4 tonnes of input of organic matter. It is therefore possible that as far as the soil of arecanut orchards is concerned, all these inputs ensure that the system is balanced. However, transferring of soil from the hills to arecanut orchards is increasingly making deep inroads in the nature's gift through the soil excavation and the plundering process has reached the outer limits of human habitation in many cases. The requirements of these orchards are then met from special mud quarries forming huge pits—five of them in the micro-catchment. Other farmers are transferring soil from somebody else's or soppinabetta lands. The changing land boundaries resulting from soil digging also cause legal complications since the farmers are encroaching on soppinabetta lands that are state owned.

The arecanut orchards lie in moist valleys and are served by irrigation-cum-drainage channels. The entire orchard is protected from ingression of rain water and silt from the surrounding hills by an outer trench. In some areas of micro-catchment the drainage is inadequate and orchards have become waterlogged.

Productivity Levels

Since the arecanut orchards are economically the most productive of lands, the farmers have been continually increasing the density of arecanut trees to the point now that the densities are excessive and total arecanut yields are diminishing. On an average, the orchard has 2,210 arecanut trees along with 4,460 cardamom shrubs per ha. The arecanut trees themselves have a biomass of 170 tonnes per ha., which may be compared to the biomass of 250-800 tonnes per ha. of high statured evergreen forests. The annual per hectare increment to the biomass, *i.e.*, the productivity, is of the order 3.1 tonnes of stem wood, 10.9 tonnes of leaves and 6.7 tonnes of fruit bunches from which come 2.56 tonnes of nuts. The dried leaves and fruit bunches plus the wood of fallen trees are harvested; it is certainly in balance with production. This annual productivity of 20.7 tonnes per ha. compares very favourably with productivity levels of 15-35 tonnes per ha. for the evergreen forests. These levels of production on paddy fields and arecanut orchards in the Sirsimakki catchment are fairly satisfactory. Thus, trials conducted by the University of Agricultural Sciences as whole farm demonstrations in Sirsi taluk led to yields of four tonnes per ha. of paddy as opposed to three tonnes per ha. and 3.4 tonnes per ha. of arecanuts as opposed to 2.56 tonnes per ha. realised in our micro-catchment. But this whole farm demonstra-

tion had also neglected the aspect of transferring organic matter input from elsewhere to these cultivated lands. Our investigations show that while the crop lands and orchards appear reasonably productive and in balance, this is at the expense of serious imbalances in lands and waters in the public domain.

Soppinabetta Lands

At 290 hectares, soppinabetta lands constitute the bulk of the public domain. These are Government lands, but under the control of individual orchard owners who can keep others out and enjoy all the usufructs except timber. These hilly lands are covered by indigenous species of trees of moist deciduous type, with an average tree cover of 360 trees/ha. and shrub and sapling density of 18,500 per ha. The grass cover is mostly *Themeda*. The trees are in poor condition because of frequent lopping of all branches and leaves, and the standing biomass is just 28 tonnes/ha., as compared to 400 tonnes/ha. for a good moist deciduous forest. The annual productivity of soppinabettas is only about 3 tonnes per ha. compared to 15-20 tonnes expected for a good stand of natural forest of this type. Our own studies have shown litter production of 6 tonnes/ha. in a good stand of such a forest in the same taluk; the soppinabettas of micro-catchment produce only 1.4 tonnes/ha. of litter. The soppinabetta lands are thus far less productive than their optimum; more significantly still the annual harvest of plant biomass at 6 tonnes/ha. is double the annual increment of 3 tonnes/ha. Thus, the capital stock of plant biomass now standing at 28 tonnes/ha. is being eaten into at the rate of 3 tonnes/ha. At this rate, it would be wiped out in much less than a decade.

Not only are the trees and shrubs on soppinabetta lands lopped for leaves and twigs, the ground is also swept of all dry leaves to be used as mulch. There are 449 cattle and buffaloes in the micro-catchment, majority of them graze on soppinabetta lands. To get a quick flush of grass with the early rains for these cattle, fires are set to soppinabettas late every summer. All of this means that when the rains come the ground is totally bereft of cover and there are huge soil erosion losses, and little slow percolation of water into the ground. We have not as yet quantified these parameters, but the increasingly bald patches and exposed rocky areas in the soppinabetta lands are clear indicators of serious and growing imbalances in the soil and water regimes.

Minor Forest

The minor forest of 28 hectares bears the brunt of an even greater pressure of extraction in relation to productivity. To this land, all have open access, this land constitutes the only source of fuel, leaf manure and fodder for the local landless families and paddy cultivators, a source of leaf manure and grazing for arecanut orchard owners and a source of fuel wood and grazing for outsiders. It too harboured a good moist deciduous forest, but now has a per hectare tree density of 144 and shrub density of 10,100. Its standing

biomass is a mere eight tonnes and annual productivity just 0.5 tonne per hectare, less than 3 per cent of the potential. The harvest however amounts to as much as four tonnes per ha. This means that in some patches the minor forest biomass is being totally denuded; and this indeed is the case. The minor forest also shares the problems of soil erosion and rapid run-off of rain water with the soppinabetta lands, only in an even more accentuated form.

Waterbodies

There are three perennial and two seasonal streams, and five perennial ponds in the Sirsimakki micro-catchment, all of them are used for irrigation during the dry season. The streams are temporarily bunded after the monsoon with mud and leaves, four such bunds also provide additional irrigation. All the streams as well as ponds have become silted by the mud brought from the soil erosion in the upper reaches, especially from soppinabetta and minor forest lands, and from the network of mud roads. Of the five perennial ponds, three have been fully silted up and one has thick growth of aquatic weeds. Siltation has reduced the potential for land irrigation in so far as the irrigation ponds are concerned from 17 ha. to 9.3 ha. Traditionally, irrigation tanks used to be desilted through community action of the local people; the last such desilting took place in 1944. The silt is an excellent fertiliser and used to be put back into the cultivated land. In the recent decades absence of desilting combined with enhanced soil erosion has led to unprecedented imbalances.

Livestock

It is also instructive to examine the livestock economy. In all, 66 of the 88 households, all of them land holders, maintain cattle or buffaloes, the number of animals ranging from one to 31 per household, with a median of 4.5. The livestock population totals 449. Of these, 77 animals, mostly belonging to very small land holders, graze free round the year, 178 graze freely on the land from August to January, and the remaining 194 are stall fed round the year. Stall feeding requires 750 tonnes of grass, paddy straw and arecanut leaf sheaths, plus 190 tonnes of pellets, cotton seeds and other concentrates. The total cost of these feeds and fodder is substantial, Rs. 9.2 lakhs a year. If we add to this the value of 12,000 man-days a year spent in tending the livestock, the total investment in livestock is of the order of Rs. 10.5 lakhs per year. In return the animals produce about 1,10,000 litres of milk and 127.5 tonnes of dung. Bullocks work in the fields for part of the year and at Rs. 15 per bullock day their contribution comes to Rs. 25,000. Putting all these together, the farmers spend Rs. 10.5 lakh to generate a return of Rs. 6.3 lakh per year. This account leaves out the substantial costs for fencing as well as the indirect costs imposed by over-grazing, soil erosion and siltation for which the animals are responsible. What has happened is that the livestock, earlier smaller in number, had adequate free range grazing when the soppinabetta and minor forest lands were more productive. In recent

years, over-grazing of these lands has led to a decline in their productivity and the farmers have to spend substantial sums on buying feeds and fodder. Since there has been no significant change in the approach and attitude to livestock management, the difficulties of managing the stock are rapidly mounting.

IV

EMPLOYMENT LEVELS

How do the people of Sirsimakki employ their time ? Of the total population of 724, 179 are either too young or too old for employment, 52 others are employed as teachers, shopkeepers, etc. That leaves 493 people dependent on land based or domestic employment. We assume that each person needs employment for 300 days a year. The 11 landless households with 19 adult males and 21 adult females thus require 12,000 person-days of work. They are actually employed for 4,437 man-days and 3,326 woman-days, about two-thirds of the total requirement. What of the landholders ? They totally require about 68,000 man-days and 68,000 woman-days of work. The women are fairly fully occupied, 38,000 woman-days in domestic and 12,000 woman-days in animal husbandry. They are then engaged for about three-fourths of the time they need employment for. As for the land holding males, as against the requirement of 68,000 man-days of work, they are employed for about 24,000 man-days in productive work of direct labour input on land and 8,000 man-days of supervisory work relating to management of orchards. Thus, the landless men are employed for 240 days a year, the landless women for 150 days a year (though they spend much time in domestic work and are therefore not truly unemployed for the rest of the year); the land holding men are employed for only about 140 days a year and the land holding females for about 220 days a year.

V

ECO-DEVELOPMENT

The Problems

This is a relatively prosperous locality; the arecanut orchards bring in an annual income of about Rs. 14 lakhs, the paddy fields Rs. 24,000 and salaries and wages another Rs. 6 lakhs. The per capita annual income of the population is then about Rs. 3,000, good by standards of rural India. Nevertheless, employment is quite inadequate, being only 180 days per person per year. There are aslo serious ecological imbalances, the productivity of land and water, which are in the public domain, is continually declining. The irrigation ponds have lost nearly half of their potential; the soppinabetta lands are producing only one-fifth and minor forest lands only one-thirtieth of their potential. The livestock is imposing a serious financial as well as ecological burden. The micro study represents broadly the heart of the problem that

plagues most of the rural India, quantitatively they could be probably more serious elsewhere.

Need for Concerted Action

The farmers of Sirsimakki have been aware of these problems, at least for the last five years. That was the reason our group became involved with them, at first with educational efforts. In 1983 we helped to set up a school nursery and then to plant on soppinabetta lands. But then our experience showed that unless we understood the whole complex of problems and tried to involve all the people, the efforts would not be really fruitful. We therefore undertook a detailed survey of the entire micro-catchment and of the requirements of each of the 88 households. The findings were discussed with most of the adult males of all households as a group. Several interesting points emerged. Firstly, the people realised that they had never got together to resolve many issues of common interest. For instance, the banana crop in the catchment suffers seriously from bunchy top, a viral disease. This can be controlled if all diseased plants are promptly burnt the moment symptoms of the disease appear. Most people do this, but unless all join the disease cannot be eradicated. No such co-ordination existed. At the other end are situations such as controlled grazing on minor forest land. If everybody refrains from grazing but decides to hand harvest and share the grass, everybody would get a larger supply of fodder. But if some of the farmers decide not to observe the restraint and allow their cattle to graze freely while others do, they will gain at the cost of the rest. This is the so-called prisoners' dilemma situation, often thought of as applicable to issues of management of common property resources. Many such issues came up during the discussions with the residents and some notable progress has been achieved in initiating common action. A fairly detailed eco-development action plan has been prepared and its implementation would hopefully lead to sustained progress in coming years.

VI

CONTROL OVER RESOURCES

Tragedy of the Commons

The major impediment in getting the plan implemented is the issue of control over resources such as soppinabettas or irrigation ponds. In pre-British times many such resources were being controlled and managed by local communities. It was perhaps a consequence of this, as Dharampal contends, that the state apparatus of those days was able to divert a rather low fraction of surplus production to its own ends. The British wanted to step this up, and as one of the measures to achieve this and in conformity with the practices that had become established in Great Britain by the 19th century, they decreed all communal control on resources as invalid. All the resources that were then not owned privately came under the control of the state.

Barring a few exceptions, soppinabetta being one, people had certain privileges of access to some of the state owned resources, as with minor forest, but had no authority to regulate access by others. The authority to regulate access only lay with the state, that is to say, with the concerned officials. These officials neither benefit from good resource management, nor suffer if the resources are depleted. They are therefore, by and large, motivated to exert the authority when it benefits them and benefits so derived are shared with the official hierarchy and political authorities.

Privatisation

As a remedy, two approaches are advocated, both involve privatisation of such resources. In one model, being followed in West Bengal, control over such land is given to the landless and small peasants, who are successfully growing commercial tree crops. The second model is being attempted in Karnataka where these lands are being handed over to a joint sector company dedicated to supplying pulpwood to a private polyfibre mill. There is a strong local opposition to the Karnataka proposal from villagers who are traditionally using such land for meeting their own fuel and fodder needs.

Production for Market and Subsistence

Both these proposals share a common objective of production for commercial purposes. In our own programmes, where the soppinabetta lands are involved, the farmers would like to grow tree crops, partly for the needs of their arecanut orchards, and partly for the market. Currently, they have no right to sell the produce of soppinabettas and therefore hesitate to invest in planting of trees on these lands. With the minor forest lands, to which all have open access, it is all the more difficult to motivate any segment of the population to observe good management rules.

There are then two issues. Should all resources in public domain be privatised? Or should a community control system be evolved to ensure serving the objective of preservation of ecological balance with measured benefits to the participants? The latter would include all classes, even the landless families too.

Community Control

We do not propose to go further into these questions. However, our own field experiences suggest that small homogeneous communities too could manage resources responsibly and that this option need not be totally rejected. Furthermore, the produce need neither be purely commercial nor only fuel/fodder for subsistence needs of village poor. Instead, it could be a mix of fuel, fodder and commercial wood production.

Employment Generation

Resolving these issues is very important for the uncultivated lands and waters in the public domain are a vital resource whose productivity can be

stepped up several folds. This process of eco-restoration can also generate substantial employment that is much needed. The soppinabetta lands of Sirsimakki, for instance, could support a good crop of sisal which could further generate employment for rope making. The irrigation ponds could support culture of carp fishes. Realisation of all these possibilities however depends on a satisfactory resolution of the issues of control over and sharing of the produce of lands and waters currently in the public domain. We would therefore urge scholars in the profession and policy makers to initiate action research in the matter and help evolve a lasting and workable solution.

VII

SUMMARY

This paper presents a case study of resource dynamics for a micro-catchment of 4 km^2 in the Sirsi taluka of Karnataka Western Ghats. Its paddy fields and arecanut orchards are well managed with above-ground annual production of 9 and 20 tonnes/ha. respectively. However, this production is at the cost of forest lands which annually provide plant organic matter inputs to the tune of 16.6 tonnes per ha./year of the orchard land. As a result, the capital stock of plant biomass of the forest lands is being liquidated. Thus, the annual per ha. above-ground production is 3 tonnes/ha. as against harvests of 6 tonnes/ha. for soppinabettas, *i.e.*, forest lands assigned to orchard owners and 0.5 tonnes/ha. as against harvests of 4 tonnes/ha. for the minor forest which is open to all villagers. These forest lands are also over-grazed and subject to annual fires. The resultant soil erosion from these forest lands has fully silted up three of the five perennial irrigation ponds and reduced the area irrigated from 17 to 9 ha. The people of this micro-catchment are reasonably prosperous, the per capita annual income being Rs. 3,000. However, there is substantial under-employment, there being sufficient work only for 180 days per year for an average member of the adult working force. Evidently, there is tremendous scope to generate employment in the micro-catchment in conjunction with better use of resources in the public domain, namely, forest lands, streams and ponds. This calls for a fresh look at how these resources are controlled and their produce shared. We are involved in an action programme taken up in co-operation with the people of Sirsimakki micro-catchment which is attempting to correct the ecological imbalances and set up better systems of management.