CHAPTER 1: INTRODUCTION
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1.1 Population, crop production and environment

At the time of the commencement of the Planning Commission in 1950, the general assumption that the country’s population would be more than double in less than 10 years time was thought to be exaggerated and misplaced. The challenge to feed the burgeoning population had been accepted by India and necessary investment on the self sufficiency in food had been made along with agricultural research and extension to the fields. The stupendous task of achieving our own food to feed the hungry mouths had been attained by 1972-73. This feat of self sufficiency in food production is one of the great achievements of Indian agriculture.

The benefits of the ‘Green Revolution’ have not come without environmental costs. Agricultural resources in several areas have been severely degraded. Signs of agroecosystem stress, and even of its break down, are abundant (Virmani 1991). In India 90 million hectares of land suffers from water erosion, 50 million hectares from wind erosion, seven million hectares is affected by salinity and alkalinity, and 20 million hectares is prone to flooding (Singh 1994).

Thus, 167 million hectares or 51 per cent of the total land surface in India suffers from soil degradation. In addition, about 20 million hectares of canal irrigated area (the mainstay of the Green Revolution) run the risk of becoming degraded. According to Dhruvanarayana and Sastri (1985), nearly 175 million hectares of the country’s land area (including 140 million hectares cultivable land) is under some form of degradation. The above findings give us an idea of the gravity and the magnitude of the problem. It is apparent that the sustainability of agriculture across the country is threatened by further increase in population. In India, about 70 per cent of the 144 million hectares are arable land which depend entirely on rainfall for crop production.

India has diverse soil and agro-climatic resources. The production potential of different eco-regions varies widely. Without wise and sustainable use of soil and water resource, the development of farming areas will not be possible. The optional use of
land requires that the land resources be well characterised, their spatial relations delineated and their capacities for all likely uses, at various level of management, be determined and implemented (Virmani 1991).

Virmani (1997) has mentioned that annual cycle of weather events poses a challenge to policy makers to innovate technical options and construct a comprehensive ‘package of practices’ to sustain rainfed crop production for different eco-regions. The technologies have to be ‘area based’ rather than individual ‘farm based’ and their fine-tuning be in accordance with available natural resources.

Rainfed agriculture research and development has been dominated by the concept of high yields for decades. It arouse from the scientific principles developed for the ‘Green Revolution’ high-input, high-output technologies. Fatigue and cracks are now developing in the green revolution areas. For rainfed agriculture, an area-based development through watershed management provides an excellent framework for sustained yield. Also the landscape watershed units focus on the maintenance of biodiversity through diversified cropping systems (Jasmin 1984, Lim Suan 1991 and Wagley 1997).

1.2 Watershed and catchment concept

Initially, a watershed was described as a mass of land that drains at a common point on a natural drainage system. However, in the due course of time, the term has evolved to cover even those areas where distinguishable drainage lines do not exist. According to Sinha (1997), the watershed, in Indian situation, would include the following:

*Watershed with well defined drainage lines

A piece of land or a geographical unit which drains at a common point on the natural drainage line and is the product of inter-play of rainfall and land mass.

*Watershed with not distinguishable drainage lines

The low rainfall and desert areas
In such an eco-system, the watershed means an index catchment, but supports, large underground aquifers or groups of small aquifers.

Drainage congestion areas of the Himalayan foot-hills

Such eco-systems are found in the drainage congestion areas of the Himalayan Foot Hills. In this ecosystem, the area that drains into a common depression (Chaur)/ or a cluster of depressions is taken up as the watershed for planning and action.

*Coastal Saline areas

Under these eco-systems, the area bounded by creeks are taken for survey, planning and implementation of project activities. In coastal watersheds, excess of water poses limitations on bio-mass production.

In other words, watershed is a geohydrological unit or a piece of land that drains at a common point. The natural unit has evolved through interaction of rain water with land mass and typically comprises of arable lands, non-arable lands and natural drainage lines in rainfed area. Sustainable production depends on health, vitality and purity of production and environment of which land and water are important constituents. Therefore, for scientific utilization of the natural resources, particularly of land and water, the ideal geographical unit would be the product of interaction of rain with land i.e. the watershed (Anon. 1991, Zijestra 1989 and Nalampoon 1995). According to Mohsin (1989), the total area contributing water, which flows through the outlet, is the watershed of that outlet. The outlet may be small natural drain, a rivulet, a stream or even a river.

For very specific and proper utilisation of land and water resources and for enabling actual microlevel planning and implementation, a much smaller area, in comparison to a ‘catchment’, is selected which is termed as ‘watershed’. A catchment may be demarcated into a sub-catchment, a watershed, a sub-watershed, a Mini-watershed and Micro-watershed on the basis of various drainage size (Mohsin 1989).
**Catchment**

A primary river is a long river having a drainage area of more than one lakh hectares with a number of tributaries of first, second, third, fourth, fifth or even higher orders. The primary river generally discharges load to the sea. The drainage area of such a river is called a catchment.

**Sub-Catchment**

A secondary river is a tributary of a primary river having a drainage area of more than forty thousand hectares. The drainage area of such a river is called sub-catchment.

**Watershed**

A tertiary stream or river is a tributary of a secondary river having a drainage area of 4 to 40 thousand hectares. The drainage area of such a stream or river is called watershed.

**Sub-Watershed**

A quaternary stream is a tributary of a tertiary having a drainage area between 2 to 4 thousand hectares. Such a drainage area is called a Sub-Watershed.

**Mini-Watershed**

A pentad streamlet is a tributary of a quaternary having a drainage area between 400-2000 hectares. Such a drainage area is called a mini-watershed.

**Micro-Watershed**

A hexad streamlet is a tributary to a pentad having a drainage area of less than 400 hectares. Such a drainage area is called a micro-watershed.
1.3 Objectives of the watershed management plan

The conservation strategies in the watershed area are based upon ecological balance and production on sustained basis for the future of our civilization. According to NWDPRA guidelines, the objectives of watershed management are as follows:

* Conservation, upgradation and utilisation of natural endowments like land, water, plant, animal and human resources in a harmonious and integrated manner. This will aim at perpetual availability of food, fodder, fuel, fibre, timber and biomass for rural and cottage industries to meet the growing demands of human and livestock population through diversified land use.

* Improvement of production, environment and restoration of ecological balance through scientific management of land and rain water. In the process, in-situ moisture conservation, introduction of scientific production system, net-work of run-off management structures and devices for recharge of ground water will ensure enhanced availability of water for human and livestock drinking purposes, domestic consumption, lift irrigation and raising of appropriate cash-crop according to agroclimatic potentials.

* Reduction of inequalities between irrigated and rainfed areas. Ultimately, stable production and processing of biomass would contribute towards better life in rural areas. This will reduce large scale migration from rural areas to cities.

* In addition to food, fuel and fodder the project would endeavour to enhance cash flow to the rainfed farmers and landless agricultural labourers through increased casual employment, marketable surplus of agricultural and dairy produce, growing of cash crops like vegetables, etc. in suitable areas.

1.4 Management of watershed

Management of watershed involves judicious use of land and maintenance of tree, bush or grass so as to conserve soil and water for immediate and long term gains along with assured productivity of the land and regular employment to the inhabitants
of watershed areas. In the past, the problem of watershed area were managed through soil and water conservation means and improved crop husbandry practices were tried on individual basis only. This approach did not solve the problems of a watershed. In the last decade, new technologies were introduced in the watershed area. Thus, management of watershed has become an important area of planning and development in the agriculture sector (Jha 1995).

1.4.1 Historical perspective and the evolution of Watershed management programme in India (Sinha 1997)

1.4.1.1 Colonial times

In pursuance of the recommendations of Royal Commission on Agriculture to develop dryland farming on a sustained basis, four research stations were started in the early 1920’s at Rohtak, Sholapur, Hyderabad and Bellari. The dry farming system developed included field bunding, deep ploughing, fallowing of land and cropping in alternate years, use of bulky organic manure and moisture conserving methods and cultural practices. The systems were popularised in late 1930’s and during 1940’s in dry farming areas. The package of practices minimised total crop failure and induced an element of stability in food production, but, there was no appreciable increase in the overall productivity. Moreover, attention was limited only to crop lands. The treatment of non-arable lands and development of animal husbandry, which is an integral part of the dry farming system, was not included. As a result, the technology achieved a limited success.

1.4.1.2 Post - Independence soil conservation research

During the 1950’s research attention was focused on developing soil conservation measures to stabilise the catchment areas of the dams, to prevent the siltation of reservoirs. The research centre conducted valuable research on rainfed analysis and soil loss and brought out ecological potential and problems of their region, but the production system was not given due attention.
After achievement of the national goal of self-sufficiency in the matter of food grains, through the development of irrigated agriculture in the early 1970's, an all India Coordinated Research Project was launched at 23 participatory research centres in the country. In the vicinity of these centres, pilot projects of integrated watershed development were launched to test, adopt and refine the research findings. The results brought out good potential crop varieties, moisture conservation measures and input oriented cropping system. Because of the inherent uncertainties in the amount and intensity and distribution of rainfall and the consequent risk in the dry areas, coupled with resource poor conditions of dry land farmers, the technology, could not be adopted in a big way.

Therefore, in the early 1980's, during the period of the Sixth Five Year Plan, the Department of Agriculture and Cooperation launched a pilot project for propagation of water conservation / harvesting technology in rainfed areas, in 19 watershed located in 15 states, representing major agro-climatic regions of the country. The Department of Rural Development also adopted this scheme in 23 watershed areas. Thus, a total number of 42 model watersheds were developed. The central point was water conservation and water harvesting. Good results were obtained and the need for bringing vegetative conservation measures and promoting a simple and low cost water management technology was highlighted.

On the basis of accumulated experience, the National Watershed Development Programme for Rainfed Agriculture was launched during the seventh plan in 99 selected watersheds of the country. These watersheds demonstrated models for successful crop production. As per project design, non-arable lands were to be developed by funds provided from other schemes. Later on, the National Watershed Development Project for Rainfed Areas (NWDPRA) was re-structured and launched during 1990 - 91.

During the process of delineation of watersheds, diagnosis of problems, development of solutions and their application in the field, major attention was paid to programme content, technical specifications of different conservation measures and the attendant costs, project implementation, supervision, monitoring
etc., in the delineated watersheds. Somehow the relationship of the watershed area with the total problem was neglected (Grandstaff and Grandstaff 1987, Halls 1987, Anon. 1989 and Anon. 1992).

One of the major shortcomings of watershed development approach has been the lack of people's participation in the programme. The only way to accelerate the pace of watershed development programme is to invoke willing participation of the people in the programme (Sinha 1997).

1.5 Why do we need watershed management?

* The neglect of the upland had affected the low land.
* The deforestation in the hilly terrain resulted in floods and soil erosion. Land became degraded with poor nutrient and moisture.
* Large scale migration of farmer in the urban areas in search of job because farming became subsistence farming.

1.6 Need to collect data on various attributes to prepare a sound watershed management scheme

In each watershed area, lands may be classified into various categories on the basis of land-use capability. The capability class does not indicate what the best use of land is. It only indicates the range of use to which each group is put. Soil and water conservation and increase in productivity in watershed area is only possible by applying mechanical as well as biological methods. Biological and mechanical measures are supplementary to each other (Klingebiel and Montgomery 1961, Brooks et al. 1986, Stepleller and Nair 1987 and Jha 1995).

1.7 Mountain ecosystem: Low yields in North Eastern region and need for management of land resource on watershed basis:

The Eastern Himalayan Region of India (Zone II) under Agro-climatic Planning, as classified by the Planning Commission, comprises seven states of the North-East (Assam, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Meghalaya and Tripura), Sikkim, as well as the district of Darjeeling, Coochbehar and Jalpaiguri of West Bengal. The region as a whole is an interesting amalgam of mountains and lush green valleys,
with a geographical area of 27.5 million ha. which constitute 8.36 per cent of the Indian sub-continent. It stretches from 22°N to 29.3°N latitudes and 88.05°E to 37.24°E longitude. The altitude ranges from 97 meters in the plains to as high as 5,000 meters above mean sea level in the hills. The climate ranges from alpine to sub-alpine in the high altitude regions, mild sub-tropical in the plains of Assam and mild tropical in Tripura. The unique feature of this region is the high rainfall ranging from 3,000 mm to 12,000 mm. In addition, there are wide regional variation. For example, in Sikkim, the annual rainfall varies from 300 mm to 2,800 mm, in Darjeeling, from 900 mm to 2,700 mm and in Arunachal Pradesh, it is 4,000 mm (Bora 1991).

The diversification of crops and high intensity cropping programmes is full of risk due to high variability in the date of commencement and distribution of rainfall in the north eastern India. Indiscriminate felling of trees for age old shifting cultivation with shorter cycle resulted degradation of land, heavy soil loss during the rainy season. The soil is acidic in reaction due to leaching of bases as a result of heavy rainfall. In general, the yield level of crops are low and unable to meet the basic requirements of the population (Sinha et al. 2000).

1.7.1 Sustained productivity through watershed based management approach

The age-old cropping practices of the region have been evolved as a result of the interaction of geo-climatic and socio-economic factors which are in harmony with nature. The existing farming systems in different agro-ecological situations need to be grouped into homogenous units to facilitate the application of tested technologies for production of crops as well as for improving livestock quality. Environmental suitability, social acceptability and economic viability should be taken into consideration in such attempts. It is, therefore, necessary to identify the appropriate farming system based on physical, biological and socioeconomic settings of different ecological zones in the region (Anon. 1992).

Interdisciplinary and integrated efforts on a priority basis are needed to manage and develop watershed both in the hilly and valley lands of the entire region to restore the ecological base of the region. Watershed development should be the strategy for soil and water conservation, river valley projects and flood control. This will help in reducing the annual loss of natural resources due to high rainfall. At the
same time watershed based management approach in the hilly areas will give opportunity to the shifting cultivators to adopt ecologically sound settled cultivation. Scientific land use planning and identification of an ecologically and economically sound farming system for each agro-ecological situation on a watershed basis, through extensive research are the strategies required to achieve the objectives i.e. increase in productivity on sustained basis without disturbing the ecology of the hilly terrain of North Eastern states. (Bora 1991, Tiwari & Jha 1997 and Sinha et al. 2000).

1.7.2 Watershed management in Mizoram

The approach and strategy for rainfed areas are now based on the integrated watershed development concept, including production of individual holdings, regeneration of common property resources and promotion of household production system. Based on these, watershed programmes are being implemented under the National Watershed Development Programme for Rainfed Areas (NWDPRA) in Mizoram (Sinha 1995 and Sinha et al. 2000). But in real sense these projects lack:

* Proper management plan on long term basis for a watershed or micro-watershed. The watershed management plan has been finalised without recording various geographical, biophysical and socio-economic attributes.

* The data generated on geographical, biophysical and socioeconomic condition of a micro-watershed helps in evolving management strategies pertaining to the sustainable utilisation of natural resources base of land and water vis-à-vis sustainable production of biomass and maintains ecological balance.

* Emphasis on mobilizing people’s active participation and making use of every resource available to the optimum level by understanding the relationship of various elements and its effect on one another. The package of practices can minimise total crop failure, but, there may not be appreciable increase in the overall productivity. Moreover, attention was limited only to crop lands.

The state of Mizoram receives little attention so far as the literature on the watershed studies is concerned. In status report on “Dhaleswari” and “Tuivai” catchment of Mizoram, the components like - runoff, soil loss, soil types, vegetation, rainfall etc., were studied (Anon. 1989). Rao et al. (1994) and Tiwari and Jha (1994)

have studied soil erosion and land degradation problems in Mizoram. They also studied rainfall, soil types, runoff, soil loss and land use etc. on watershed basis.

For a detailed and comprehensive watershed management study, the physical behaviour of watershed is to be ascertained through the analysis of various factors like - geophysical, biophysical and socio-economic. The physical factors include - slope, soil types, rainfall, runoff, soil loss (sediment yield); biophysical include vegetative resources, cropping pattern, live stock and animal husbandry while socio-economic factors include human resources, their literacy, economic and social status.

Although, various Government Departments like Forest & Environment, Soil and Water Conservation and Agriculture etc, are engaged in the study of watershed for the purpose of their management, a detail work on closer domain is yet to be carried out.

1.8 Scope and objective of the present study

Need for the management of natural resource on the watershed basis is felt. Nevertheless, no effort has been made in Mizoram to study in detail the geophysical, biophysical and socio-economical attributes of Tuirini River Watershed, in order to evolve a comprehensive watershed management plan. Therefore, the present study was designed to study in depth various attributes of Tuirini River with the following objectives:

* Study of the geophysical, biophysical and socio-economic attributes of Tuirini watershed in order to evolve a comprehensive micro- watershed management plan.

* Framing the strategies for conserving soil and water vis-a-vis sustainable utilisation of natural resource, and

* Screening of the farming system developed in the North Eastern India or in other parts of country which would be able to tackle biophysical problems of the land and socio-economic problems of the farmers of Tuirini watershed.
REFERENCES


Agriculture, India, pp 24 - 30.

