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SOCIAL FORESTRY AND WATER RESOURCES

Issues and Studies

JAN LUNDQVIST
SEPTEMBER 1992

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Dear Reader,

We apologise the delay of this issue due to various unavoidable factors. However, the delay is a blessing in disguise since we are able to get the final report of Dr. Jan Lundqvist on Social Forestry and Water Resources.

Dr. Lundqvist is a Professor, Linköping University, Sweden. His contribution towards understanding the various dimensions of social forestry is immense. He was kind enough to accept a fellowship from Research and Development Cell during 1991-92. The objectives of the fellowship was to define the research priorities and to study water resources *vis-à-vis* social forestry.

Dr. Lundqvist travelled to the nook and corner of Tamil Nadu to understand the concepts and practices relating to water resources and social forestry. He prepared a draft report on the basis of his experience and this report was presented in a workshop during the earlier part of this year to a select group of academicians, NGOs and policy makers. Based on the reaction from this workshop, Dr. Lundqvist prepared his final report. The present issue of SFREAD is giving this report and I am sure that this would contribute to further your understanding on water resources and social forestry.

The interaction with Dr. Lundqvist was an important event in the R & D Cell and we are sure that we would have more such interactions.

We invite your reactions to this article which would help in further define our research priorities.

Keep in touch,

Yours sincerely,

K. BALASUBRAMANIAN
R & D Manager
and
SANJAY SHUKLA
Forestry Programme Assistant

PREFACE

This report was written in connection with a two months fellowship under the R & D Cell, Tamil Nadu Social Forestry Project, Madras. The assignment was to identify the R & D needs concerning the relationships between social forestry and water resources in Tamil Nadu and to draft a research strategy in the field. The assignment has involved a lot of travelling in Tamil Nadu and to some extent also outside the State. Ample opportunities were provided to meet people who are involved in social forestry activities and also colleagues engaged in research on social forestry or with a keen interest to take up such research. At the end of my assignment, a workshop was arranged where a large number of representatives from departments, institutions and NGOs discussed the issues presented in the report.

Quite a number of people have actively contributed to the report. Many of the ideas and suggestions presented in the report have come up in discussions with people at Government Departments, NGOs and University Institutes. It was particularly stimulating to visit the various social forestry projects in the field.

Due to the great number of people and places involved, it is impossible to name all those who have contributed to the preparation of the report. I would, however, like to mention a few colleagues. Dr. R. K. Sivanappan has been my companion and guide throughout the work. His profound knowledge in the field and his dedication has been invaluable. He has also prepared appendix B. Dr. Åke Nilsson, Coordinator, ISO/Swedforest, took the initiative to this fellowship and has very actively supported the study and helped to specify ideas that came up in this connection. Dr. K. Balasubramanian, R & D Manager, ISO/Swedforest, provided me with a lot of important information. Particularly his knowledge about the social and institutional aspects has broadened my view on social forestry. Finally, I owe the staff of the ISO/Swedforest office in Madras, a thanks for their help and nice companionship.

The conclusions and proposals presented in this report and the discussions that took place during the workshop will be used by the R & D Cell to prepare an operational plan for research on water resources and social forestry.

Madras and Linköping, February 1992

JAN LUNDQVIST

CONTENTS

Abbreviations used:

AD	=	Agriculture Department
DRD	=	Directorate of Rural Development
F/WI	=	Forest/Water Interrelationships
FD	=	Forest Department
GOI	=	Government of India
GOTN	=	Government of Tamil Nadu
IFF	=	Interface Forestry Madras
R & D cell	=	Research and Development cell, ISO/Swedforest
S&WC	=	Soil and Water Conservation
SF	=	Social Forestry
TNSFP	=	Tamil Nadu Social Forestry Project

1. FOCUS AND PURPOSE OF REPORT

Widespread degradation of forest areas in Tamil Nadu as well as in other parts of India and abroad, has a number of direct and indirect detrimental effects. Apart from well-known hardship associated with dwindling supplies of fuelwood, timber etc., degradation and removal of forest cover will have far-reaching consequences for the environment. It will affect the composition of flora and fauna and also the air, soil properties, micro-climate and water balance parameters. All of these, in turn, have repercussions on livelihood conditions of the communities and for the State as a whole. Although it is widely agreed that these impacts are basically negative, the complexity of the interactions and their temporal and spatial dimensions, contribute to a fragmented and unsatisfactory understanding of the issue. In addition, systematic efforts to rehabilitate degraded forest areas or barren lands in general, are comparatively recent and the full impact of these efforts are yet to be seen in practice.

The focus of this report is on interactions between social forestry activities and water resources. Water is but one of the essential resources needed for food and biomass production, for environmental care etc. But in Tamil Nadu it is, more often than not, the scarcer resource and it has no substitute. As a result of interannual fluctuations in amount, uneven seasonal distribution and erratic character of rainfall, its availability is also unpredictable.

An attempt is made to identify research issues that should be relevant with regard to the current and future social forestry activities. In Tamil Nadu and elsewhere in India, intensive work is going on in the social forestry sector. It is of significant importance that constructive research and monitoring could be carried out in conjunction with these efforts. Research on these issues is also a challenging task from an academic point of view. The purpose of this report is to stimulate such research and, again, to highlight the social forestry - water resources interactions.

2. SOCIAL FORESTRY, WATER AVAILABILITY AND WATERSHED DEVELOPMENT

2.1 Improving Water Availability

One of the objectives of Tamil Nadu Social Forestry project (SF), and particularly its Interface Forestry component (IFF), is to improve water availability for various socioeconomic and environmental purposes. Improvement in water availability is advantageous for the rehabilitation of the forest area itself. Improved availability, particularly during the drier parts of the year, is also a precondition for an enhancement of the productivity of the agricultural lands. These include watershed areas downstream of the Reserve Forest (RF), the so-called "buffer zone" and command areas under tanks covered by tankbed plantations. Similarly, water availability is crucial for agroforestry which is under development in "waste" lands. Conservation of rainwater from the monsoon period for the use during drier parts of the year is furthermore of significant interest for household water supplies, for cattle and for other year - round demands.

Improved availability basically refers to increased amounts of rain-water stored as soil moisture in the root zone and as ground water in the aquifers. Soil moisture is a precondition for food and other biomass production and groundwater recharge will refill the wells and regenerate the streams. Various treatments included in SF (see 2.2) are supposed to contribute to an improved availability in the above sense. But planting of trees and regeneration of natural vegetation will also increase the biomass in an area and for that water is required. The assumed gains in water availability through SF activities must thus be seen in relation to the increases in water consumption, that is, the increased interception and transpiration from growing trees.

In terms of consumed amounts of water, the initial stage of afforestation is, for natural reasons, not a big issue. In any case, a primary concern must be to achieve a satisfactory survival rate of seedlings, for which soil moisture conservation is crucial. At this initial stage, only small amounts of water are needed. Once the root system has developed and the trees start to come up, they will consume more water. But to what extent and under what circumstances they compete for the available water (and nutrients) and how they will affect ground water recharge, surface runoff and thus water availability on a watershed basis, are questions that need to be addressed. When trees reach a mature stage, the water consumption is probably reduced as compared to earlier growth stages. After coppicing it may increase again. Water requirements vary thus over the life cycle of trees. Trees may also withstand periods of moisture deficits and "tide over" periods of less water. Finally, it is important to mention that trees, also after their felling, contribute to the infiltration capacity by creating macro pores in the soil.

Summing up, improved water availability in this report refers to:

a) in situ conservation of moisture, and soil (of prime concern for the survival rate of seedlings and their establishment). The objective is availability of (small amounts of) water at critical phases around the roots of the seedling to avoid moisture stress.

b) water resources conservation on a watershed or on a regional basis. This presumes an increased infiltration of rainwater into the ground and a reduction of "unproductive water losses" in terms of surface run-off from the area and direct evaporation from moist surfaces. An improved water holding capacity of the soil and thus a slow-down of sub-surface movements of water, is also of importance. The objective is to bring about changes in water balance parameters on a large scale, that is, on watershed, so that the maximum amount of rainwater can be made accessible over extended periods of the year for various productive and consumptive uses (cf. Figure 1, page 7).

2.2 Treatments in SF Projects

Various categories of land are subject to SF activities. Depending upon land characteristics (topography, land-use, etc.) and other circumstances, various treatments are carried out. In some of the SF projects the emphasis, and expenditure, is on planting seedlings. This is the case in about half of the 39,000 tankbeds and tank foreshores where Acacia Nilotica and Acacia Leucophloea have been planted. In other areas and projects, a combination of soil and water conservation and afforestation activities are going on.

These projects include plantings along the roads, railway lines and in other similar locations, the so-called strip plantations, agroforestry (carried out by Agriculture Department) with trials of intercropping of seasonal crops between rows of trees and also in situ soil and moisture conservation. The productive use of barren land, or "waste" land" through some kind of agroforestry or block plantation is an important component of the overall SF policy.

Agroforestry is intended for the "waste", barren or fallow lands. Altogether some three million hectares in Tamil Nadu belong to this category. A main feature of these lands is that seasonal cropping is risky due to rainfall amount and regime and the yields being very low. By adhering to five principles (motivating / motivated farmers, planting at proper time, good quality seedlings, soil and water conservation and adequate care after planting) a high survival rate of seedlings should be assured.

As will be noted below, a prime consideration must be given to what is actually the "carrying capacity" of the barren lands with regard to water resources. In other words: to what extent and under what design is it realistic to raise both trees and seasonal crops in areas which today are left fallow or discarded for almost any use because they are looked upon as too barren? And how will a large scale agroforestry programme affect the availability of water in down-stream locations?

The most comprehensive and ambitious programme is the IFF. While the above mentioned SF projects are concentrated to the Patta, Poromboke and "waste" lands, the focus of the IFF is on the watershed with treatments both in the RF and in the adjoining agricultural areas. To protect and restore the degraded RF and to improve productivity of the entire watershed area, various treatments are carried out:

(i) soil and water conservation (S&WC), that is, construction of contour stone walls, semi-circular bunds, percolation ponds and check dams, contour trenches, vegetative barriers, etc. - S&WC aims at improved water availability in the twin sense mentioned above, that is, both in situ and on a watershed basis,

(ii) a regeneration of the natural vegetation by "social fencing" or other closures,

(iii) planting of trees.

Apart from the treatments in the RF, the agricultural areas, the so-called "buffer zone" does also receive some treatment, mainly in terms of S&WC and provision of tree seedlings, including fruit trees, to the farmers. Taken together, the treatments are supposed to conserve soil and water resources and boost productivity of the entire watershed.

Although the protection and restoration of the land, water and biotic resources is important from an environmental point of view, the development aspects are crucial. Unless the productivity of land and water resources can be enhanced, the increased potential be productively utilized and benefits flow to the communities, it is futile to imagine that a sustained improvement of the environment will be accomplished. For socioeconomic reasons and for the sustainability of regenerated forests, it is fundamental that the improved productivity will not be confined to RF areas or other afforested areas only, but that it will accrue in agricultural areas as well. Seen from a water resources perspective, a competition between forest regeneration and enhancement of agricultural productivity can not be ruled out. And if there is such a competition, the trade-off between the various components of SF and their effects should be looked into. Officially and hopefully, there is a complementariness between afforestation projects and agricultural and rural development.

2.3 The Impact from Various Treatments on Water Availability

The three types of treatments described in 2.2 are bound to effect significant water balance parameters.

Soil and water conservation (i) will have an immediate and positive effect by arresting surface run-off and facilitate infiltration.

The effects of the other two treatments (ii & iii) are complex and, contrary to the engineering treatment, the impact will be gradual. Perhaps more important, the afforestation of an area involves both conservation as well as consumptive effects vis-à-vis water (see further in appendix A).

Natural vegetation (ii). Based on the experience from the protection of degraded forest areas and agricultural lands in Tamil Nadu and elsewhere, the regeneration of the natural vegetation can be quite fast. Within the span of a couple of years or up to five years, the natural vegetation may recover and virtually cover previously denuded areas. The canopy of leaves, branches and litter will help to reduce the erosive force of the rains. The vegetation may also improve soil structure and help to build up soil organic matter. The positive effects on water availability as a result of regeneration of the natural vegetation are likely to dominate and be achieved fairly quickly. The increased amount of water transpired back to atmosphere from the growing bushes and other natural vegetation is probably less than the water conservation effects since the increment in the amount of biomass is small in absolute terms and since the natural vegetation is adjusted to climatic conditions.

Tree planting (iii). The hydrological impact from the planting of trees is more uncertain. Moreover, it will take several years or even decades, before the full impact can be ascertained. Most planted trees grow slower than natural vegetation and depending upon the species selected, the water consumption per unit of biomass will vary. Similarly, the effect on soil properties and the micro-environment will also vary with species.

The various treatments and their effects can be summarized as below:

	ENGINEERING TREATMENT	BIOLOGICAL TREATMENT
IN SITU	Semi-circular bunds, catch pits, v-ditch, trenching, tie ridges. Immediate and spatially limited effects.	Mulching, Quick effect
WATER-SHED	Percolation ponds check-dams, contour trenches & stone-walls & bunding. Quick effects in watershed	Hedges of vetiver, agave, natural regeneration, tree planting, etc. Gradual effect

3. PRODUCTIVE AND UNPRODUCTIVE WATER

3.1 The Basic Idea and the Relevant Questions

With reference to the above definition on improved water availability, the enhancement of productivity is achieved by (1) increasing the share of the precipitation that is made available for food and other biomass production, and (2) by prolonging the period of the year when water is available as soil moisture and ground water.

As further discussed in appendix A, the assertion that afforestation will improve water availability does not enjoy a wide acceptance in scientific literature. Or more precisely, there is no general agreement or understanding as to the role of afforestation in conservation of water for other areas or uses outside the afforested area itself nor for augmenting the dry season base flow. Supported by the results from a number of studies, forest hydrologists tend to argue that afforestation or reforestation will reduce total water yield and to some extent also the base flow, that is the water yield in streams and wells from groundwater discharge, during the dry season. Few systematic studies do, however, refer to semi-arid conditions and the type of conversions of landuse associated with SF. Probing into the relationships is therefore of great relevance both from a development perspective as well as from a scientific point of view.

The logic of an assumed positive effect on water resources availability is that afforestation in combination with other treatments, will reduce the substantial losses of water - which occur without achieving any gains - from a degraded area in terms of direct evaporation from moist surfaces, surface runoff ahd rapid underground movements of water (lateral movements of water in the upper portion of the soil, generally called interflow or through-flow). A significant justification for SF projects is that landuse including the planting of trees and agricultural practices, should be designed with the intention to get an optimal and socially desirable output from the land and water resources. Expressed in other words, the treatments should aim at reducing those losses of water which do not serve any productive purpose and optimize production per unit of water available.

This basic idea assumes significant importance in view of the fact that water is a scarce, erratic and vulnerable resource in large parts of Tamil Nadu. Naturally, direct evaporation from moist surfaces will be of no use to the development of an area nor to the environment, whereas the water consumed by trees, seasonal crops and other sectors of society, represents a "productive" or gainful return flow to the atmosphere.

We cannot stop the hydrological cycle. Neither should we aspire to adjust rainfall amount nor its pattern (cf. appendix A). The return flow of water to the atmosphere (after the rains) is as natural as it is necessary for the production of food, trees, etc. From a socioeconomic point of view and also from an ecological perspective, the interesting question is not so much the fact that water returns to the atmosphere (due to high potential evapotranspirative demand). The important questions are rather how and when water returns to the atmosphere or how it leaves the area over which rain falls. If it returns quickly after the rains in the form of direct evaporation from moist surfaces, nothing is gained, whereas if it infiltrates into the soil and feeds food and biomass production and thus returns as transpiration, tangible gains are accomplished. And that is what matters to people. It can be argued, that what goes back to the atmosphere (as evaporation and transpiration) will eventually also come down. But we don't know when or where it will return as rains again (see appendix A). Horizontal movements of water are also of interest; flash floods create havoc in down-stream areas and desiccation of landscape in up-stream locations, whereas more gentle flows are natural.

3.2 Productivity of Water and Land

Just as a piece of land can go waste or yield differently depending upon management and use, a quantum of water may be "lost" or yield differently. We are accustomed to think of the productivity of land in terms of yield per acre or hectare. Since water is often a more scarce resource than land and for which there is virtually no substitute, it would make a lot of sense to think of the productivity of water. Most if not all people are prepared to pay for land and other factors of production but few want to pay for water. For some reason an awareness of water as a scarce and *finite resource is not* well developed. Land and water use should, however, not be seen in isolation. An integrated management of these two basic resources is the appropriate strategy.

In Figure 1 some of the aspects discussed above are visualized. A distinction is made between productive and unproductive losses of water. The assertion from Figure 1 is that by adopting appropriate and integrated land and water management, it is possible to increase the share of the potentially available amount of water and thus to improve productivity both in situ and on a watershed basis.

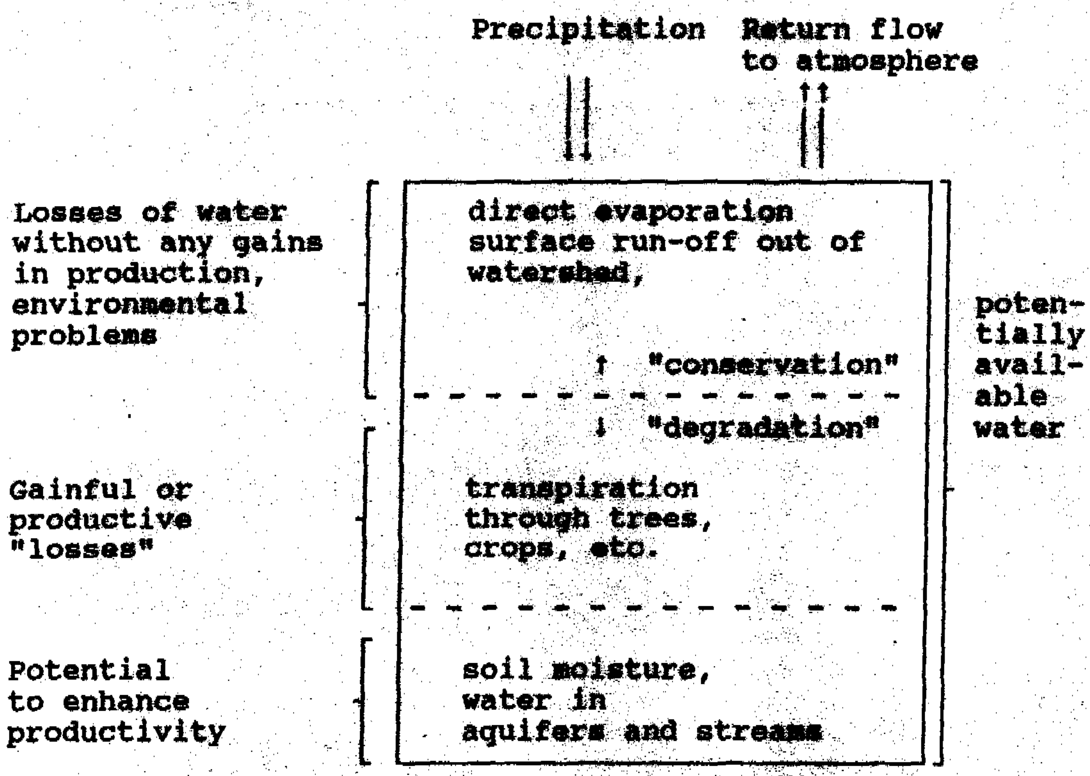


Figure 1. A simplified illustration of important water balance parameters for a (small) watershed and how they can be labelled with regard to their importance for development (and the environment). "Conservation" refers to S&WC but also to the effects of "appropriate" landuse.

The distinction between productive and unproductive water is important in discussions about water resources conservation and management. Far too often the emphasis is on management of the amount of water that is supposed to be available in reservoirs, wells, etc. But the amount of water that is available in a particular reservoir or tank varies considerably from year to year. In addition to the naturally given fluctuations in water availability, the large scale changes in landuse that occur in many parts of Tamil Nadu and elsewhere, may significantly affect the amount of water in streams, reservoirs, wells, etc. in downstream areas. It is therefore of paramount and increasing importance that water resources conservation and management is done on a watershed basis.

Changes in landuse will not only affect the amount of water available for different purposes but also its temporal and spatial distribution. Figure 2 illustrates an assumed principle difference in hydrographs for denuded areas (I) and areas with forest cover (II), that is, the distribution of stream-flow and base flow over time. The assumed difference is important in two respects. One is that the dry season flow is often better in watersheds with an appropriate forest cover as compared to watersheds with degraded and denuded forest areas. Another important feature is that although the total annual water yield may be higher in a non-forested area, the capacity to store the heavy streamflows (in tanks, reservoirs, etc.) might be insufficient (I). The result is that some of the water flow will not improve the overall availability but will instead contribute to erosion and flash floods. The problem of surface storage is, of course, reduced if more water can infiltrate through the ground surface and be stored as groundwater.

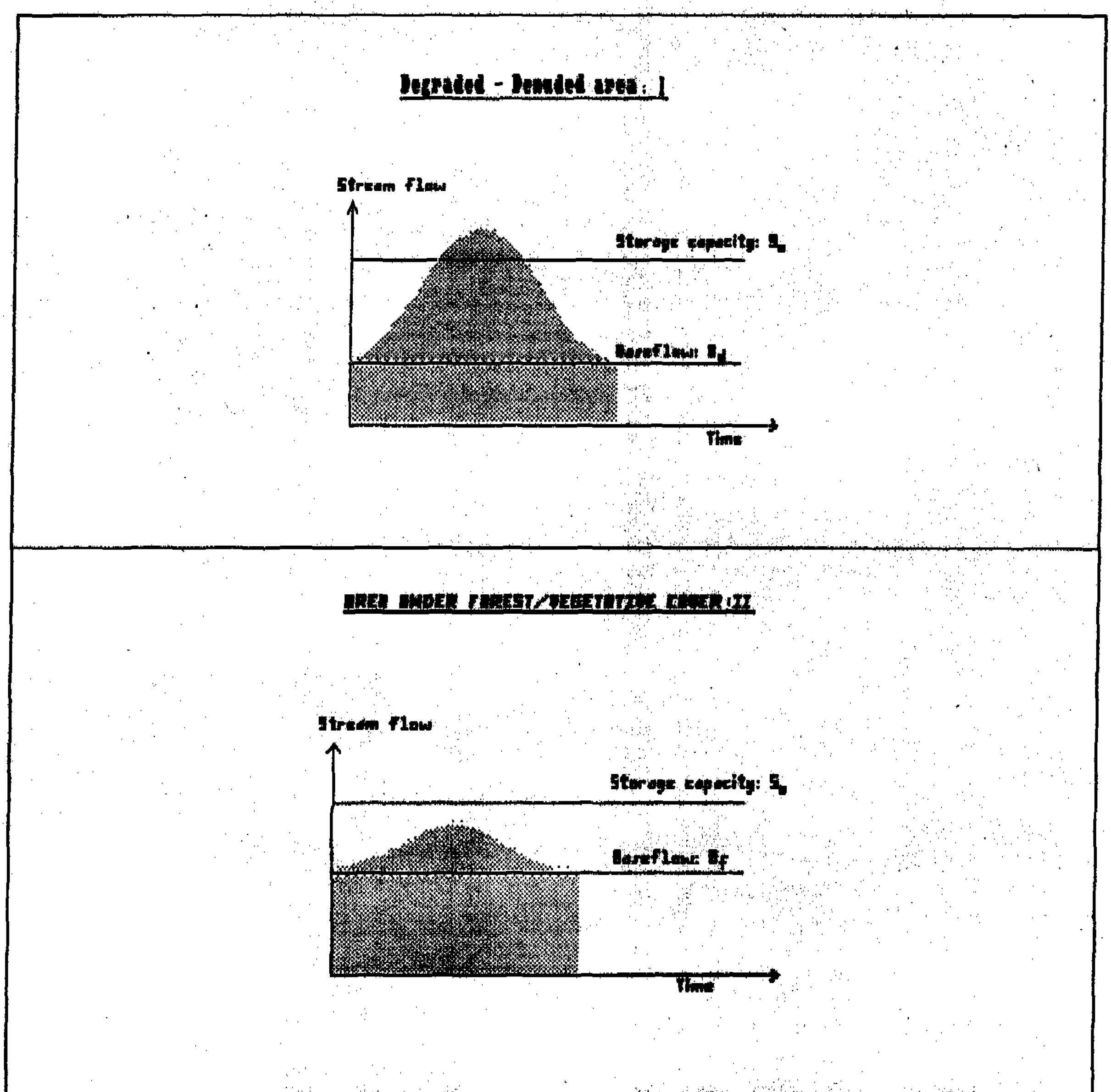


Figure 2. An illustration of presumed principle differences on streamflow (water yield) in a degraded area (I) and in an area with an appropriate forest cover (II). It is assumed that baseflow is higher in the forested area as compared to the degraded area.

The distinction between unproductive and productive losses as made in Figure 1 must also be seen in a geographical perspective. What is run-off from one area is run-on to other areas. To the extent that run-off will not go to the sea, run-off represents a loss only with regard to a particular area over which the rain falls. In Figure 3, some key components of the hydrological cycle are presented in relation to up-stream and down-stream areas of a landscape. With reference to the discussion above, a reduction in the run-off will mean that there will be more water in one segment of the watershed, that is, the up-stream location whereas the down-stream part of the watershed will be getting comparatively less water. Similarly, if more of the water is consumed in the upper segment of a watershed, there will be less water available for various purposes in down-stream areas.

The discussion concerning water availability in up-stream versus down-stream areas and what constitutes the most desirable productive use of scarce water resources is relevant in watershed development programmes (see further in 3.3).

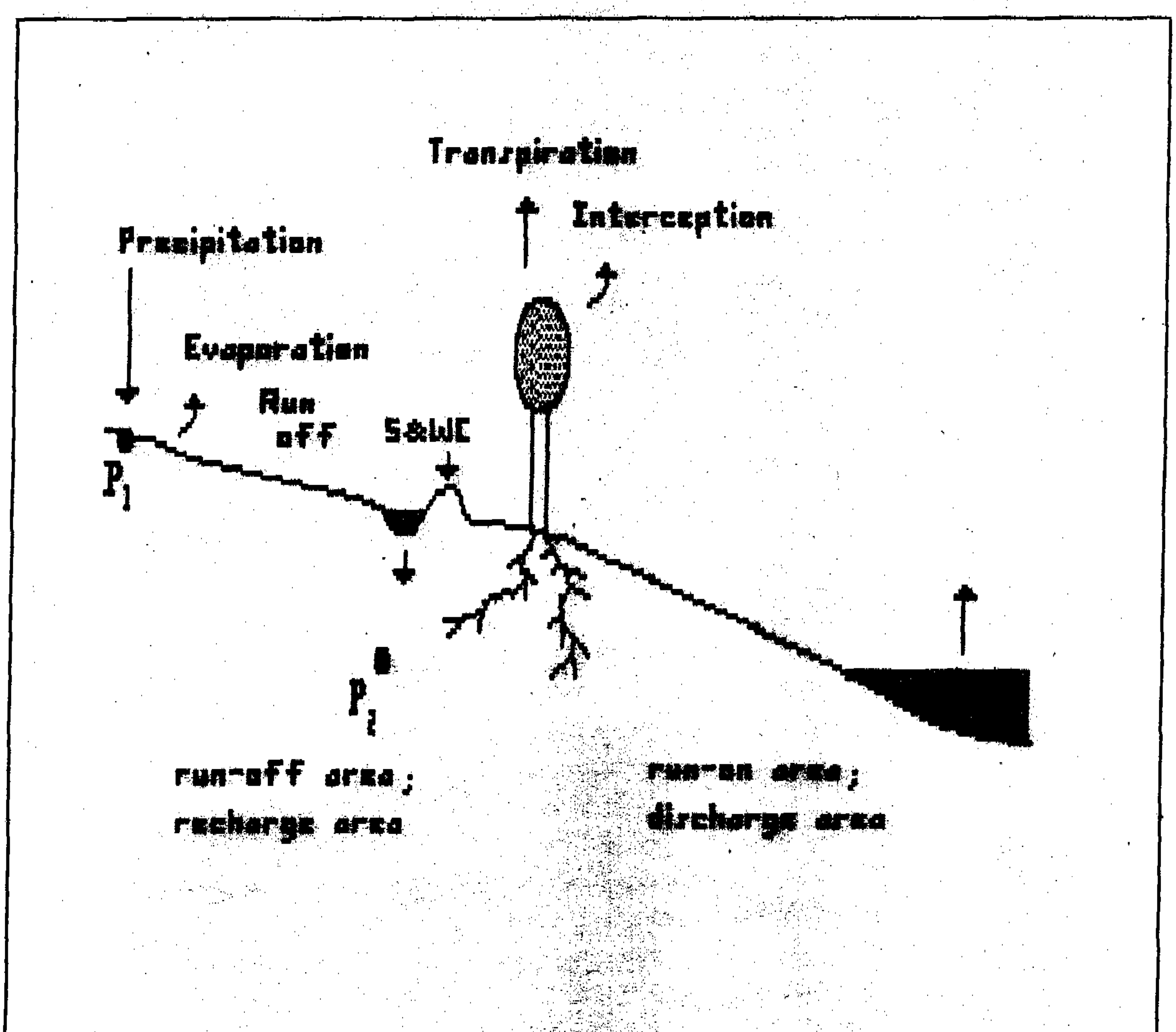


Figure 3. A profile of a watershed with some key water balance parameters. P_1 and P_2 are the two partitioning points for water.

3.3 Spatial and Temporal Aspects

As discussed above, water availability could be seen at two main spatial levels, e.g., a) the *micro-environment* around the plant, and b) the watershed. For an efficient improvement of water availability, the proper siting and engineering design of various S&WC measures are important (see appendix 2 for details of various in situ S&WC measures). In principle, the in situ S&WC can be carried out anywhere in a watershed but should consider slope and contour of the site around the plant. For S&WC on a watershed basis, the siting of check-dams, percolation ponds, etc. should primarily be in the middle and upper portions of the watershed, that is, in the water recharging segment of a catchment (Figure 4). The sites must also be chosen with due regard to drainage network, soil type (coarse material to allow infiltration) and similar landscape engineering considerations.

The water recharge areas of watersheds will, in general, coincide with the RF or other forested areas (Figure 4). By combining and concentrating S&WC measures and afforestation programmes in the water recharging areas, the SF will, hopefully, have two positive effects. It will regenerate the natural vegetation and the forest and it will arrest soil erosion as intended. But how will it affect the water discharge areas, that is, the flow of water to the down-stream, "buffer zone"? In a study of Allikuli IFF programme (Lundqvist, Sivanappan and Ramakrishnan, 1991) we found a unanimous claim among farmers and officials that water availability in the wells in the "buffer zone" had indeed improved as a result of the IFF recently carried out in the area.

To what extent this view referred to S&WC works or the regeneration of the natural vegetation and afforestation is difficult to say. According to our knowledge, there is virtually no fear on the part of farmers of a diminishing amount of water for agriculture or households within a watershed, as a result of IFF or SF in general. Similar views have been forwarded by people involved in other IFF's.

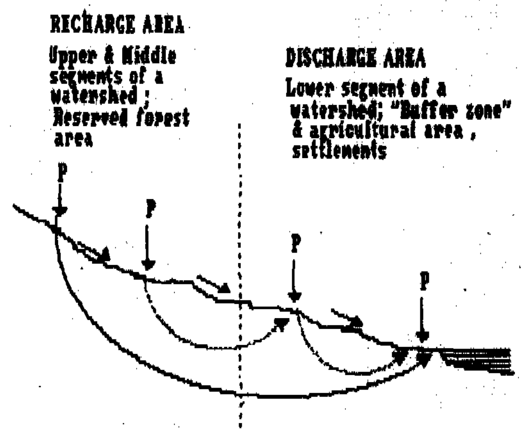


Figure 4. A schematic presentation of water recharge and discharge segments of a watershed.

These views are, of course, of significant importance for a support from the local communities where the SF are to be implemented. Supposedly, they will also facilitate the future management and protection of the projects which have to be carried out largely by the local communities. But in view of the findings reported from various studies (see appendix A) that afforestation will, in fact, reduce the streamflow including its base flow, it is relevant to have a second look at the long-term consequences on water resources from large-scale afforestation programmes.

In agreement with the general assertion among farmers and many Department officials, we may assume that the availability of water during the initial stages of a IFF in wells on a year 'round basis, will improve as a result of IFF. (Unfortunately, this assertion can not be substantiated for Tamil Nadu due to lack of baseline data and monitoring programmes). The improvement could be a result of the three treatments mentioned under 2.2 above.

Although it is quite logical that water availability will improve more or less immediately as a result of the S&WC measures, the long-term effects from the other SF activities are more uncertain since water uptake and transpiration by the growing trees will increase gradually. A pertinent question is if water availability in the "buffer zone" and also in areas outside a particular watershed, will continue to be above the level before the SF projects? If the afforested area is large in relation to the agricultural area in a watershed, it will mean that most of the rainwater will fall over the forests. And if a regenerated forest will consume the precipitation that falls over the forest area or most of it, nothing or little will be left to recharge the aquifers. If that scenario would come through, the post-project water availability is likely to be below the pre-project level (Figure 5). In other words, what is the appropriate (optimum) design of SF programmes with regard to an increase in overall watershed productivity?

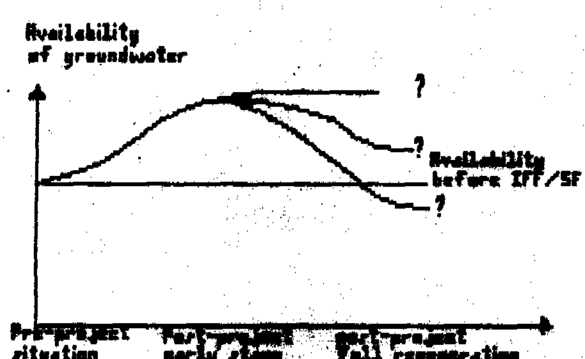


Figure 5. Illustration of the assumed long-term effect on water availability in downstream areas as a result of SF including S&WC.

3.4 A Note on Farmers' Views on Water Availability

Farmers have a solid and practical experience from real life situations. And they don't have to worry about sophisticated theories and established points of view to make up their minds about what is good for them and what will affect them negatively. For this and other reasons, their views should be taken seriously. Although there are reports of farmers having uprooted seedlings, fearing that they will reduce water availability for their farming activities and also objected S&WC in upstream locations of watersheds, a much more widespread positive attitude to tree planting and in particular to a combination of tree planting and S&WC seems to prevail among them. The views expressed by farmers in Allikuli is one example (Lundqvist et al., 1991), and there are others from various parts of India and other countries.

It may be that the farmers are right. Are the skeptical views of forest hydrologists on reduced water availability as a consequence of afforestation programmes perhaps a result of special cases which have limited validity? (Depending upon tree species and other circumstances there are cases when afforestation will consume the total rainfall and even "mine" soil moisture and ground water. See, for instance, Institute of Hydrology, 1991).

But there are also circumstances that could lead to a biased opinion among farmers. First of all, farmers' knowledge and views basically reflect what they have experienced. We should not expect that their knowledge extends to issues on which they have no direct experience. It is probable that when the farmers grew up some twenty, thirty or forty years ago, and thus established their basic world view, the forest cover was more dense than it is today. On a per capita basis, the availability of water was also better. The tremendous increase in population is probably not realised or seen as a problem at the village level. When comparing the situation of the past with the current one, it is perhaps quite natural to believe that there was a functional relation between forest cover and water resources in "the good old days". Now the forests are severely degraded and water supplies are a recurrent problem. On top of this, there is a lot of talk on the need to afforest the state and all the positive results it will bring. The farmers do, of course, also know that SF means transfer of resources to them. So why speak against it?

3.5 Forests Consume Water but Bring Rains?

It is not only the farmers who argue that afforestation will improve water availability. The Forest Department has, for instance, put up signs along roads saying that "Forests for rains, rains for food". During visits to various parts of Tamil Nadu and in discussions with people at State Departments, farmers and also colleagues at Universities, the view that forests will bring rains has often come up. Similarly, a very common argument is that in "the old days" when there were comparatively dense forests there were also perennial streams, which, unfortunately are not often to be seen these days. A more detailed or scientific explanation for the connections between landuse, precipitation and streamflow is, however, not presented. These are extremely complex interrelationships about which a proper explanation is largely lacking. Moreover, any possible change in precipitation amount or pattern must be interpreted in relation to large scale conversions in land use and also for quite extensive periods. It is beyond the scope of this report and my capacity to try to interpret the supposed connections between forests and rainfall. Some points could, however, be mentioned.

With a large-scale afforestation programme (or other large-scale changes in landuse), the micro-climate will be affected over extended areas. The energy balance (the albedo; the share of solar energy that is returned back to atmosphere) and the heat gradient in the soil profile will change. A vegetated area will take up a larger proportion of the solar energy as compared to barren land and will not loose it as quickly as denuded areas. Degraded areas are thus characterized by a high return flow of energy and the temperature variations in the soil both over time and in the profile are more pronounced as compared to areas with more dense vegetation. The energy balance varies thus depending upon land use and these variations are associated with differences in air movements (wind velocity, vertical movements). Similarly, the composition of particles in the air, which are important as nuclei for vapour condensing to raindrops, will vary depending upon landuse and vegetation cover. At some stage, the precipitation pattern and perhaps precipitation amount, may change.

According to studies made by colleagues at French Institute at Pondicherry (Meher-Homji, 1988) based on data primarily from Karnataka and Tamil Nadu, it is suggested that changes in afforested area may lead to changes in precipitation pattern whereas the amount of rainfall is less likely to be affected. According to the result of the analyses, a deforestation tends to lead to a reduction in the number of rainy days and to a more intense rainfall since the total amount of rainfall does not seem to be so much affected. Rainfall pattern and intensity are of crucial importance since they are related to erosion, runoff and directly and indirectly to the extent of wet versus dry periods of the year and thus to crop survival. Other studies analyzing long-time series of precipitation from various parts of India have, however, concluded that variation in rainfall is rather due to random variations in rainfall (Mooley and Parthasarathy, 1983).

4. RESEARCH ISSUES - WHAT TO DO

4.1 A Note on Research Criteria

The important task for the R & D cell is to promote research which can be translated into action and to use research results as a corrective to on-going SF activities. Although general criteria of research would apply to any kind of research endeavour, it is of paramount importance in this research to arrive at some tangible results within a reasonable period of time. In fact, a number of SF activities are going on in the field but the very organization and collection of data from the various sites is neglected. Systematically collected empirical information from the field with a certain degree of general validity for SF is thus hard to come by. As mentioned above, it is not only the monitoring of ongoing projects and their effects that need to be looked into. It is equally essential to have baseline data which unfortunately are largely missing.

As expected, it is easier to find results from detailed and elaborate studies under controlled conditions. In general, the availability of data and information, official as well as from researchers, and also their dissemination, is poor. With regard to the issues discussed in this report, reliable and systematic measurements of precipitation, soil moisture, ground water, water consumption (of trees or forests), landuse and landscape features are required. Socioeconomic information collected with empathy on farmers' acceptance of programme idea, management skills, etc. is of equal great interest.

Valid information is as important as accurate measurements. Too elaborate measurement programmes tend to compensate for the absence of valid research issues and also delay the presentation and interpretation of results. However, it might be "better to be approximately right than to be precisely wrong". Once the design of a research programme is done by competent researchers, much of the work can be carried out by local communities, NGO's, students at various levels, etc. There is nothing mysterious about reading a rain gauge regularly and writing down some figures on a pre- prepared table or collecting information about vegetation type or density, etc. It is more tricky to acquire valid information on socioeconomic conditions. In any case, it is important that data collection is done with a sense of critical observation and scrutiny of available data.

In accordance with this research concept, it would be fruitful to ask, for instance, NGOs and students to summarize data in tables, to comment them, etc. The main interpretation and dissemination of the results, again, requires competence which is presumably not readily available among those collecting the information (see more about organization of research in chapter 5).

4.2 Brief Outline of Potential Research Issues

As indicated above, the impact on water resources from the various treatments of SF is a composite of various effects, some of which are immediate while others materialize only gradually; some are to be studied in a micro-perspective, others on a watershed basis or even a basin-wide basis; some are fairly well comprehended whereas others are subject to contradictory views and limited empirical substantiation. The long-term perspective which is needed to evaluate the result of a given afforestation programme poses special methodological challenges. The only practical option seems to be to design a study (studies) to cover areas where the forest is under different stages of growth, density, composition etc., so-called paired studies. Another important issue is what conclusions can be drawn as to the effects of certain treatments in a watershed where not only the treatments but a number of factors may (co-)vary. The availability of water in the well of an individual farmer might, for example, be affected by SF activities in the watershed but also if his neighbours dig more wells or deepen existing ones, if they draw more water, etc.

Several research issues and approaches could, no doubt, be worked out. Some of them are briefly outlined below. The outline is by no means supposed to cover all the intricate aspects. Hopefully, it will serve to feed the discussion about what would be relevant and realistic research with regard to the needs of the parties concerned (R & D Society, FD, AD, DRD, R & D Cell, NGOs, Swedforest).

With reference to the definition of water availability and what factors influence it (chapter 2), it seems relevant to identify issues that should cover water resources-SF interactions at three geographical levels: i) the micro-environment, ii) the watershed, and iii) the State or basin-wide level.

I. An analysis of precipitation amounts, geographical and temporal pattern is a basic component for studies on all the three geographical levels mentioned above. With no information about precipitation, no inferences can be made about the forest- water interrelationships (F/WI).

* At the micro-level studies should be designed to identify how effective various S&WC measures are with regard to the survival rate of seedlings and/or crops. Several factors affect survival rate, of which moisture deficiency is a significant one.

* Analyses of surface water runoff and soil loss under different landuse types is another issue that can be taken up in sample plots with various treatments and under various slopes.

* Watershed based studies to assess the main water balance parameters and how they are affected over time with changes in land use/afforestation. Monitoring of IFF programmes would be appropriate. Baseline data are required. (It is, however, problematic to determine the baseline since the situation at the initiation of a SF might not be representative. With due consideration to cost, a baseline survey should consider "the average situation" but also the variation over time). Special concern should be given to monitor changes in groundwater recharge and water withdrawals.

* Studies on a state or basin-wide level are a challenging task. Since changes in vegetation cover and landuse at this level must be seen as gradual and their effects on micro-climate and rainfall obviously are complex and comparatively small in quantitative terms (although they may be quite significant from a water resources point of view), time-series of rainfall data for many stations would be useful. A search for any systematic relationship between changes in precipitation pattern and amount on the one hand and changes in landuse on the other is important. This research issue is a truly inter-disciplinary one, in which meteorology, hydrology, physics, remote sensing and geography could give valuable contributions.

II. The studies indicated above require empirical information from the field. In addition to such studies, it is relevant to promote studies under experimental or controlled conditions.

* It is, for instance, important to get details of tree-water interactions: a typology of trees with regard to increment of biomass per mm of water, drought resistance, rooting pattern, etc. (cf. the intense debate about eucalyptus).

Similarly, studies on the performance of various combinations of trees and crops are needed for the agroforestry programme. New technologies to reduce transpiràtion by use of antitranspirants: how efficient are they and can they be used by the ordinary farmer? Biofertilizers? Allelopathic effects?

III. As a complement to the studies indicated under I and II, it is of significant relevance to take up studies which deal with these issues as seen from the farmers and from other groups of people involved in SF activities.

* Identification of the most widespread view on the presumed effect of SF on water resources and how they are constituted. What is the main message of the Forest Department (FD)? What is the dominating view of the farmers? From where do these views originate (textbooks, experiments, or elsewhere/nowhere)?

In any case, it is of interest to look into the rational, persistence and spread of the dominating views on the F/WI. This is important for a policy analysis but it may also give some clues for a better understanding of the F/WI and for the design of field measurements. Farmers' views may serve as an entry point for identifying and posing relevant questions.

* Calculations of socioeconomic benefits and costs. SF is supposed to cater for essential livelihood needs of the farmer communities and at the same time improve environmental conditions. A lot of financial and human resources are invested in these programmes and scarce natural resources are allocated to specific uses. Although forests can produce a wide range of utilities (timber, fuelwood, fruits, honey, environmental, etc.), SF will preclude alternative resource utilization options. So what are the opportunity costs, if any, of SF projects, to what extent and in what areas will a protection of the natural vegetation achieve the objectives? What are the long term benefits? What will be the implications for tenure, price of land and willingness to invest, etc.? Who are the winners and how can "the unreached" be reached and benefit from these programmes? What significance will forest produce have in the future in the village based economies and in the regional/national economy? According to a study carried out by Institute for Social and Economic Change (Ecology-Economic Unit), Bangalore, the economic benefits outnumber the economic cost by several multiples (Nadkarni et al., 1991). The calculations are, however, made for a long period, upto 50 years after the commencement of a project. In terms of the acute socioeconomic needs, we need to know what are the tangible results in a shorter time perspective. Needs can not be postponed.

The economics of water and, indeed its management and allocation between various groups, uses, etc. is a highly relevant research topic since it is a scarce resource with a number of alternative allocation options.

A summary of some potential research issues and how they can be characterized:

	State of Relevant knowledge for SF; What can actually be found out?	Resource persons; in Tamil Nadu, India, Sweden, elsewhere	Time before results can be expected	Non-compartm. research
I				
II				
III				
.				
.				
.				

5. ORGANISATION OF RESEARCH - HOW TO GET IT DONE

The response to a letter sent by Dr. Sivanappan to 44 different Universities/institutions, Govt. Departments, NGOs and private companies/individuals, asking them to state whether or not they were engaged in relevant research work and/or if they were interested to continue/take it up, shows that there is quite a keen interest. It also showed that the competence covers many relevant aspects. At this stage, there seems to be two important aspects to consider. One is the advantages of facilitating linkages and exchanges between interested people into a coherent programme. As it is today, there are limited contacts between the institutions and individuals who are doing research on the concerned issues and/or who want to contribute.

The other aspect is how to involve other people than the qualified researchers in the research, that is, NGOs, community representatives, students, etc. In other words, it is of interest to stimulate research with respect both to horizontal and vertical considerations. The way that research is organized will also be of relevance when it comes to the translation and dissemination of the results to the proper target groups (see chapter 5).

5.1 Three Principle Ways to Organise Research

The following three types of organization are presented as an illustration. Two of them are common today (B & C), while the first one (A) came up in discussions at the Society.

A. A Core Group (or core groups) consisting of a few resource persons (probably not more than 3 - 4 persons) competent in relevant disciplines/fields who take on the responsibility to i) design a research programme (in collaboration with the R&D Society), ii) organize the collection of information with the help of, for instance, students from the polytechnics, NGOs and schools, and, iii) analyze and interpret the information. Write-up of a common report would be logical but publication of results could be done more on an individual basis. Probably it is appropriate to appoint one person as the principle researcher.

B. Network of researchers/institutions. Compared to A., this model could include many researchers/institutions. They should work on a common research programme with defined tasks but they would be more free with regard to how they choose to carry out the actual research. Regular meetings and exchange of ideas and results would be productive in this model as well as in A. A contact person who takes on certain coordinating functions should be identified.

C. Individual researchers, the "same procedures as last year" version. This is the most practised model where individual researchers submit applications to funding agencies and compete for funds on basically scientific criteria.

The three models are not clear-cut in reality. Combinations and modifications can certainly be found. They have their limitations as well as strength. While A & B will facilitate the cross fertilization and blending of various disciplinary views and results, the C model may be more efficient to deal with details. A and B will probably also need more time to function properly. To function properly and to achieve the objectives, it is necessary for A & B to have a clear focus of the research issues, who should do what, etc. For both A and B it is logical that some research theme(s) is identified by the funding agency. A strong organization is required and, hopefully, members who are committed to joint efforts.

6. LINKING R & D

Research results can be presented and distributed in various ways. To link research with development, it seems necessary and efficient to translate and disseminate the messages of the research to three target groups. They include:

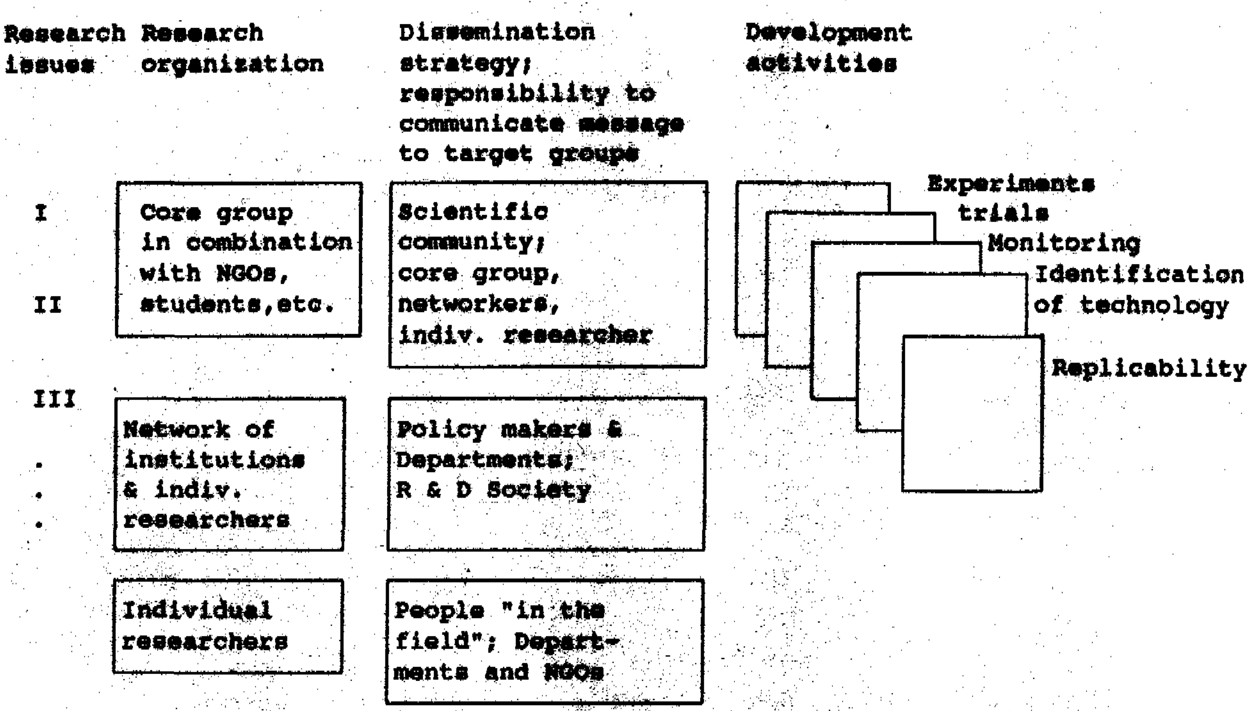
(i) People in the field, including NGOs/VOs

(ii) Policy makers and extension department staff, and

(iii) Scientific community, the media.

In getting the message across to the target groups, it is natural that various groups of people do the "translation". For the scientific community, it is logical that the "core group", network members or individual researchers publish the results, attend scientific meetings, etc. For the second target group, it seems natural that the R & D Cell assumes this crucial task. Finally, the spread of the message to the people in the field should be a responsibility of the Departments and NGOs.

In the following graph the discussion in the report is summarized:



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APPENDIX A.

FORESTS AND WATER RESOURCES - STATE OF KNOWLEDGE OR STATE OF VIEW?
(Comments to selected literature.)

A.1 Allegations of the "four M's"

In a state-of-knowledge publication by Bruijnzeel (1990), Lawrence S. Hamilton writes in the Foreword:

> In spite of valiant efforts of a small band of scientists who have attempted to dispel the misinformation, misinterpretation, misunderstanding and myth about the role of forests with regard to hydrology and erosion, and what happens when the forest is altered or removed, many of these "four M's" still continue to dominate popular and political thinking. This applies especially to tropical humid forests, which seem to automatically put emotion into command over reason.

In addition, the discussions and analyses on the impact on water resources from major conversions in land-use are hampered by "semantic fuzziness" (Hamilton and King, 1983, 131). The quotes refer to the intense and rather confusing debate about the role of forests with regard to water balance parameters like ground-water recharge, flood moderation and dry-season discharge (baseflow). Hydrologists concerned about the implications of forests on hydrological parameters and represented by "the small band of scientists" tend to argue that deforestation has a positive effect on annual water yield and also, although with less emphasis, dry season flow. The main reason is the large reduction in (evapo)transpiration as a result of stripping areas of their forest cover.

> All available research work indicates that there is an increase in water yield when forests are converted to grassland. ... . All catchment studies involving partial or total conversion of forest to annual cropping have shown increased yield in annual streamflow. These increases usually occur throughout the year but especially during the dry season (ibid., p. 74 and 102).

Conversely, reforestation (planting of trees in areas previously without forest) "... usually leads to decreased water tables, with effects most pronounced in the dry season" (ibid., p. 113). The same principle view is presented in a state-of-the-art report summarizing the result of studies carried out in 94 catchments in various parts of the world. It is concluded, that areas under forest cover yield less water both in terms of surface runoff and groundwater recharge than do grasslands (Bosch and Hewlett, 1982). In a report by the Water Authority of Western Australia (1989), it is shown that clearing the virgin vegetation leads to rising groundwater table. A special point is often made with reference to water consumption of eucalyptus. The debate in India in this regard is all too well-known and does not need to be recapitulated here.

There are thus quite a lot of scientific data in support of arguments that afforestation or reforestation will lead to a reduced water availability on a watershed basis (as defined in 2.2). A number of studies carried out in, for instance, South Africa (Bosch and Hewlett, 1982; Department of Water Affairs, 1986) and in Australia (Batini et al., 1980) show a direct correlation between percentage reduction in forest cover and percentage of river discharge. Others have presented detailed data on the changes in water yield with changes in landuse: "Converting lowland rainforest land to well managed grassland or annual cropping may produce permanent increases in total water yield of 200 - 300 mm/year" (Bruijnzeel, 1990, 179), and "In the first year after clearing forest, streamflow increased by a maximum of 6 mm for each 1% of the area cleared" (Oyebande, 1988, 16). The latter quote refers to six tropical regions.

A.2 An Alternative View

But there are also studies indicating an opposite result from deforestation on water availability. (As far as I am aware, there are much less of documentation of afforestation in this regard). One case is, for instance, presented from Indonesia where deforestation led to a reduced dry season flow (Bruijnzeel, 1990). The reduced dry season flow was interpreted as a result of poor land management after deforestation. For India, Gupta (1980) has reported an "improved basin moisture regime and mitigated effects of droughts" as a result of afforestation in semi-arid areas. The most striking example of the devastating results on water availability from large scale deforestation is, however, the developments in the area around Cheerapunji in northern India. This area is famous for its world record of annual rainfall of some 10,000 to 13,000 mm. It has now acquired another epithet: "the wettest desert on earth" (Clarke, 1991). Major changes in landuse are obviously to a very large extent explaining the alarming change. "Even in Cheerapunji in Meghalaya today where the rainfall is highest in the world there is a drinking water crisis. Why? Because of denuded forest and our total neglect of natural resources" (Poojary, 1988). With regard to the consequences on rainfall from deforestation, the works of Meher-Homji (1980; 1988; 1991) are quite interesting and also relevant in connection with this report since they refer partly to Tamil Nadu. The findings suggest that deforestation on a large scale in inland locations will affect rainfall, primarily in terms of pattern (less number of rainy days - more intensive downpours) but also a tendency of less amounts. Other studies for India do, however, indicate that variation in rainfall as seen over long periods, is rather the result of a random distribution over time (Mooley and Parthasarathy, 1983).

No wonder that the debate is fierce and confused. The complexity and the number of issues involved and the tremendous variation, makes a review impossible in this brief account of some major arguments. Summing up the discussion, it might be useful to refer to Figure 5 presented in the main text. It illustrates the main components of the hydrological cycle and how they may be modified by land-use. With reference to the discussion above, a major feature of a forest (trees) is the impact on the two partitioning points (P1 and P2). Forests will in general facilitate an increase in the infiltration (at P1) but will also take up part or all of the infiltrated water (at P2) and transpire water back to the atmosphere. If the water uptake by the roots is big in relation to the infiltration little or nothing will be left for recharge of the aquifers (see further in Falkenmark et al., 1990; Falkenmark and Lundqvist, 1992). As indicated from on-going research in Bangalore, there might even be (temporary) situations where the uptake of soil moisture exceeds the amount of precipitation (Institute of Hydrology, 1991). If, on the other hand, water uptake is less than the amount of water infiltrated, there will be a recharge of the aquifers.

Interception of rainfall is another significant component of the local water balance. In tropical forests, up to 35% of the rainfall may be intercepted by the canopy and evaporated back to the atmosphere (Bruijnzeel, 1990, 79). The configuration and the layers of the canopy are important not only for the interception but also to moderate the erosive force of rainfall.

A.3 Possibilities of Convergence of Views?

Two quite contradictory views are thus noticeable and both seem fairly well established. In one very important aspect, the possibility for convergence of views seems better, namely concerning the impact from deforestation on dry season (base) flow. Quite a number of studies have presented material showing that a diminished dry season flow is associated with deforestation (see, for instance, Madduma Bandara and Kuruppuarachchi, 1988; Eckholm, 1986; Myers, 1986).

Studies reporting a decreased base flow as a result of deforestation are particularly interesting since most of them refer to field situations whereas studies showing increases in base flow are based more on controlled conditions. Among those who are skeptical of a positive impact of afforestation on water yield, it is argued that the reduction in base flow in connection with deforestation ".. is not so much the result of clearing itself but rather reflects a lack of good land husbandry during and after the operation" (Bruijnzeel, 1990, 113). But where and to what extent do we find good land husbandry in the extensive areas that previously were under good forest? And even if that were to be case, to what extent will grasslands cater for the needs of the population in poor Third World countries?

A.4 Concluding Remark

There is convincing scientific evidence to suggest that in general forests tend to reduce the total, annual availability of water for other productive and consumptive uses on a watershed basis. It is less clear how dry season base flow will be affected. At the same time, there is also quite convincing examples of the devastating consequences for water availability on a year round basis of degraded forest areas. And there is reason to assume that with proper land management, including soil and water conservation as presented in the report (see appendix B), in combination with protection of the natural vegetation and selective planting of certain species of trees, it is possible to augment water availability on a year round basis also in areas outside the forests.

The lack of appropriate land and water husbandry in large parts of the semi-arid and arid parts of the World in combination with a poor and burgeoning population are very much the circumstances that constitute the scene today and in time to come. The issue is not that forest areas are converted to well managed grasslands or to other decided-upon landuses. The issue and the challenge is rather that previously rich forest areas are being tapped of their resources with a number of far-reaching socioeconomic and environmental consequences. This issue and challenge should be a basis for research on water resources and Social Forestry interactions.

APPENDIX B.

ILLUSTRATIONS OF MAIN IN SITU SOIL AND WATER CONSERVATION WORKS

Soil and water conservation (S&WC) and water harvesting should be constructed with an objective to improve the situation in situ and in a watershed. The following illustrations refer to in situ S&WC. Before in situ moisture conservation measures are taken up, the land should be provided by vegetative barriers or bunds along the contour lines.

Once a barrier is formed on the contour, it will guide the farmers to plough the land and to do other farm operations. Contour ploughing, cultivation and tree planting will also help in moisture conservation in dry lands.

After the area has been treated with vegetative barriers or bunds and planting and cultivation along the contours have been taken up, the following in situ S&WC measures may be practiced.

For agricultural crops and annual crops:

1. Forming ridges and furrows
2. Broad bed and furrows
3. Forming basins
4. Tie-ridging - random tie ridges
5. water spreading

For tree crops:

6. Micro catchment
7. Saucer basins or semi circular bunds
8. "V" ditch technology
9. Tie ridging
10. Catch pits
11. Deep pitching

The details are given in the figures on the following pages:

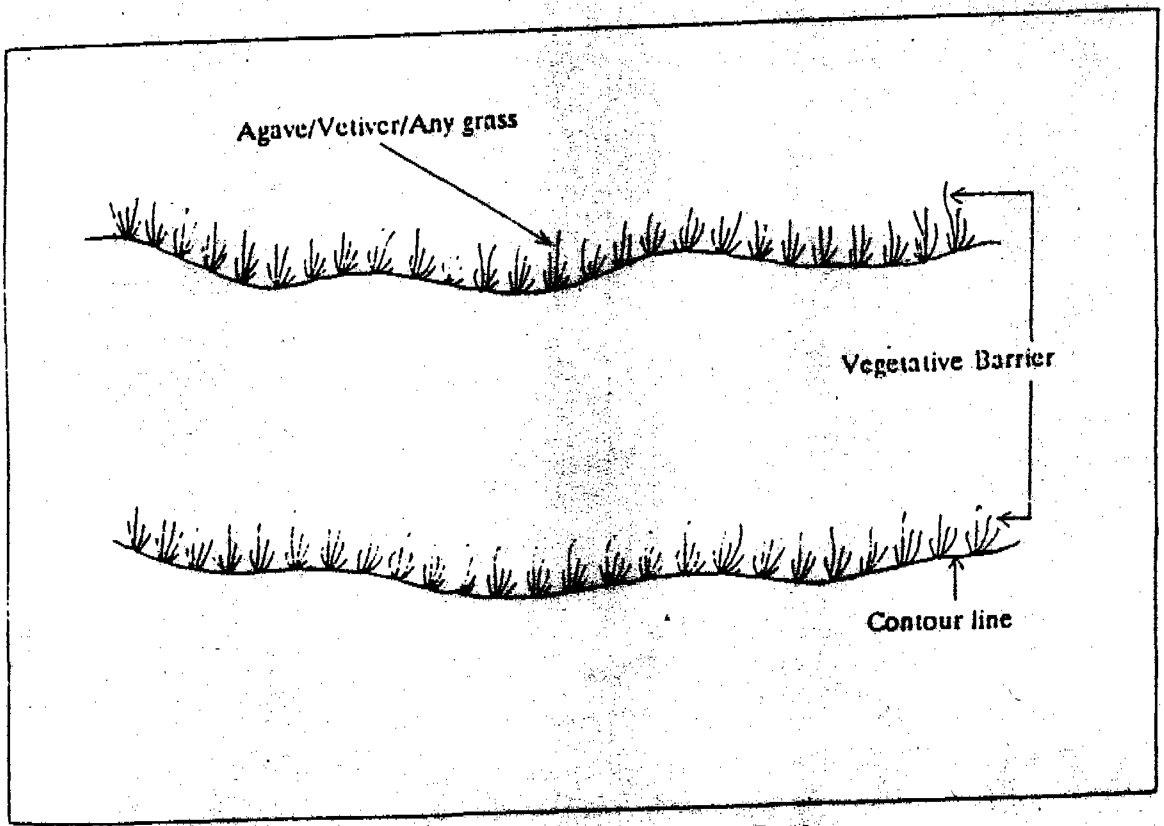


Fig.1 Vegetative Barrier on the Contour

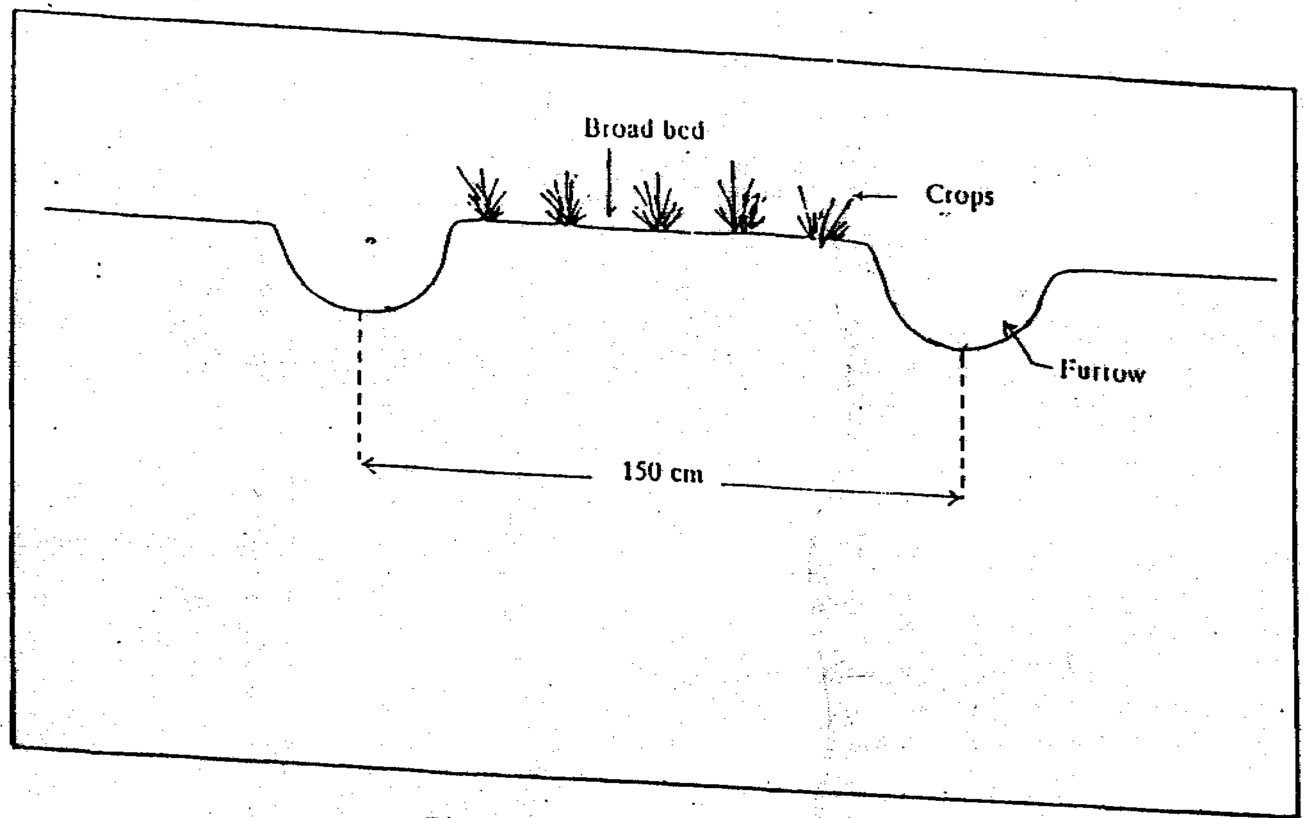


Fig.2 Broad bed and furrows

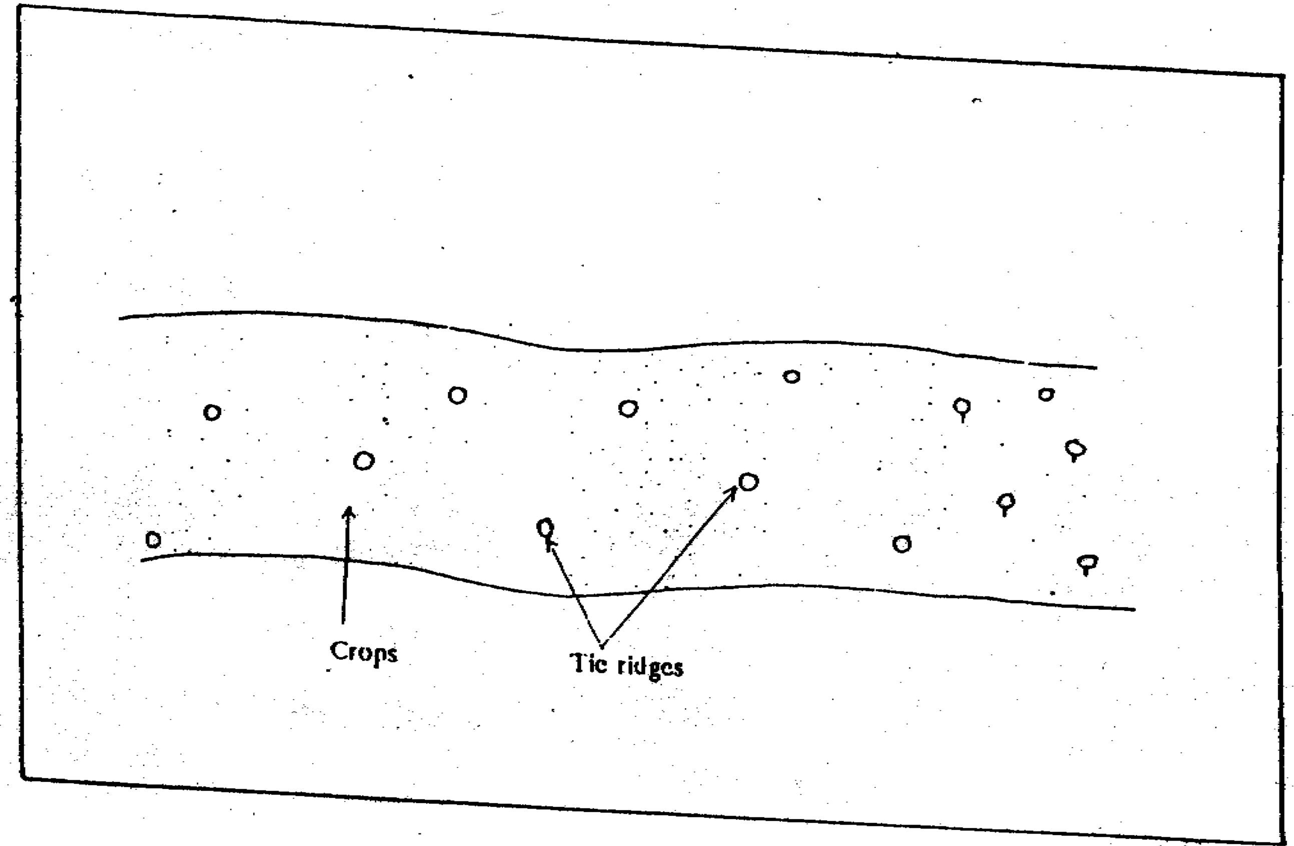


Fig.3 Tie-Ridging

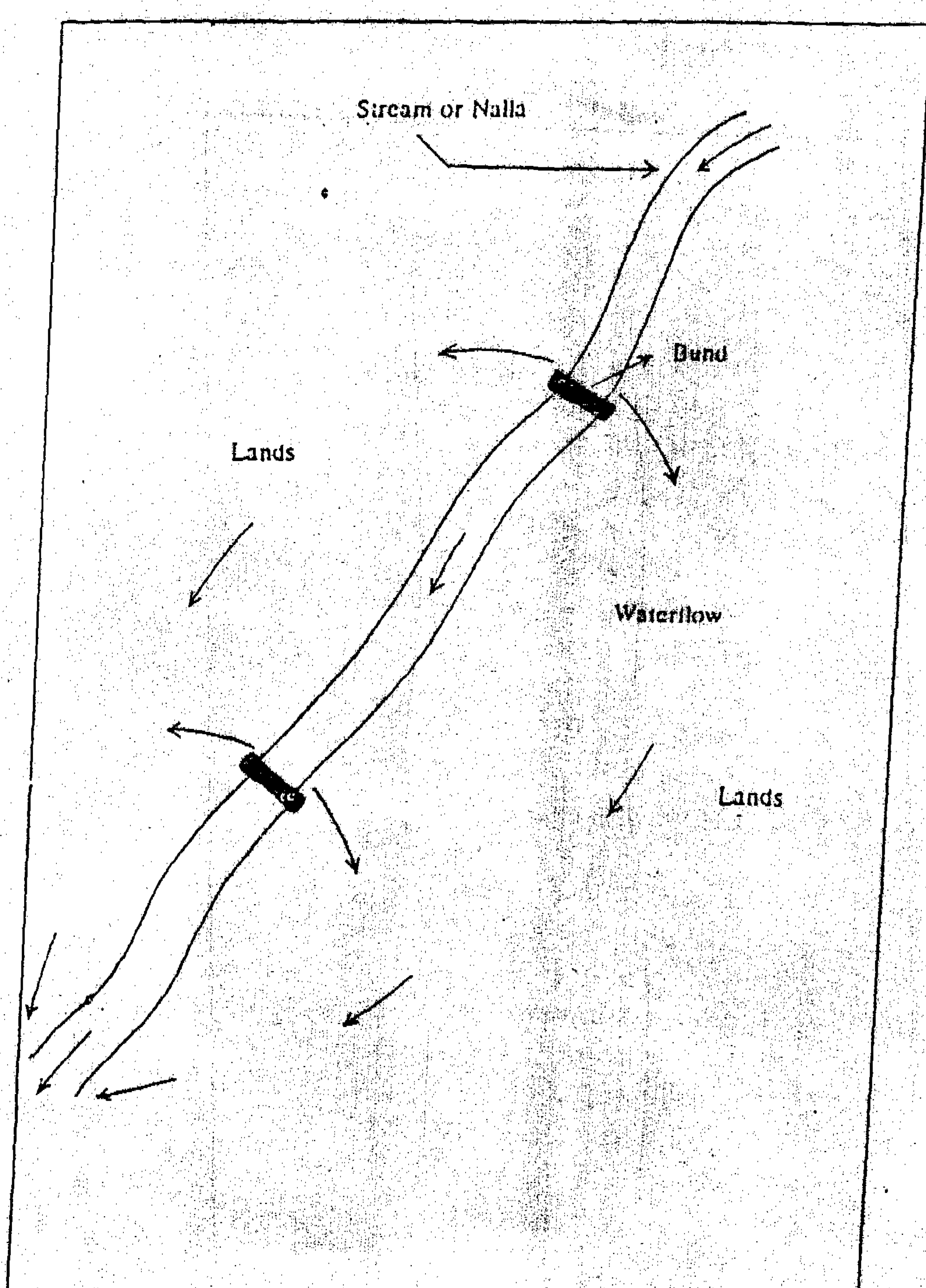


Fig.4 Water spreading

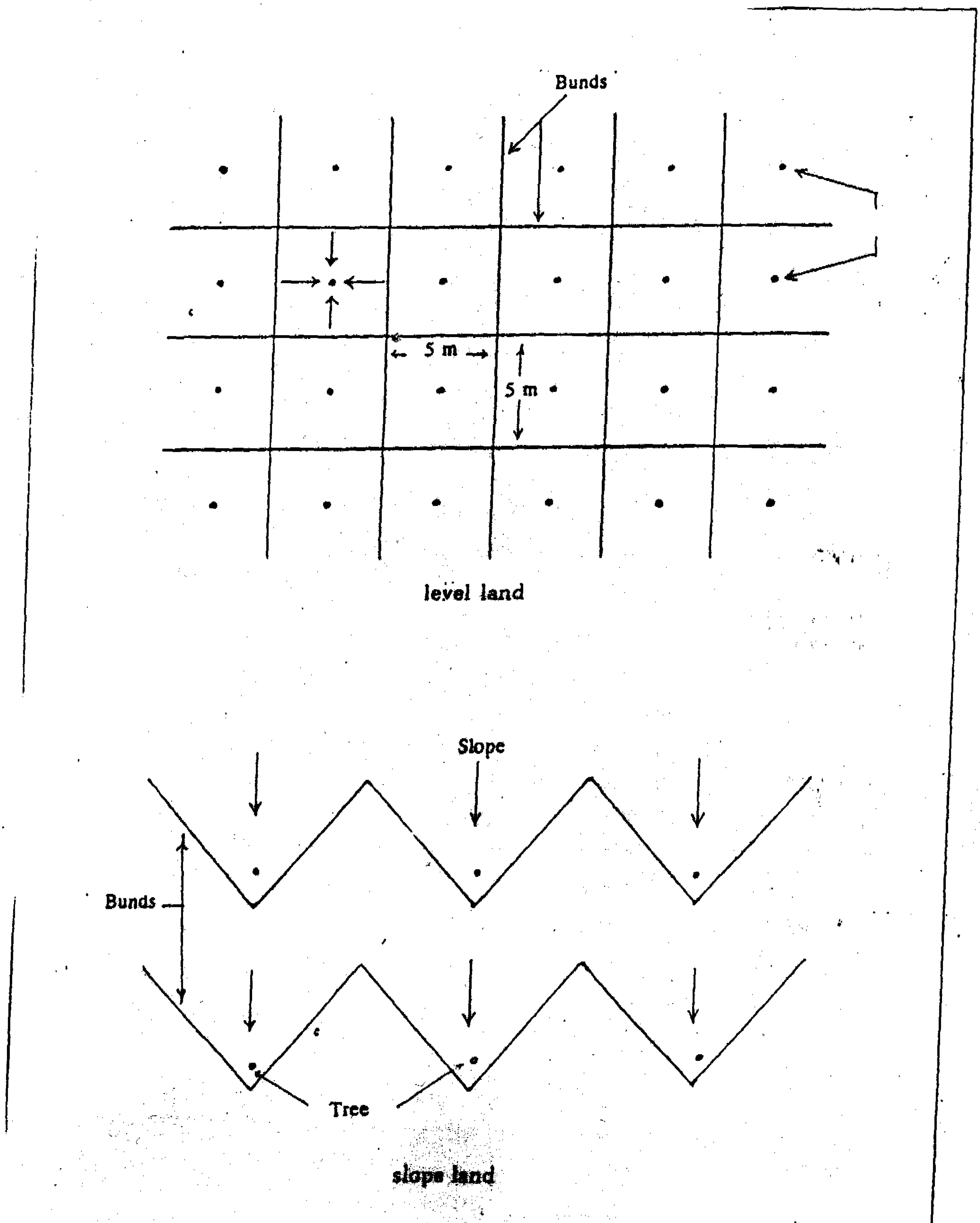


Fig.5 Micro catchments

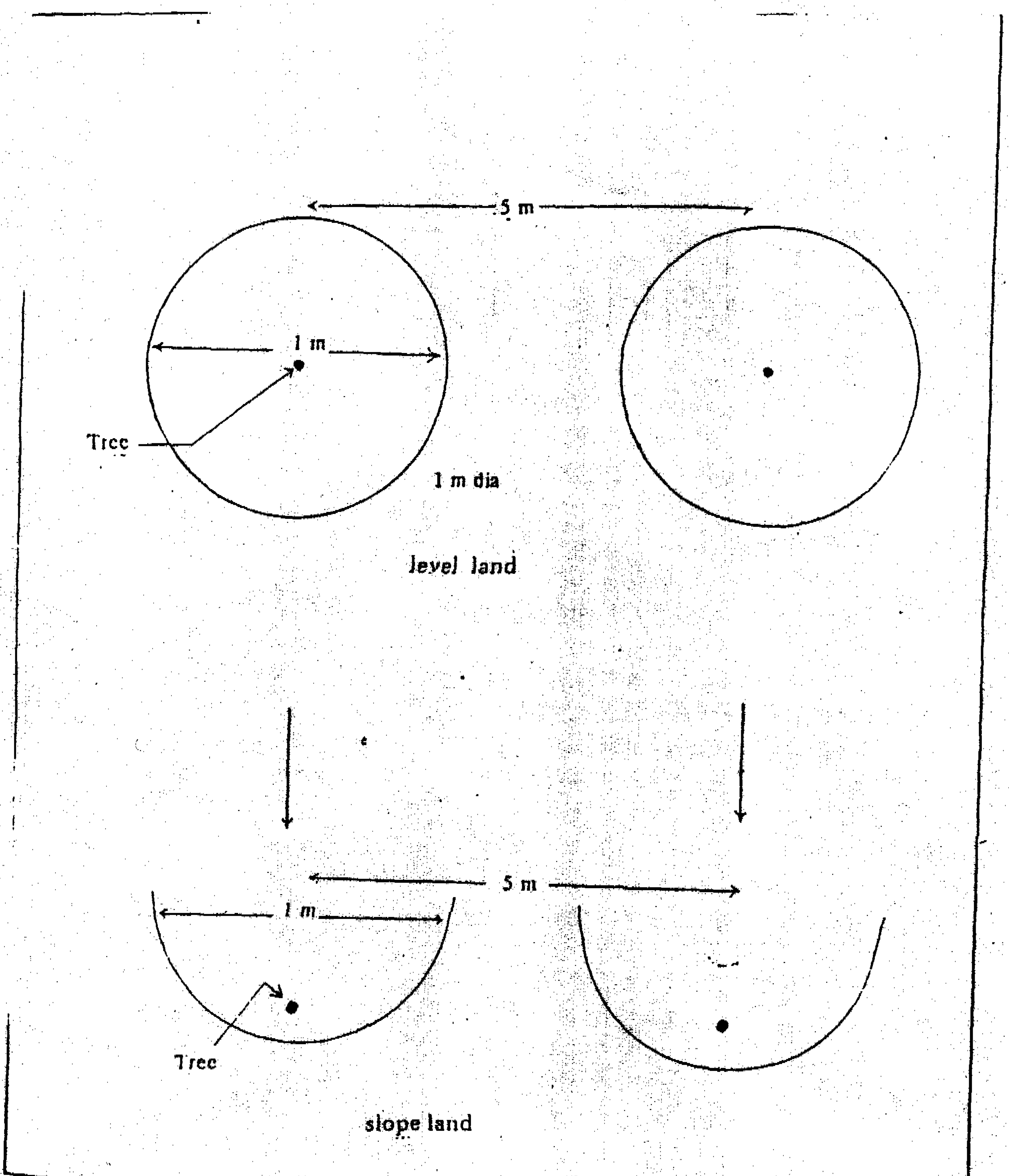


Fig.6 Saucer basins/Semi-circular bunds

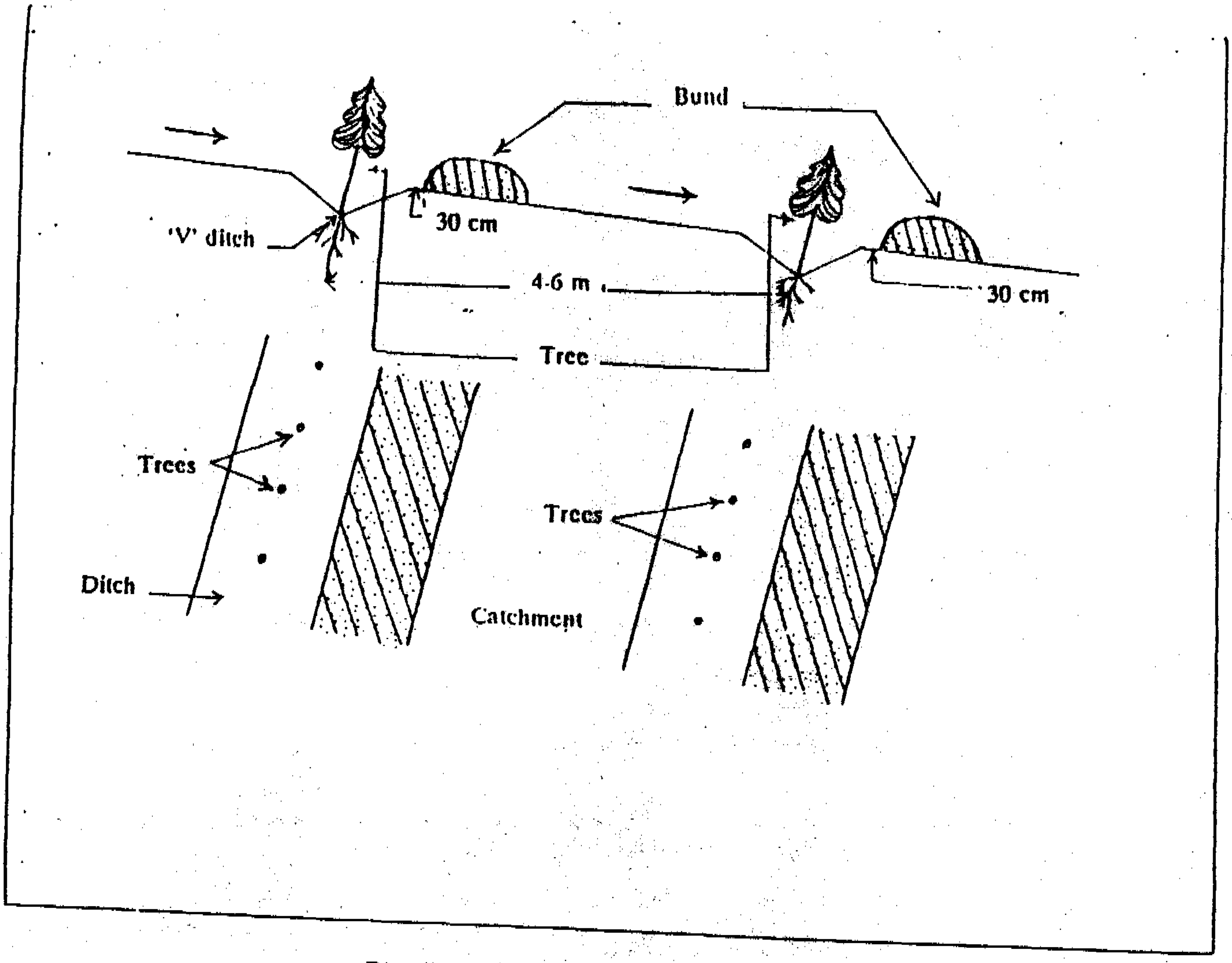


Fig.7 "V" Ditch technology

APPENDIX C

A BRIEF NOTE ON TAMIL NADU SOCIAL FORESTRY PROJECT AND RELATED ORGANIZATIONS.

ISO/Swedforest coordinates the SIDA aided Tamil Nadu Social Forestry Project. This project is being carried out since 1981. During the first phase (1981-86) the orientation was towards raising community plantations in tankbeds, hillocks, etc. and agroforestry. The Social Forestry wing of the Tamil Nadu Forest Department was implementing the project. Before taking up the second phase (in 1988) a decision was taken to transfer the component of agroforestry to the Agriculture Department due to their access to the farmers. Similarly it was decided to hand over some of the community plantations to the village panchayats from the Forest Department. Though the Social Forestry wing is involved in managing most of the community plantations, it has set a new direction by adopting a programme called Interface Forestry, which aims at an afforestation of degraded reserve forests in an integrated manner. Tree planting, soil and water conservation, and socioeconomic inputs form an important component of this programme. It aims at integrating the forest to the peripheral village economy in a sustainable manner.

The new directions of social forestry implies higher productivity and stronger ecological relationships. This could be achieved only through inputs from research. Hence it was decided to evolve an autonomous body for research during the second phase. Society for Social Forestry Research and Development, Tamil Nadu, was inaugurated in 1989. Under the guidance of the renowned scientist Dr. M.S. Swaminathan, the Society has been funding relevant applied research projects for the past two years. The Government is also actively involved in the Society facilitating the transfer of the research to the development programmes of the government departments and Non governmental organizations.

A Research and Development Cell (R & D Cell) of ISO/Swedforest, Madras, assists the Society in translating its objectives into field reality. One of the important functions of the R & D Cell is to identify the priority areas of research in terms of needs. At present it is involved in chalking out a programme for research activities in the field of water resources related to social forestry. For this purpose, it has invited Prof. Jan Lundqvist, Department of Water and Environmental Studies, University of Linkoping, Sweden, under a Research Fellowship to assess the research areas with relevance to Tamil Nadu Social Forestry Project.

Mr. **Jayakumar**, Project Director, Centre for Water Resources

Dr. **Karmegam M.**, Professor, Centre For Water Resources

Mr. **Kumarvelu G.**, Dean, Forest College

Dr. **Lundqvist Jan**, Professor, c/o ISO/Swedforest

Mr. **Mahamood Hussain**, Forestry Consultant

Dr. **Mohan S.**, Assistant Professor, Hydraulics & Water Resources Engg.,IIT, Madras

Mr. **Mohd. Osman**, Scientist Central Research Institute for Dryland Agriculture

Dr. **Muthuchelian K.**, Lecturer, School of Energy

Dr. **Nagaratanam**, Insitute of Remote Sensing

Mr. **Nandgopal**, I.A.S., Spices Board, Cochin

Dr. **Nilsson Ake**, Coordinator, ISO/Swedforest

Mr. **Pal Karlsson**, Associate expert, ISO/Swedforest

Dr. **Palanisamy K.**, Department of Civil Engineering, Regional Engineering College, Trichy

Dr. **Paul Appasamy**, Madras Institute of Development, Studies

Mr. **Ponnusami, P.K.**, I.F.S., Conservator of Forests, Social Forestry Circle

Mr. **Pramod Keskar**, Generaal Manager Agroforestry South India Viscose Ltd.

Mr. **Prasanna**, ODA Coordinator, Aranya Bhavan

Dr. **Rajgopal Aruna**, Director, Water Technology Centre

Mr. **Roy R.N.**, Extension and Training Officer, Bay of Bengal Programme

Dr. **Samraj P.**, Officer-in-charge, Central Soil & Water Conservation

Mr. **Shukla Sanjay**, Forestry Programme Assistant, R & D Cell

Dr. **Sivanappan R.K.**, Consultant, 14, Bharati Park

Mr. **Srinivasan A.S.**, Scientist, Dalmia Research Foundation

Dr. **Surendran C.**, Professor and Head, Forestry Research Station

Mr. **Thangam E.S.**, Krishnamurthy International Agricultural Development Foundation

APPENDIX D

WORKSHOP PROCEEDINGS

Based on the report of Dr. Jan Lundqvist it was decided to organize a project design workshop. The objective of the workshop was to arrive at a research strategy on water resources in social forestry including specific programmes and projects to identify possible actors and to evolve a research methodology.

The two-day workshop was organized in February, 1992 at Madras. Thirty nine specialists in the areas of soil and water resources management and forestry participated in the workshop. There was a substantial representation from the universities, government and non-governmental organizations.

The participants were requested to contribute through thematic discussions with the intention of evolving specific action programmes for research and development activities.

The participants were:

Dr. **Swaminathan M.S.**, Chairman, M.S.Swaminathan Research Foundation.

Dr. **Narayan S.**, I.A.S., Commissioner and Secretary, Government of Tamil Nadu

Mr. **Rangarao G.**, I.A.S., Commissioner and Secretary, Government of Tamil Nadu

Mr. **Elangovan S.P.**, I.A.S., Commissioner and Secretary,Government of Tamil Nadu

Mr. **Sankaramurthy S.**, I.F.S., Chief Conservator of Forests, Social Forestry Wing

Mr. **Kolappan P.**, I.A.S., Director Agriculture, Directorate of Agriculture

Mr. **Kunder W.S.O.**, Director Institute of Hydraulics & Hydrology

Mr. **Nanjan B.T.**, Additional Director Agriculture, (Agroforestry)

Mr. **Subramanian K.V.**, Joint Director, Rural Development Department

Dr. **Balasubramanian K.**, R & D Manager, ISO/Swedforest

Dr. **Bhaskar V.**, Department of Farm Forestry, University of Agricultural Sciences

Dr. **Dayanandan**, Professor, Department of Botany

Mr. **Fatimson F.**, Project Director, Social Forestry Information Project

Dr. **George C.K.**, Spices Board, Cochin

THE WORKSHOP

On 10 February, 1992, the morning session began with a welcome address of Dr. Åke Nilsson, Coordinator, ISO/Swedforest, Madras.

In his address, Dr. Nilsson stressed the direct relationships between forest cover and soil and water resources. He emphasized the need to achieve a positive impact on hydrological conditions in the downstream areas of afforestation projects. According to Dr. Nilsson, there is a lacunae in the current database, making a proper analysis on the relations between landuse and water resources impossible. Identification of resources in terms of institutions, individuals and knowledge and, the full exploitation of their potential could develop new, productive systems where use of land and water resources can be optimized. To aim at developing these efficient systems, Dr. Nilsson invited the participants to come up with proposals which could be taken up by the Society for Social Forestry Research and Development, Tamil Nadu.

Mr. Rangarao, Secretary, Agriculture Department and Mr. S.P. Elangovan, Secretary, Rural Development Department gave the opening address.

Mr. Rangarao stressed the need for better flood control measures and also for rejuvenating the fallow lands into ecologically stable units of production. He reminded the participants that both these areas were a concern to the government and schemes were already initiated to rectify these ills.

Mr. S.P. Elangovan, Secretary, Rural Development Department stressed the idea of planning for better productivity of water resources while maximizing the production on land. He gave the example of tankbeds where appropriate planting could result in better recharge for the tanks without reducing the tree crop production. These processes could be better defined during the workshop, he suggested.

The keynote address was given by Dr. M.S. Swaminathan.

Dr. M.S. Swaminathan began by reiterating that the key themes in the report and findings of Dr. Jan Lundqvist and Dr. R.K. Sivanappan on issues of research and development on water resources and social forestry would form the basis for dictations during the workshop.

A dynamic social forestry programme could be designed, he said, wherein afforestation of catchments could be an integral part of the development project. Conservation of resources and optimization of their use for sustainable development would be an appropriate strategy. The concept of sustainable development could be at the district level.

It was important, while striving towards greater development, to maintain harmony among different interest groups dependant on the resources. Dr. Swaminathan highlighted the example of the changing objectives of forestry from the end-user perspective - the conservation forestry, the commercial forestry and community/social forestry. The dichotomies arising due to contrary objectives being recommended and pursued must be minimized. This could be done by a combination of social dedication and an input of knowledge systematically developed through research.

Applied as well as adaptive research could look into the areas of water and land management, tree crop selection, genetic organization, nutrient recycling and such related issues. These would have a better concatenation in design if they were considered distinctly at three levels - micro catchments, macro-catchments and the larger watersheds, Dr. Swaminathan suggested.

Dr. Swaminathan hoped that, in this age of information technology, the poor would also find access to the developed technologies and a higher priority be accorded to "reaching the unreached."

Perspectives of the R & D Cell were given by Dr. K. Balasubramanian, Manager, R & D Cell. Dr. Balasubramanian gave the context in which the Society was formed in 1989. The identification of field reality and promotion of research designed to change the reality in a pre-determined direction is the primary approach the Society has adopted. Areas for research priority, collected through a careful survey of practitioners of forestry, include fodder development and minor forest produce production. To derive a comprehensive set of current priorities the present workshop would be rewarding, Dr. Balasubramanian concluded.

Dr. J. Lundqvist, Professor, Linkoping University, Sweden, introduced the theme of the workshop. Dr. J. Lundqvist briefly described his two-month experience in Tamil Nadu on the basis of which he had prepared a draft report which would give the themes for discussions in the workshop.

The themes have been broadly classified into four areas - water availability and watershed development, research issues, organization of research and the linking of R & D.

For the theme of watershed development the issues to be discussed were:

1. to improve water availability

2. treatments in SFPs and their impact on
   - soil and water conservation
   - regeneration of natural vegetation by 'social fencing' or other closures
   - planting of trees

3. basic ideas and questions

4. productivity of water & land

5. the impact from various treatments on water resources

6. spatial and temporal aspects

7. the question whether trees m water

7. the question whether trees m

The research issues could be discussed by defining the research criteria at first and then the potentials of research issues.

The discussions on linking R & D could start with an identification of the elements such as people in the field including NGOs/VOs, policy makers & extension staff and the scientific community, together with the media's involvement.

Dr. Lundqvist suggested that it would be desirable that each participant's involvement be intense and meaningful and to create such an opportunity it was best that the group be divided into five smaller sub-groups, each specifically discussing a particular theme. The outcome of the discussions could then be shared subsequently during the seminar in an open forum. Finally the findings of the workshop could be arrived at.

The suggestion was well received. The afternoon session of the workshop was dedicated to group discussions with groups being formed in accordance with the interest and experience of the individual participants. Prior to embarking on the group discussions each participant shared with the floor, their reaction to the frame-work design, their assessment of the current field effort required for water resource management and the nature of research prompted by these efforts. The session was chaired by Mr. Rathin Roy, Extension officer, BOBP project of FAO.

Dr. Sivanappan set the stage for discussions with a brief background on the water scenario in Tamil Nadu and India. He said water scarcity was common and only research would clearly say if large-scale afforestation could improve water availability. Dr. Sivanappan, through slides, described the measures already being carried out, with various degrees of success, both among government and non-government efforts. This experience could be a thought provoking process, he felt.

THE GROUPS

The themes of the groups were as follows:

Group 1: Precipitation - total amount/intensity; number of rainy days vis-à-vis afforestation/deforestation in hills and plains. Perceptions and substantiations.

Group 2: Effect of soil and water conservation work (treatments) and afforestation/regeneration on water availability in the lower parts of the catchment for agriculture purposes and other needs. Water balance studies with regard to land use/afforestation in interface forestry. Policies, perceptions and substantiations.

Group 3: Micro-level studies - how effective are the different in-situ moisture conservation techniques with regard to the survival rate/crop growth and water balance parameters.

Group 4: Evapotranspiration requirements of various tree species - biomass production per mm of water, drought resistance and rooting pattern, etc. Anti-transpirants, jalshakti, fertilizer requirements vis-à-vis moisture availability, etc.

Group 5: Agroforestry, tankbed plantations - effects on water quantity and quality. Economics of agroforestry, typology of land use with regard to moisture availability and its 'carrying capacity'.

The above five themes were discussed in order to bring out the state of knowledge, work in progress, work to be done and its relevance to social forestry and identification of specific research areas.

GROUP ONE

The group realized that adequate and accurate data would be the key-stone for any analysis for the water cycle. A choice would have to be made between the present alternatives of automatic rain gauges or manual gauges. The automatic were prone to malfunction while the manual rain-gauges had spatial limitation, i.e. if data at the taluk level has to be collected, as the current hydrological thought suggests, the cost of data collection out-reaches its use in the analysis.

Linked to the empirical data collection is the need to ascertain the landuse pattern, current as well as historical, and link it to the hydrological cycle. This could be done from a sociological point of view wherein the perceptions of the people regarding the link could provide a clue to better planning and implementation.

The question of the impact of deforestation and its impact on rainfall would require extensive statistics. Advantages of the existing studies, such as that of the French Institute, Pondicherry which has compiled rainfall data from 4,000 stations in the Western Ghats, Department of Statistics, GOTN, Indian Meteorological Department, GOI, Indian Institute of Technology, Universities, Forest research stations, non-governmental organizations and other academic institutes could be made use of to arrive at a beginning point for further research.

A predictive model for the hydrological cycle could prove very useful for planning. The interrelationships between the elements of the hydrological system would have to be defined to develop a model. Research in the study of linkages between the physical and the atmospheric dynamics, though not of direct relevance to social forestry, would still be fruitful to determine policy for the programmes.

The group discussed the methodology that would have to be adopted in the context. A questionnaire survey for the social science studies and appropriate instrumentation including remote sensing for physical parameters was agreed upon. An active participation by the decision makers, such as government representatives, in this process of data preparation was recommended.

GROUP TWO

The group agreed to the following areas for research:

1) Systematic study on soil erosion, runoff, soil moisture, recharge of groundwater in watersheds having different slopes and vegetative cover.

2) Water balance studies on where soil and water conservation works and afforestation are completed compared to the existing degraded forest area in fairly big water sheds.

3) Effect of water harvesting structures (catchment areas) in the command areas.

4) Optimize the afforestation and soil water conservation works and the agriculture crops from the given land and rainfall characteristics.

GROUP THREE

The following four major thrust areas were identified to increase the survival and the rate of good growth:

1) different in-situ moisture conservation methods,

2) different moisture loss prevention measures in the field,

3) increasing different moisture retention methods, and

4) moisture crisis management.

Future research should study the techniques, effects and economics of these factors for:

1) different tree species,

2) different soils,

3) different agro-climatic zones, and

4) forest and agricultural lands.

GROUP FOUR

The fourth group identified the following areas for research in the areas of evapo-transpiration, biomass production and water utilization.

1. Various forestry models which are ecologically and economically viable vis-a-vis agro-climatic and soil zones.

2. Hydrological relations between annual crops and tree species.

3. Comparative efficiency in water use in different land use such as agroforestry, farm forestry etc.

4. Evaluation of different tree species for their water use and harvesting potential and package of practices for moisture improvement and fertilizers for different species in different agro-climatic zones.

5. Designing suitable alley cropping systems for better soil and water conservation.

GROUP FIVE

The fifth group discussed the research issues of agroforestry and tankbed plantations. The group noted the weak link between the research and the agroforestry component of TNSFP. At present the agroforestry programme consists of two parts - the main programme where the farmers are given free seedlings and cash incentives, and the development programme where on-farm trials are conducted to act as a catalyst for agroforestry.

The group felt that the on-farm trials have been concentrating on the in-situ moisture conservation for tree crops alone without much emphasis on agriculture crops. The group found very little relationship between the main programme and the on-farm trials. The group also agreed that the criteria for agroforestry is different from forestry. While the forestry (mostly by government) can afford to take risks with lower survival rates, the farmers cannot take such risks. Hence, minimizing the risk of the farmer within a sustainable ecological frame-work should be the objective of the research in agroforestry.

The group classified the research and development activities into three types:

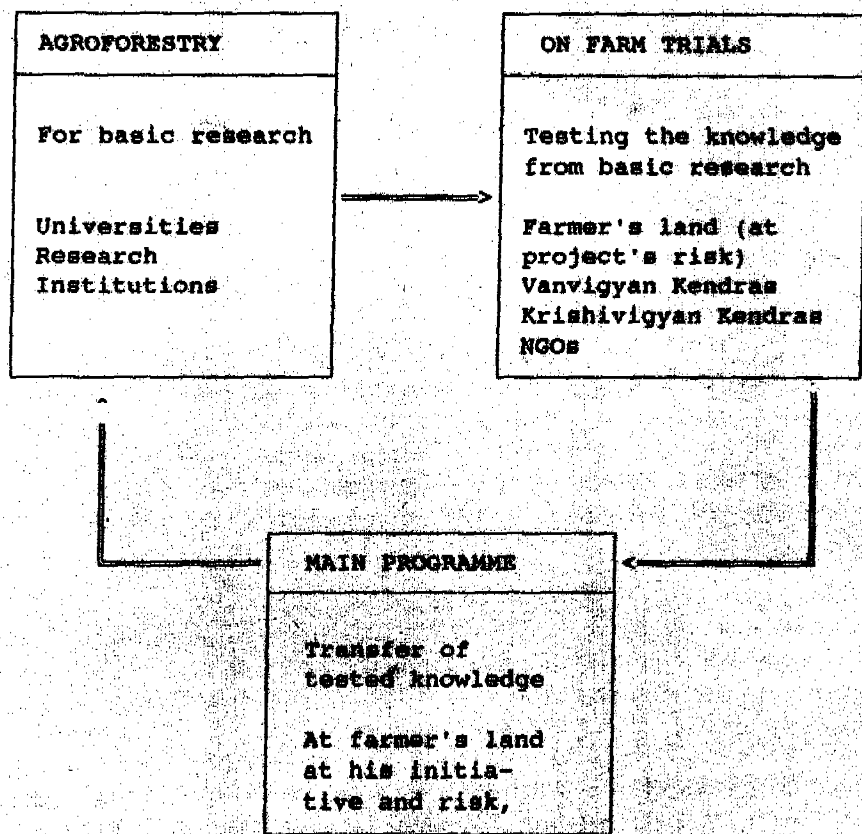
1) The basic fundamental research in new areas where information is not available.

2) The applicability and the replicability of the knowledge gained through the fundamental research by means of on-farm trials.

3) The transfer of effective on-farm trials to the main programme.

At present there are no linkages between the above mentioned types. While the basic research is being carried on in the Universities, its relevance to the on-farm trials is yet to be identified. Similarly, the on-farm trials are trying to create new knowledge rather than consolidating the existing knowledge.

The group proposed the following relationship to strengthen the transfer of research knowledge.



The group discussed through extension at length the research priorities in agro forestry vis-a-vis water resources.

Knowlwdge in basic research

Through the activities of Tamil Nadu Agricultural University, University of Agricultural Sciences, Bangalore, and Central Research Institute for Dryland Agriculture, Hyderabad, the following areas have been adequately covered or being covered.

a) Soil and water conservation for maximising growth for tree crops.

b) Resource sharing in tree crop mixed system.

c) Impact of tree species on soil physics and chemical properties.

d) short rotation intensive cultivation.

e) identification of tree species suitable for problem soils and stress conditions.

f) the effect of tree crops and field crops involving eucalyptus, sisoo and Casuarina on the soil moisture in three agro climatic zones.

g) alley cropping techniques.

h) Silvo-pastoral systems : Lucaena lucocephala, Stylosanthus hamata system; Lucaena leucocephala, Cenchrus ciliaris systems.

i) role of agave, vetiver and dwarf variety of castor.

The existing knowledge is yet to be transferred to large-scale on- farm trials. However, there are certain lacunae in the existing knowledge. The group felt that the following areas require immediate attention to improve the quality of agroforestry system:

a) While in-situ moisture conservation techniques are available for agricultural crops and tree crops separately there is not much of attempt for in-situ moisture conservation techniques in agroforestry systems given the differential dynamics of annual crops and tree crops. Any attempt to encourage agroforestry without the above techniques may not yield desired results.

b) Water consumption of different tree species not merely in terms of total moisture consumption but as a guide to rooting and moisture uptake with depth and the degree of competition that might be expected in intercropping systems, issues of rooting depths, root activity and root extension.

c) Identification of species which complete at least most of their growth during the period when adequate moisture is available.

d) Efficient watering methodology (though some work has been done at U A S, Bangalore, more information is required on the various techniques).

e) Methodology to identify the carrying capacity of a particular piece of land vis-a-vis agroforestry and the effect of the system on the down stream water balance.

f) Comparative efficacy in water use of different land uses like agroforestry, traditional cropping and forestry.

g) Economic efficiency of watering and non watering vis-a-vis growth and yield.

The institutions available for the above activities in Tamil Nadu are limited. The Tamil Nadu Agricultural University is the only one with personnel and instruments to carry out the above mentioned studies. Therefore it would be ideal to use this University through institutional arrangements and set research projects in the above areas. An Agroforestry Integrated Research Programme could be created to undertake the above research which could yield results in three to five years. The initiation of such activities in other institutions may involve substantial expenditure on infrastructure.

<u>The knowledge and on-farm trials</u>

As mentioned earlier the knowledge derived from the on farm trials are limited since the emphasis is only on tree crops and not on tree-crop relationships. However, there is a strong possibility to replicate the studies mentioned in the knowledge under basic research in the on farm trials. The group suggests that the on farm trial models could be designed with the help of the investigators who carried out the research in the universities particularly in Tamil Nadu Agricultural University. However, the trials could be conducted by NGOs, Colleges and Government in the farmer's land. Care should be taken that the risk of the farmer in these trials should be minimum.

<u>Tankbed plantations</u>

A research project has already been launched by the Society for Social Forestry Research and Development, Tamil Nadu, to assess the impact of Acacia nilotica plantations on the quality of water and the tank ecosystem. Hence the group suggests that further research could be taken up after the completion of the above mentioned project.

CONCLUDING SESSION

The session in the afternoon started with Dr. S. Narayan, I.A.S., Commissioner and Secretary, GOTN, Environment and Forests Department, chairing the session.

Dr. Lundqvist welcomed the members and spelt out the agenda:

(1) Comments from Dr. K. Balasubramanian on the role and activities of R & D Society and R & D Cell.

(2) Comments on the reports of the working groups presented in the morning - summarisation of the points raised after the discussions.

(3) Institutional interaction.

Dr. K. Balasubramanian in his comments mentioned that the crux issue now is who is going to fund, what kind of funding agencies are there to take up these kinds of activities and initiate them. Then he went on to explain the role and activities of R & D Cell and R & D Society. The period 1989-90 has been a period of consolidation. The R & D Cell has developed a scientific basis for assessing proposals. It has launched surveys and identified certain priority areas. This workshop is to identify one such priority area. He pointed out that the R & D Cell and the R & D Society would not be able to launch all the projects discussed during the workshop. He emphasized the need to identify certain priorities. He underlined the role of Departments implementing the projects and cautioned that it would take some time to evolve new proposals keeping in mind the needs TNSFP. It will take some more time for the Cell to identify new proposals - this has to be done keeping in mind the needs of TNSFP.

Dr. Lundqvist then summarized the various issues that came up during the discussions over the last two days.

There was a comment on institutional interaction - the need for better collaboration an interaction between Universities, State departments, forest department, Agriculture department, Rural Development Department and NGOs.

Dr. Åke Nilsson said he had been presented with 25-30 proposals and it was impossible to find funds for all of them. Proposals in priority areas could, however, be taken up first. Moreover, it was important that the researchers were able to find access to data collated by implementing government departments. There was a need for the cooperation between the people who actually did research work and those who utilized the results by testing the new ideas and technologies. Accessibility of data was very important. To what extent was there an interaction between scientists, scientific communities and the government?

Dr. Åke Nilsson stressed the need for an interdisciplinary approach and a proper forum for interactions between scientists, the government and the communities.

During the discussions the interactions between the government and the non-governmental organizations were elaborated upon in particular reference to accession of compiled data.

Dr. Narayan in his speech pointed out that the repeated reference during the workshop to data availability reflects the lacunae in the interaction between the organizations in sharing information. He emphasized the need for external monitoring of various organization involved in the implementation of social forestry programmes. He however cautioned that the monitoring should not be a mere academic exercise but should be tool for identifying the appropriate methodology for better implementation.

He explained the need for a better access knowledge at the various levels of the implementing agency and complemented the workshop for focussing attention on the transfer of knowledge.

VOTE OF THANKS

Dr. Balasubramanian thanked Dr. Narayan for his thought-provoking message and his valuable cooperation. He also thanked the various government officials such as CCF, Additional Director of Agriculture, Joint Director Rural Development Department, eminent scientists, NGOs and other participants for being able to get together. Special references were made to R & D Cell, ISO/Swedforest and the R & D Society and for all the cooperation and hard work put in by each one of them.