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## MANAGEMENT OF RENEWABLE RESOURCES : A S AND T PROGRAMME



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### I Recommendations

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 development efforts have tended to stress intensification of resource use without due regard for long term sustainability of the effort and for concomitant degradation of other resources. The consequences have been disastrous; 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. This difficult situation offers a unique challenge to our science and technology establishment for the relevant problems are highly location specific and have to be largely solved through our own efforts. Since the efforts will necessarily have to involve people at the grassroots as well, it is also an opportunity to promote a broad culture of science in our country.

We believe that the science and technology inputs called for relate not so much to specific sectors as to the adoption of a holistic approach, of viewing the system as a whole, of understanding all relevant interactions, including

of course, the human factors. This will have to be a co-operative endeavour involving not only scientific and technical experts, but also the development planners, local educational institutions and other organizations such as youth and womens' groups and mandal panchayats. The appropriate spatial scale for planning, implementing and monitoring of good resource use in such an effort will be a micro-catchment of few hundred or thousand hectares corresponding to one or more villages.

We propose that the Government of India launch an experimental five year programme of application of science and technology to microlevel planning of utilization of renewable resources for a series of micro-catchments representing the different ecological zones of the country. This programme with a total budget of Rs. 500 million could be co-ordinated by the Department of Science and Technology of the Government of India and implemented through the State Councils of Science and Technology. Our ultimate aim, of course, would be to extend such an approach to cover the entire country in three phases over the next fifteen years.

## *II Preamble*

The Science Advisory Council to the Prime Minister has identified the management of the country's renewable resources as an important area in which the Council would like to suggest some programmes/missions to the Government for its consideration. This is an area of great significance since our ability to sustain the process of national development depends vitally on the health of our resource base of soil, water, vegetation, livestock and genetic diversity. It offers a unique challenge, for the problems of management of renewable resources are highly location specific and have to be largely solved by us through our own efforts. This affords a great opportunity to nurture a truly indigenous scientific and technological effort without being continually worried about whether we are lagging far behind the others and merely reinventing the wheel. Since by its very nature the effort will have to ultimately involve people at the grassroots, it is also an opportunity to promote a broad culture of science in our country.

The science and technology effort that underlie the green revolution was just such an endeavour that had to be adapted to our own local conditions and was successfully carried through with many notable organizational innovations. It has rendered us self-sufficient in food and has enabled us to pursue modernization with a measure of confidence. We are, however, now beginning to be aware of the limitations of this approach, for it was a single minded effort to intensify resource use without adequate consideration for its wider environmental repercussions. The sustainability of growth in our agricultural production is, therefore, in some doubt, as is our ability to diffuse green revolution throughout the country. Our continued progress, therefore, depends on a more holistic approach that would have its focus on the health of the resource base. An effort in this direction would require innovations as radical as those that ushered in the green revolution. The purpose of this report is to suggest a programme that would initiate such an effort.

### *III The Problem*

A whole variety of problems plagues our renewable resource base :

- (1) Reduction in the percolation of water into the ground, increase in the runoff. Deforestation, compaction of the ground due to overgrazing by livestock, inadequate levels of mulch on cultivated fields, excessive growth of built up areas have all led to a lowering of the levels of percolation of rain water into the ground, though little concrete data are available.
- (2) A consequence of increased runoff, along with siltation of river beds has been the floods. Flood prone areas in the country have dramatically increased from 19 million ha. in 1960's to 59 million ha. in 1984. These include areas in entirely new states like Andhra Pradesh, Madhya Pradesh, Maharashtra, Gujarat and Tamilnadu which had no flood problems before 1970's.

- (3) Irrigation water is used in a very inefficient manner through flood irrigation. Sprinkler, drip and other systems that could tremendously enhance the efficiency are as yet little experimented with and little used.
- (4) Water logging and salination plague vast tracts of land, for instance in the black cotton soil belt in Karnataka, Maharashtra and Madhya Pradesh, and the so-called usar lands in Uttar Pradesh. Pushing irrigation projects, without adequate provision for drainage, is the single most important cause of this disaster.
- (5) Inadequate recharge of ground water and its over-drawal have led to serious problems of lowering of ground water table, with many open wells going dry, for instance, in Gujarat, Marathwada region of Maharashtra, Anantpur district of Andhra Pradesh and Coimbatore district of Tamilnadu. However, bore wells continue to be dug without any investigation of whether the drawal of water is being compensated for by recharge, and without any measures for enhancing the levels of the ground water recharge.
- (6) There has been extensive pollution of surface as well as ground waters. Again no thought has been given to the costs involved; for instance in loss of fisheries, and whether acceptance of these costs is justified by the benefits conferred by the activity generating the pollution.
- (7) Deforestation, overgrazing, improper road construction; a number of causes lead to heavy soil erosion losses, estimated at 16 tonnes per ha. of India's land surface. This results in steady depletion of the productive potential of our land that never forms part of any economic calculation.
- (8) Something like 3000 million tonnes of soil is yearly deposited into our stream and river beds and 500 million tonnes into the dams. This cuts down the irrigation potential and increases flood damage very substantially.

- (9) Our present day agricultural technology would easily allow us to produce enough food from good, fertile lands alone. Nevertheless large tracts of hill slopes or extremely dry lands that would be much better left under tree and grass cover are brought under the plough by subsistence farmers just to eke out a living. The grain production from such lands is often a meagre 3-4 quintals per ha. and the farmers cannot afford any soil and water conservation measures. The result is an enormous burden of soil erosion. Nevertheless, there is no reliable data base on the relation between land capability and land utilization and no well thought out programmes for bringing about more appropriate land use.
- (10) It is suspected that with depletion of sources of organic manure and reliance on chemical fertilizers that do not supply micronutrients such as zinc and boron, our agricultural soils are being progressively depleted of their nutrient capital. Again there is little reliable information on this vital problem.
- (11) Fertile soils have suffered degradation from mine tailings, from brick making, from industrial effluents and through improper use of fertilizers and pesticides.
- (12) There has been a tremendous loss of traditional crops, such as leafy green vegetables or tubers and of cultivars of cereal crops, fruit trees and so on, as well as strains of domesticated animals. While serious effort has been mounted for ex situ maintenance of the cultivators of major crops, there has been no attention paid to other plants, for instance, the innumerable mango varieties of the Western Ghats, or to in situ conservation.
- (13) With attention focussed on production of cereals and cash crops on agricultural land, and timber and industrial softwood in forest plantations, our needs of fuelwood, fodder, organic manure and small timber have been grievously ignored. The result has not only been the overharvest of plant biomass with degradation of forests and pastures, but also a

further chain of consequences such as soil erosion, siltation of reservoirs, reduction in recharge of ground water, drop in ground water levels and so on.

- (14) India supports half of World's buffaloes and one seventh of World's cattle and goats on one fortieth of World's land. As the livestock population has increased, grazing lands have shrunk by being brought under the plough and have become more and more overgrazed. Nevertheless practically nothing has been done to enhance our fodder resources and change the animal husbandry practices. There is little scientific information on the livestock under field conditions and constraints under which they are managed. The grazing pressure has a whole series of implications for destruction of vegetation, compaction of soils, reduction of ground water recharge, etc. which are utterly ignored.
- (15) Plant production on the non-agricultural and forest lands of India is totally ignored; so that the productivity levels are far below the potential, often less than 10%. There is little scientific information available, except bureaucratic data on extent of land under control of Revenue and Forest Departments. Even then, there is little reliable information on extent of encroachments on Government land. The whole issue of management of these lands needs serious attention from natural as well as social scientists.

A variety of causes underlie these problems. Amongst the most significant of these are :

- (1) Narrow sectoral approaches by the experts and development administrators. Thus irrigation projects have consistently neglected the vegetation cover of catchment areas and veterinarians the provision of fodder. More complex interactions such as the role of overgrazing by cattle in depleting vegetation in catchments of rivers have been totally ignored.
- (2) Neglect of many vital issues, such as fuelwood and

small timber needs or destruction of fisheries by water pollution.

- (3) Neglect of long term considerations, for instance what happens to the fertility of soils under continued application of chemical fertilizers.
- (4) Neglect of traditional knowledge and practices, for instance, use of neem as pesticide or the cultivation of highly nutritious green leafy vegetables.
- (5) Neglect of social implications of resource use; thus in Karnataka thousands of hectares of former C and D class revenue lands are proposed to be utilized to grow softwood for industry. Since villagers critically depend on these lands for their biomass needs, the project has met with widespread opposition.

We, therefore, suggest that the science and technology inputs now most urgently called for relate not so much to one specific issue, such as provision of good drainage under irrigation or genetic upgrading of livestock, but to the introduction of a holistic approach, of viewing the system as a whole, of understanding all relevant interactions, including of course the human factors.

#### *IV Role of Science and Technology*

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 on bamboo from Arunachal Pradesh, and their effluents affect fisheries in Tamilnadu. From a physical point of view topography as reflected in a watershed/catchment provides an appropriate spatial unit, as does a village from a social or a mandal panchayat from an administrative viewpoint. An area of a few hundred to at the most a few thousand hectares with a human population of a few hundred to a few thousand people would provide the right scale for a detailed enough planning and monitoring exercise. We, therefore, suggest that the choice should be of one or more villages falling within the jurisdiction of a single mandal panchayat and

with land area corresponding, as far as possible, to one catchment of appropriate order.

Within such a microcatchment the tasks to be undertaken will be :

- (1) Surveying and inventorying the status of resources including land, water, cultivated crops, orchards, livestock, natural vegetation and animal life, as well as human population.
- (2) Investigation of the dynamics of resource base, for instance removal and replenishment of nutrients from agricultural lands, annual increment and harvest of fuelwood produced on private, village grazing and forest land and how its harvest is regulated.
- (3) Documentation of folk knowledge and traditions of resource use, for instance, maintenance of village irrigation tanks, systems of intercropping, regulation of grazing.
- (4) Assessment of problems of resource degradation in light of socio-economic structure and processes.
- (5) Identification of the causes leading to resource degradation; both the triggering factors and factors sustaining degradation processes.
- (6) 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 for a given set of conditions.
- (7) Identification of ways and means of implementing these technological packages within the given social, economic, administrative and legal constraints.
- (8) Communication of the identified package of practices to the local population and the administrative machinery.
- (9) Monitoring of the on-going patterns of resource use,

including especially the implementation of the recommended package of practices.

Ideally the execution of these tasks should be a co-operative endeavour of the scientific/technical experts from different disciplines, teachers and students in local educational institutions, local people and their organizations such as youth and ladies' associations and group of associations and development planners and administrators.

#### *V Relevant Experience*

We can draw upon the experiences of several programmes in the past to work out a framework within which to carry out the proposed experiments. These include amongst the Government sponsored efforts, the Karimnagar district experiment of CSIR, the watershed development programmes under the dryland development project of the Government of Karnataka, the comprehensive watershed development programme of the Government of Maharashtra, the Uttara Kannada microcatchment ecodevelopment programme of the Karnataka State Council for Science and Technology, the Sukhomajri experiment of the Central Water and Soil Conservation Research and Training Institute and the voluntary efforts of the Dasholi Gram Swarajya Mandal.

The Council of Scientific and Industrial Research had attempted to prepare a comprehensive plan for development of Karimnagar district of Andhra Pradesh. The basis of this exercise was the use of aerial photographs along with minimal ground checks, leading to the production of detailed 1:25000 scale maps on the following themes :

- (a) present land use
- (b) Geology
- (c) Hydromorphology
- (d) Forestry
- (e) Soils
- (f) Land resources
- (g) Optimal land utilization

These are obviously part of the essential data for good resource use planning. However, this is not enough for the maps provide only static information on resources; their dynamics is equally if not more relevant and has to be taken into account. In fact the preparation of optimal land utilization maps without this base can be only preliminary. Nevertheless, this was a first valuable attempt at looking at and planning for good resource use in a holistic fashion. It failed to progress because CSIR ended up acting alone and could not secure the essential cooperation of other organizations such as the Indian Council of Agricultural Research.

Sukhomajri, a village in the upper catchment of Sukhna lake supplying water to Chandigarh city has been the site of an experiment in soil and water conservation by the Central Soil and Water Conservation Training and Research Institute of ICAR. A unique feature of this experiment has been the establishment of a local "Water Users' Association" and working together of experts and local people.

Dasholi Gram Swarajya Mandal is a voluntary organization in the Alakananda Valley of Garhwal Himalayas devoted to the tasks of eco-preservation and ecorestoration. They have been pioneers in involving local villagers including women and harijans in planning for good resource use of their own locality. Unfortunately there has been little tie-up with either technical experts or Government machinery.

The dryland watershed development programme of the Karnataka Government is an ongoing attempt at looking at soil and water conservation of a watershed as a whole on an integrated basis involving coordination of activities of Agriculture and forest Departments. The University of Agricultural Sciences, Bangalore, is also actively involved in this programme with an operational research programme in one of the watersheds. Each watershed is being looked after by a multidisciplinary team, which however lacks some critical inputs such as from animal husbandry department. There is also little active participation and learning from the experiences of the local population, although there is an active campaign to educate them.

This most valuable beginning is now being taken further by a Comprehensive Land Use Management Programme (CLUMP) that pays due attention to the animal husbandry sector and aims to involve the local people more actively in programme formulation and implementation.

The Western Ghats Ecodevelopment Action Research programme of the Department of Environment is attempting to focus on several identified micro-catchments in the hill tract of Western Ghats, and promote programmes of resource planning and development by simultaneously involving scientific institutions, universities, colleges, schools, local people as well as Government departments. The experiment is progressing well in two micro-catchments in Uttara Kannada district of Karnataka. Here very detailed ground surveys based on mapping by Survey of India at 1:5000 scale have been followed by preparation of detailed action plans by a multidisciplinary team of scientists put together by the Karnataka State Council for Science and Technology. Local high schools and junior colleges have also been actively involved in collection of data and preparation of these plans. These plans are now being implemented in consultation with Government development agencies and with the help of ecodevelopment task forces of local people.

#### *VI Action Plan*

##### **(a) Short Term**

This is evidently a mammoth task which calls for co-ordinated effort of agencies as diverse as Agricultural Universities, local high schools, mandal panchayats and forest and animal husbandry departments. While it is essential that we must address this task and evolve ways and means of bringing all the actors together, we must begin the effort on a manageable scale and gain experience before venturing on a more massive scale. We, therefore, suggest that the first phase should concentrate on a small number of catchments of a few hundred to a thousand hectares so selected as to represent the various ecoclimatic zones of each state.

We suggest that the Department of Science and Technology of the Government of India serve as a nodal

agency to handle the whole programme at the Central level, with the concerned State Councils of Science and Technologies (SCST) being made responsible for the actual execution of the programme in the experimental catchments. The actual choice of catchments would depend on the level of competence of the various SCST's to take up such a programme, the willingness of local Universities and Research Institutions to Participate and the availability of active voluntary agencies like Dasholi Gram Swarajya Mandal to co-ordinate the effort at the local level. These programmes should be linked to the on-going Watershed Development projects involving ICAR.

The Karnataka State Council for Science and Technology has developed some valuable experience in the execution of such a scientific programme over the last two years. In light of this experience they have formulated a five year programme which provides useful pointers as to how the different State Councils may evolve their own programmes.

An important component of the programme would be the involvement of local educational institutions. In particular the local colleges should be encouraged to include project work on resource inventories, resource dynamics as well as social dynamics of resource use as part of curricular requirements. Simultaneously, we should promote the development of new syllabi for courses that would emphasize material on resource dynamics and social dynamics of resource use as the theme around which different subjects are to be taught. This will have to be backed up with a centrally coordinated effort at generating textbooks, workbooks, manuals and other materials for such an approach at college education. The programme proposed by the Karnataka State Council for Science and Technology also visualises involvement in the preparation of such educational material.

The programme should have five year guaranteed continuity with full autonomy in using the funds flexibly, without, of course, any expenditure on construction, vehicles other than bicycles or mopeds, expensive equipments or excessive air travel. With such constraints, an amount of Rs 500 million may be made available to DST.

**(b) Long Term**

In the long run, of course, we envision such careful detailed local-level planning of resource use to become a norm over the country with the exercise being gradually extended to other districts, and more and more watersheds in each district. Simultaneously, school and college curricula and teaching practices should be revolutionized using resource dynamics and resource use as a central theme, so that what is taught will be related to actual application of science and technology in real world around the students. Relating modern knowledge and practices of resource dynamics and resource use to traditional knowledge would serve to both enrich our own science and technology, as also make it more readily accessible to the bulk of the population, thereby helping create a genuine culture of science and appreciation of technology in the society at large.

*VII Concluding Remarks*

Such an endeavour will necessarily be a peculiarly Indian endeavour. No other country will have an interest in developing such a knowledge base which is especially relevant to us and us alone. This strongly contrasts with the science and technology base underlying defence or urban consumer interests. In these areas other countries have strong interests, obliging us to often fall behind and be forced to borrow from others destroying our faith in ourselves. Undoubtedly this is no justification for abandoning serious efforts in these areas, rather it calls for focussing them on a limited number of defined programmes so that we can achieve something worthwhile with concentrated efforts.

Nevertheless, that would still mean a rather limited approach for much of our science and technology effort with no hope of it touching the masses, of generating a broad culture of science that is necessary for us to become a modern nation. On the other hand, the focus suggested here would generate a massive, fully indigenous science and technology effort that would have real relevance not only to solving our pressing problems of

bringing about good resource use and creating large scale employment, but also help develop a broad-based national culture responsive to science and technology.

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