CHAPTER VII

CONSERVATION AND MANAGEMENT

INTRODUCTION

Soil-water-plant resources are nature's gift to mankind. Overgrazing, deforestation, faulty cultivation, shifting cultivation and carelessly built roads in the catchments, has led to devastating effects downstream. These include gullying and floods leading to destruction of farm lands and villages; drop in flow during the dry season and consequent loss of crops; and siltation of reservoirs and canals. The problem has been further aggravated due to high rate of population growth – both human and livestock, resulting in indiscriminate exploitation of natural resources, for meeting the ever-increasing demand for food, fodder, fuel, fiber and fertilizer. Thus continuous degradation of production base and imbalance in land-water-plant, human-animal systems is leading to ecological imbalance and economic insecurity, through severe soil erosion and threat to the quality of our life.

7.1. WATER MANAGEMENT

Water is among the most essential requisites that nature has provided to sustain life on the Earth. Now a days, perhaps water out stress all geo-environmental factors to enter more prominently into considerations of human and economic development and environmental quality. It must be realized that rapidly increasing demand for water, degradation of water due to contamination, water scarcity in both rural and urban areas, frequent incidences of water borne diseases etc., are becoming order of the day. Hence, the development of water resource for their optimum use involves proper conservation, management and proper planning of the resources.

7.1.1. Control of Water Losses

This method is applicable mainly in the uses of groundwater as

well as surface water in irrigation. Water is lost due to adoption of faulty method of irrigation and seepage from the canal system. The application losses also result when field irrigation channels, grading and shaping of fields, consolidation and rectangulation of holding, suitable methods of irrigation, irrigation scheduling, rotational supply of water, appropriate cropping patterns etc. are either inadequate or non-existent. This type of water loss can be checked by volumetric charging of water or educating the farmers about the adverse consequences which they have to face if they don't control flow of irrigation water. Canal seepage can be checked by lining the canals, though it involves heavy expenditure. Drip and sprinkle method of irrigation should be increasingly adopted.

7.1.2 Conservation Through Artificial Recharge

Artificial recharge of the groundwater may be defined as the augmentation of natural infiltration of precipitation or surface water into under ground formations. Artificial recharge may be needed for improving the water quality, for disposal of flood waters, and for reduction of salt water intrusion and for the prevention of land subsidence etc. the selection of a suitable recharging method depends upon local topography, soil conditions and quality of water to be recharged and its ultimate use.

a) Methods of artificial recharge by water spreading:

i) Flooding method.

ii) Basin method

iii) Furrow or Ditch method

iv) Natural Channel method

v) Irrigation method.

b) Recharge through wells:

c) Recharge through seepage:

7.1.3 Conservation of Soil Moisture

The moisture content of the soil is defined as the amount of water lost when it is over dried and may be expressed as the volume of water per unit volume of bulk soil. The infiltrating water when stored in the

soil pores raises the moisture content. The major loss of water is occurred through evapotranspiration by plants. Soils with large amount of available water are generally more favourable for plant growth.

7.1.4 Conjunctive Use of Surface and Ground Water Resources

Conjunctive use of water resources of an area or a region means proper utilization of its groundwater and surface water together, is a planned manner. Large development can be achieved by integrating both these resources. Thus, conjunctive use involves optimum utilization of available surface water during the years in which the rainfall is above the average and storing the excess water underground by artificial recharge.

7.1.5 Water Quality Management

A comprehensive multi-pronged water quality management strategy includes strict implementation of pollution control laws, promotion of cleaner technologies, fiscal incentives and economic instruments of appropriate prices, taxes and property rights.

7.1.5a *Water Conservation for Pollution Control:* Water is still treated as a free good, to be used liberally and to be sullied with impunity. Pricing water to reflect its scarcity value, can encourage users to be more prudent is its use. Better pipeline management, reused and recycled domestic wastewater for agricultural and industrial purposes, drip and sprinkler irrigation technologies can curtail water losses. To reduce water damage we have to reduce fertilizer or pesticide or chemical sun-off from agricultural fields reducing the amount of pollutants that eventually find their way into the water bodies. Polluters usually do not feel the effects of pollution caused by them and adverse effects are borne by the third parties. Quantifying and putting a cost to the polluters for these adverse effects of pollution and then incorporating them into the decision making process and deciding the price of water accordingly can resolve such problems.

7.1.5b *Encouraging Industry to Act:* Waste water treatment facilities should be made mandatory in the industries. Industrial effluents must be treated and clean water should be drained out of industries before

meeting other water sources.

7.1.5c *Domestic and Agriculture Pollution Control:* Cheaper domestic waste water treatment technologies, like biological treatment need to be examined as alternatives to the more expensive conventional treatments. The first important Step in the agriculture sector is to curtail over use of fertilizers and pesticides. Environment friendly practices like vermiculture, use of organic manure and integrated pest management practices that obviate the need for persistent pesticides should be vigorously encouraged.

7.1.5d *Mass Partnership:* It is visually impossible for the Govt. alone to monitor the water management systems. People should be more conscious and aware and create pressure on the industries and other agents which a polluting water to rectify their habits and maintain a clean profile.

7.1.5e *Institutions:* To monitor industrial, domestic and agricultural pollution institutional mechanisms that could involve the stack holders need to be evolved. The Pollution Control Board should generate and maintain data that can be made available to the concerned citizens, who can play an important role to consume water resource and maintain environmental health.

7.1.6 Change in Municipal Systems and Recycling Methods

Numerous cities all over the world are facing the stark reality that it will be extremely impossible and expensive to increase the supplies of water by traditional means. They are discovering the real steps to reduce water consumption and wastage. A considerable number of cities have programming to repair the leaky water pipes and installed low-flow shower heads, water displacement devices in toilets etc.

7.1.7 Exroscaping

Planting of less water consuming plants over the bear surfaces, open lands and lawns of the houses is considered another measure of water conservation especially in dry regions. These plants do not require additional watering whereas consume less water than the

previous plants.

7.1.8 Grey-Water Recycling

Slightly dirty water collected from sinks, showers, bathtubs, laundry tubs, collected in holding tanks and used for such purposes as flushing toilets, watering lawns, gardening, washing cars etc. is considered another measure to save wastage of fresh water.

7.1.9 Methods to Increase Water Inputs

Due to increasing demands for water and disparity of water distribution throughout the earth, hydrologists and engineers have tried to sort out the problems by other methods like

a) Towing ice-bergs from higher latitudes to lower latitudes,
b) Desalinization of ocean water,
c) Cloud seeding,
d) Transporting water thousands of kilometers from water rich to water poor regions,
e) Inter linking of rivers. Most of these ideas are related with environment, political and economic concern.

7.1.10 Rain Water Harvesting or Storm Water Management

Rain water harvesting is done by constructing a reservoir, which receives and holds the surface run-off during periods of heavy shower or storm waters. Water from this may be gradually infiltrated into the soil or it my trickle out slowly through a stand pipe mounted in the reservoir or pond. Thus the reservoir plays a role imitating groundwater storage and it may also create a pocket of natural wet land supporting wildlife. Large storm water reservoir-flood controlling reservoirs may serve additionally as recreational areas with the facilities of boating, fishing and so on. Small trenches and wells filled with rock, sands and gravels get rain water from the nearby roof tops, parking zones, roads, etc. allow to percolate the water through soil. This type of infiltration may again recharge the ground water table and also helps to supply water for drinking purposes. (De, 2005).

7.1.11 Accelerated Water Storage Development

Numerous water storage structures like Low Density Poly Ethylene (LDPE) and Ferro cement tanks are constructed to store water.

7.1.12 Role of Media, Communities and Professional Societies

People have to be made an integral part of the water management system. Media like T.V., Radio, FM channels etc. should play a vital role in educating the people and making them aware of the fact that water is precious and we must know how to use it judiciously. Communities and professional societies can conduct rallies exhibitions, painting competitions on water related matters, its proper use and conservation.

7.1.13 Water Management Measures for the Tea Gardens

Tea is a rainfed crop and remains with inadequate or no rain for a period of five months starting from December to April. During this period of five months plants suffer from water stress which affects photosynthesis, respiration and growth there is an internal water deficit causing dehydration of protoplasm, reduction in cell and leaf size. Scorching and wilting are the visible sign in drought prone areas, young tea plants suffer more which leads to death and the mature bushes suffer severely during the bud break which leads to late flushing. The measures adopted for water management are –

7.1.13a *Proper Shade Establishment:* Tea is a shade loving plant. Proper shade management not only provides leeway to the bushes from being exposed to direct sun but also acts as a good neighbour to the tea bushes by providing nutrient and water.

7.1.13b *Improving Soil Structure:* The prime factor before implementation of water management is to study the initial moisture content in the soil, which promotes cohesive forces of soil particles and water molecules. Soil should be in good tilth so that the roots can penetrate deep in the soil for an easy access to water and nutrient. Capillarity, infiltration, percolation and air movement is easy in sandy loam type of soil. Soil water content should be in between field capacity

and permanent wilting point. The soil structure should be improved by breaking the hard pans, rehabilitation of worn out soil by adding cattle manure, oil cakes, compost and mulching with grasses like Guatemala, Citronella, Lemon grass, pusa napier and water hyacinths etc. will provide organic matter to the soil and subsequently the population of micro organism will increase making various nutrients available to the plants by the process of mineralization.

7.1.13c *Mulching*: Mulching in young tea areas should complete before moisture depletes from soil and mulch materials dry out. Mulching is the practice of spreading an extraneous material on surface of soil to increase water infiltration, check evaporation, reduce soil erosion, improve edaphic environment and suppress weed growth. (Kumar et al., 2002)

7.1.14 Tillage and Land Grading

Tillage is known to increase infiltration rate, reduce evaporation and enhance root penetration into deeper layers of soil. Increased infiltration results in higher soil-water storage in the root zone of crops and greater availability of soil water for crop decreases the need for supplemental irrigation. Land grading is essential for uniform distribution of water by surface irrigation or undulating and sloping lands. It obviates chances of over flooding of low-lying areas and under irrigation of raised locations.

7.1.15 Fertilizer Use

Use of high doses of fertilizer should be avoided where water supplies are limited.

7.1.16 Cropping Pattern

The role of crop planning in making more efficient use of water is important because

a) crops differ markedly in timings and amount of their irrigation needs,
b) they exhibit a wider range of photosynthesis efficiency for similar water requirements and

c) they exhibit differential sensitivity to water stress imposed at various growth stages. Short season species grown during rainy season require less irrigation then the long duration and summer season species. Reduction of growing season by even a few weeks during summer can bring about a saving of one or two irrigations. Further, crops with deeper and more profuse root systems utilize greater amount of profit-stored water and can withstand drought better than the shallow-rooted crops. Mathematical models based on water production functions should be developed and used for optimizing cropping patterns for high water-use efficiency (Kumar et al., 2002).

7.2 SOIL-WATER MANAGEMENT

Soil-water management aims at soil conservation. Soil conservation aims at obtaining the maximum sustained level of production from a given area of land while maintaining soil loss below a threshold level (Morgan, 1986). The various effective soil conservation methods are 1) agronomic measures, 2) soil management and 3) mechanical methods.

Agronomic measures like planting cover crops, contour farming, mulching, strip cropping, inter-cropping with legumes, using high yielding improved seeds, fertilizers, manures, pesticides etc. should be practiced. Land from 33 to 50 percent slopes may be utilized for suitable horticultural plantations. Land shaping, such as orchard terraces may be used. Barren slopes, which have thin soil are not suitable for tree growth and thus may be developed into grasslands. Terrace risers in the agricultural land may be protected by growing fodder tree species or horticulture plants or grasses.

7.3 LAND USE AND CONSERVATION AGRONOMY

The differences in erosion rates caused by different land use practice on the same soil are much greater than the corresponding values from different soils under the same land use. Therefore, the best

land management may be defined as the most intensive and productive use of which the land is capable of without causing degradation.

Contour planting involves cultural operations across the slope i.e. by keeping them on contour or nearly so. The contour furrows so created would form a multitude of mini barriers across the flow path of the runoff which improves vastly the detention storage in situ.

Contour binding consists of constructing narrow based trapezoidal embankments (bunds) on contours to impound water behind them so that all the impounded water is absorbed gradually into the soil profile for crop use.

Graded bunds are constructed in relatively high rainfall (>600mm) areas where the excess water is to be removed safely out of the fields to avoid water stagnation. These are narrow based versions of the channel terraces where the design of the channel of a sufficient capacity rather than the embankment is important. In fact the bund serves only to guide the water spilling from the channel safely. The grade of the channel is predetermined, depending upon the soil type so as to be non-erodible under the action of the flowing water.

Bench terracing has been practiced in the steep hill slopes since time immemorial. Bench terracing, which involves converting the original ground into level step-like fields, constructed by half cutting and half filling, helps in reducing the degree of slope, substantially. In rainfed areas, bench terracing is practiced normally in the 16-33% slope range.

Grassed waterways serve as outlets for channel type of terraces to conduct the surplus waters safely into natural drainage courses without causing gullying. Where grassed waterways cannot be located in natural courses, they are artificially constructed and are located, if possible, along fence lines or hedge rows to avoid inconvenience to farm operations. Grassed waterways are usually constructed one or two seasons ahead of the construction of channel terraces and diversions so that by the time the accumulated excess runoff is let into the waterway the vegetation in it is well established to take care of the

onslaught of the following water and no gullying takes place. The vegetation in the grassed waterway should be periodically trimmed, bushes and shrubs removed. Sediment accumulation in the water course should be cleared periodically.

Diversion drains are provided at the top of the arable area to intercept the uncontrolled flow of runoff water from the upper catchment area and to conduct it laterally safe into a natural or protected water course. The provision of diversion drain is vital since all the conservation structures lower down in the cultivated land are designed with the assumption that the water from the upper non-agricultural land is safely diverted. If the diversion drain fails to serve this purpose, the water released from the system is almost certain to breach all the structures in the agricultural area. Diversion drains are also provided to divert the storm runoff away from gullies so that gully head extensions can be avoided. While grassed waterways are constructed along the prevailing slope, diversion drains are provided across the slope on a slight gradient.

Gully plugs prevent the eroding and down cutting of gully beds. They reduce the gully bed slope thereby reducing the speed of runoff water, redistributing it and improving the percolation. They encourage the deposition of silt and create favourable soil moisture regime for the development of plant cover. Gully plugs of various materials such as brushwood, log, earth, boulder, sand bag, brick and stone masonry are used in India. The size and material used for gully plugs depend on their width, length and bed slope (Tajwani et al, 1960).

Land levelling or grading is done by removing excess material from high areas and filing the low areas, to remove the surface irregularities, to make the surface plane and control the flow of water. This provides better surface drainage and checks soil erosion.

Jhora training is done by making permeable gabion drop and guide structures. The guide walls are provided along the bank in descending steps. The slope in the bed of the *jhora* is broken by providing gabion drops across it.

The catchwater drains are basically constructed for diversion of runoff from sites likely to get damaged more than others. Catchwater drains are used extensively for the treatment of landslides. Besides landslide, surface run off is also needed to be kept away from sinking zones. In such cases, a series of parallel catchwater drains are needed.

Retaining wall and breast wall have been the chief gravity structures, constructed along the roads. A retaining wall is a wall built to resist the pressure of earth filling deposited behind it, after it is built. A breast wall is a similar structure built to protect the freshly cut surface of a natural ground, whether with vertical or inclined face, to prevent it from fall due to the action of climatic factors.

The training of a river involves construction of revetments, spurs and retards to confine the flow and protect the bank from scouring.

Check dams are usually constructed in series, to raise bed level up to a height where safe support is provided to the slopes, to reduce the river gradient and to reduce the water depth by widening the river bed.

Palisades and wattles are constructed along the contours on the sloping ground having loose debris susceptible to move down slope at the slightest disturbance. Palisades are mechanical structures constructed on steeper slopes. These are pole terraces, which increases the debri holding capacity of the slip. These are usually applied on slopes steeper than 30 degrees. Wattling, on the other hand, are more biological in nature and are applied on milder slopes with slope less than 30 degrees.

Choice of Crop: In older days, crops were divided into two categories, viz. row crops or erosion permitting crops or soil robbers and erosion resistant crops or soil conserving crops or soil builders. Soil erosion depends not on what crop is grown but on how it is grown. So crop management is more important than the type of crop. Crop canopy should be such that it covers maximum exposed land. Plant roots are the best binding factors for soil. Grass root followed by legume

Photograph 7.1 Soil Conservation Method (Palisade)

Photograph 7.2 Soil Conservation Method (Protecting Wall)

root, help in improvement of soil structure owing to higher root mass and root secretion, which help in binding of soil particles.

Cultural practices includes the following:

a) Land preparation including post-harvest cultivation and preparatory tillage influence and rather increase infiltration rate, obstruction to surface flow and decreases the rate of erosion.

b) Advancing dates of sowing, at times, help in soil-water conservation.

c) Contour cultivation, adopted on sloppy lands, controls soil erosion.

d) Too dense crop geometry may lead to severe moisture and nutrient stress from soil. So crop population and crop spacement should be such that less soil gets eroded. v) Advantages of mixed cropping are good crop cover, feeding of crops from different soil layers and under rainfed an assurance to farmer against total crop failure.

e) Mulching of open land surface in a cropped area is done by spreading stubble, trash or any other vegetation. The objectives of mulching are to minimize splash and influence of rain on bare surface, to reduce excessive heating and to allow microbiological changes to occur at optimum temperature. The different types of mulching are polyethylene mulching, stubble mulching, trash mulching etc. The limitation with mulching practice is the non availability of plant residues for mulching purposes.

f) Adoption of organic manures and green manures not only supply plant food elements like fertilizers but also help in improving the soil physical conditions. Soil structure and infiltration rate increases there by reducing soil erosion.

g) Crop residue retention was found to be a valuable asset for the reduction of soil erosion but is practiced mostly in the developed countries.

h) Line sowing of mixed crops give rise to intercropping which reduces soil erosion.

i) Strip cropping involves growing of few rows of erosion resisting and erosion permitting crops in alternate strips on contour or across the slope with the objective of breaking up long slopes on farm and preventing erosion and soil loss

j) Crop rotation involves incorporation of legumes with cereals in a sequence in order to take advantage of different feeding zones, both for nutrient and water, and to offset disadvantages of mono-cropping in controlling insects, pests and diseases.

The aims of soil management are to maintain the fertility and structure of the soil because fertile soil results in higher crop yield, good plant cover and therefore, in conditions which minimize the erosive effects of raindrop and run off. Good soil fertility can be achieved by applying organic matter because it improves cohesiveness of soil, increasing water retention capacity and also promotes a stable aggregate structure.

The various mechanical measures (also called engineering measures) usually involve construction of mechanical barriers across the direction of flow of rainwater to retard or retain the run off and thereby reduce the soil and water losses.

The important principles to be kept in view while planning mechanical control measures (Rama Rao, 1960) are:

a) Increasing the time of concentration of run off and thereby allowing more of it to be absorbed and held by the soil.

b) Intercepting a long slope into several short ones so as to maintain less than a critical velocity for the run off water. c) Protection against damage due to excessive run off.

7.4 NATURAL RESOURCE MANAGEMENT

In the mountainous areas, arable land is limited and existence of forest is a must. So there is less scope of expansion of agriculture at the cost of forest. Forest land is very important for the survival of the mountainous ecosystem. Forests not only checks soil erosion but if managed scientifically can provide sufficient fuel and fodder to the

people of such regions. High population growth exerts tremendous pressure on the forest land. Deforestation is very harmful for the maintenance of balanced ecosystem. So forest being one of the most important natural resource, needs proper scientific management for the sustainability of the fragile mountain ecosystem. There is huge scope of turning wastelands into forests to save the ecosystem. Moreover healthy forestry practices can lead to economic development of an area. Presently, sustainable development is redefined as a management system for the use of renewable natural resource that ensures food supplies, income and livelihood for present and future generations and improves rather than merely maintains the economic productivity and ecology of those resources. Forest lands are classified under Reserved Forest, Protected Forest and Unclassed forests. Reserved forests are scientifically managed and well stocked to provide effective cover to the soil. Protected Forests are forests whose, unless otherwise prohibited, rights of user are admitted in respect of forest produce, grazing, break-up land for cultivation etc. These forests are over-exploited and hence subject to erosion. Unclassed forests comprise of village forests, panchayat forests, civil and soyam forests. Owing to unscientific management and unregulated over – exploitation, these forests are also degraded. To regain all such degraded, highly eroded and deforested lands, correct forestry practices are the need of the time. By proper measures, based on scientific principles of silviculture and other forest managements, forests could be availed of in perpetuity, without further degradation. Various methods of forest management have been developed taking into account the type of forests, the requirement of the species, with particular reference to soil, water and light conditions, favourable for their growth and local or industrial needs for produce from the forest. To develop natural resource like forest, availability of area specific healthy seedlings is very important factor. So the first move is to set up proper nurseries which can produce the various seedlings required for the proper functioning of the forest management programmes. Organization like World Bank, funds for the development

of natural resource of any area. The objectives of different forest management programmes are discussed, from where proper methods have to be selected for the development of the study area.

7.4.1 Social Forestry

Social forestry is the practice of planting trees on barren lands, wastelands, along the roads, canals, railway lines etc. The main components of social forestry are strip plantation and farm forestry.

7.4.2 Farm Forestry

The basic component of operation is the organization of a substantial programme of the planting of trees on the bunds or boundaries of fields of the farmers, which is to be taken up by the farmers themselves. The basic objective of 'Vana Mahotsav' accepted in the planned development of forestry is to encourage farmers to participate in this programme and regenerate forests for their own benefits. The Govt. has exempted the value of trees standing on agricultural land from wealth tax to encourage afforestation. It meets the fuel wood demand of the rural areas and generates a source of income to the villagers.

7.4.3 Strip Planting

Strip planting not only reduces pressure on natural forests but also creates sufficient resources on public and private lands for meeting the local demand of timber, fuel wood and fodder. Strip planting along the road side is also intended to have an aesthetic appeal.

7.4.4 Joint Forest Management

The idea of joint forest management was introduced to protect and develop the degraded forests with the co-operation of fringe dwellers. Under JFM, the forest fringe dwellers participate in the protection of the forests and its resource in lieu of which they are granted certain benefits. The dwellers are allowed "25% of the sale proceeds at every final harvesting of the concerned plantation/forests (i.e timber, pole etc). They are also entitled to collect 'fallen twigs, grasses, fruits, flowers, seeds etc." as well as one forth of the produce obtained as intermediate yield from multiple shoot cutting, thinning

etc. For all these, the dwellers have to form the Forest Protection Committee (FPC). The FPC is formed by dwellers living near the ordinary forests. After the formation of the FPC, the members have to involve themselves at least five years in forest protection before being eligible for the benefits. The FPCs are formed by the divisional forest officer in consultation with the local panchayat samiti. The committee selects the beneficiaries, identified from amongst the economically backward people. The main objectives of JFM are to conserve and improve forest productivity.

7.4.5 Agro-Forestry or Inter – Cropping

The term 'Agro-Forestry' encompasses any and all techniques that attempts to establish or maintain both forest / tree and agricultural production on the same piece of land. Agro-forestry is a system of land use which combines growing or raising crops (and or livestocks) with woody plants. Land can be used to produce agricultural crops- agriculture; animals and their products – animal husbandry; and trees and their products – forestry. The product can be obtained by either growing or raising them separately or in different combinations. Agro-forestry includes silvo-pastoral, horti-pastoral and fodder–fuel plantation system. The fuel fodder plantation or silvo-pastoral system of grassland development is probably the best system for overcoming the shortage of fuel and fodder. This can be practiced on vast areas of cultivable wastelands and marginal forest lands. The leaf fodder is rich in nitrogen, crude protein, phosphorus etc. and can reduce cost on concentrates fed to animals during lean season of fodder availability. Fodder trees like *Lencaena latisiliqua*, *Albizzia lebbek* etc. are highly recommended. When in orchards, fodder crop is grown, it is known as horti-pastoral system. Raising horticultural plants on a degraded land is more profitable and economical per unit area per unit time as compared to that of trees or gasses. Where soil and climatic conditions are favourable, either multi-storeyed cultivation of horticulture plants or agronomical crops with fruit trees (orange and ginger etc.), can be raised successfully and thus increase the productivity per unit area per

unit time. Cultivation of fruits is a highly remunerative enterprise. Horticulture has been, is own and will continue to be of great economic, political and social importance to mankind. Present day horticulture may be defined as the science and technology involved in production, processing and merchandising of fruits, vegetables, flowers etc.

Livestock management is a type of natural resource management because livestocks not only provide milk and meat but they are used as traction power and for transport. They also produce ample organic manure. Proper grassland management if implemented, then livestocks can easily get their share of fodder from such grasslands. Fast growing grasses with high nutritive value, needed to be grown. Pisciculture is another way to lead to sustainable development. Water bodies artificially created or natural fishes of fast growing variety which has high economic value. Cultivation of medicinal plants may be of great economic importance because demand and export of these valuable herbs is increasing day by day. Trained manpower is needed for collecting, drying, grading, storing and marketing of these herbs. The medicinal species need to be conserved and managed in a scientific and judicious manner by planned cultivation on the pasture lands. The cultivation of herbal plants will boost the economy of the region.

7.5 HUMAN RESOURCE MANAGEMENT

Human beings are the most intelligent among all the creatures in the world. Such a resource needs proper utilization for the development of the society. Human resource is useless if not utilized properly. To develop human resource, attainment of knowledge and education is very important. People have to be educated not only academically but also scientifically and technically. Skilled human resource in different spheres of life is important. Constant research should be carried out to develop the human resource. Along with education, there should be enough scope of employment. Employment generating units like IT sectors, tourism sectors and industrial sectors should be opened up. Training in floriculture, horticulture, technical skills should be

imparted which can lead to self sufficiency by self employment. To develop human resources, growth rate of human beings should be checked by applying different birth control measures. Environment and living conditions of people has to be developed by providing them with all the basic amenities, necessary for life. Human activities need to be eco-friendly for the sustainable development.

CONCLUSION

Since soil erosion, is one of the major problems of the study area, so immediate attention is given to the importance of soil – water conservation in the study area. Water has to be channelized properly so that there is minimum loss by various methods. Artificial recharge can be practiced in the foot hill regions. Recycling and reuse of water, conserves water to a great extent. The leakage in pipes and water supply systems need proper attention. New methods like grey-water recycling, exroscaping, rain water harvesting needs to be practiced on a larger scale. Above all people has to be made aware of the fact that water is precious and needs to be used judiciously. In agricultural fields water wastage can be managed by proper utilization of water and applying scientific techniques. Methods like mulching, choosing proper cropping pattern is gaining importance in the study area. Soil conservation measures like contour planting, terracing, construction of diversion drains, *jhora* training is to be done extensively in the study area. Natural resource management by social forestry, joint forest management, agro forestry should be practiced by the people of the basin. Afforestation by planting local, fast growing varieties will help in sustainable development of the area. Human resource management can be rightly done by educating the general masses and developing responsibility sense among them regarding their surround environment.

Apart from different management methods which are suggested to be adopted in the study area, review of the past strategies which were already implemented for the development of the basin in general

and the people in particular, is to be done on an urgent basis. New strategies should be formulated for the present situation and suggestions should be given for future development. All these are done in the following chapter, for the overall development of the study area.