Soil and Water Conservation Measures for Alternate Land Use Systems

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Introduction

Land degradation is a major cause of productivity losses and soil erosion is the most serious one among the various factors affecting land degradation. Therefore soil conservation is of primary importance in any land development work. Also, in drylands, soil water (moisture) conservation is of vital importance for successful crop production. There are many time-tested technologies for soil and water conservation that can be adopted for Alternate Land Use Systems whether it is Horticulture, Agro-horti systems, Agro-forestry, Silvi-pasture system or any other. The type of soil and water conservation measure will depend on the size and shape of the areas to be developed for cropping, its location with in the watershed of which this area is a part, the kind of plantation being taken up etc. For small areas, in situ conservation practices such as formation of basins, or micro relief systems and agronomic conservation practices may suffice whereas for large plantations, watershed scale development work may have to be taken up.

Diversion Drain:

Diversion drains are used to divert runoff water coming from the upper reaches of an area so as to avoid erosion in the cultivated area. Usually, they are aligned along contour as far as possible with some gradient provided to facilitate flow of runoff water. The diversion drains are designed to safely convey the peak runoff from the watershed area above the land being developed. Usually, they are of trapezoidal cross section with stable side slopes depending on the type of soil. The dug out earth is generally put on the down slope side and shaped to form a bund. Such bunds enhance the runoff handling capacity of the diversion drain and can be planted with useful grass (eg. *Cenchrus ciliaris,* bushes (eg. *Pongamia, leucaena* spp.,, *glyricidia,* etc.). *Glyriciidia* grown on bunds can be used as mulch-cum manure for the fruit/ tree plantations for conserving soil moisture and improving soil fertility.

The diversion drains are essentially to be connected to a protected water-way or drainage line. Special measures such as grassing, vegetative checks and drop structures may be needed to protect such drainage ways to take care of the enhanced runoff expected to be handled by them because of the additional runoff from diversion drains.

Bunding and Terracing:

i. Earthen bunds:

Bunding and terracing are done to protect the cultivated land from soil erosion and also to conserve rainwater with in the cropped area (unbunded lands are susceptible to runoff concentration and consequent soil erosion). The runoff may carry along with it fertile topsoil and also organic matter and some times applied fertilizers and manures with it. Such losses are to be prevented.

Earthen bunds are generally recommended for slopes upto 6 %. They are preferably laid out on contours with gradients to facilitate conservation of rainwater by allowing more opportunity time to infiltrate into soil and drain the excess water safely within permissible velocities. There are formulae for arriving at the vertical interval between two consecutive bunds but in most cases, 0.5 -

1.0 m vertical interval can be adopted. If the bunds are laid out on contours, 0.21 sq.m. cross section is sufficient in most situations (bottom width: 1.0 m, top width: 0.4 m and height: 0.3 m). However in private property development, existing boundaries are to be respected and bunds have to be suitably designed and constructed. Bunds are laid out across major slopes along the field boundaries in such cases. Such bunds may have to be strengthened along local valley lines/undulation and provision of waste weirs made where necessary. All such bunds must be protected with grasses and where permissible, with bushes and trees of economic value (eg. *Cenchrus ciliaris, Stylo, Glyricidia, Subabul,* teak and flowers such as marigold and even vegetables can be grown on bunds).

ii. Stone bunds and stone pitched bunds:

In some areas (eg. Anantapur, Hindupur in Andhra Pradesh), stones and pebbles occur naturally and removal of them may be desirable for establishing Alternate Land Use systems.

In such areas, stone bunds could be made with the removed materials, thus serving two purposes of land reclamation and bunding for soil and water conservation. In certain cases, if the boulders are fewer and bigger, they can be used to pitch the downstream side of earthen bunds constructed on steeper slopes providing protection and stability to bunds.

iii. Bench terracing:

If the slope is steep and the bunds/terraces are too close, it will be better to develop them into bench terraces. Bench terraces are usually made by half-cut-half fill method where soil depth permits. However, in drylands and wastelands, topsoil depth is limiting and it is not advisable to resort to land leveling. In such areas, stone bunds or stone pitched bunds can be spaced in such a way that, over a period of time, they become bench terraces by gradual deposition of soil on the upstream of the terrace.

Waste weirs:

In all cases of land development, it is necessary to make provision for disposal of excess rain water from a given area. The soil has a certain capacity to absorb rain called infiltration capacity (which is high initially and varies with time and finally stabilizes at what is called the basic infiltration capacity, an inherent characteristic of given soil). When the rate of rainfall exceeds the infiltration rate at a given point of time, rainwater accumulates over soil surface and tends to flow down. This is called runoff. Such runoff has to be safely taken out by providing suitable waste weirs or spillways. Waste weirs can be made by a variety of materials such as grasses, stones, pipes, etc. They have to be so designed that they are capable of carrying the peak runoff expected from the drainage area above it. They are usually located at the lowest point of the field forming the inter-bund area.

Waterways:

Runoff coming from several waste weirs is carried along a waterway. A waterway preferably should have shallow depth and flat side slopes. They have to be protected with grasses. And if the gradient along the waterway is steep, drop structures may have to be constructed at frequent intervals. A drop structure is one, which allows passage of runoff from a higher elevation to a lower elevation within the waterway over a protected control structure without causing erosion/damage to the waterway. Where the drop or elevation difference is about a feet or so, vegetative check such as agave can be adopted. If the drop is higher, special stone/masonry drop structures may have to be constructed.

Although it is advisable to align the waterway along natural drainage lines, it may have to be taken along field boundary lines when developing private property resources.

Loose boulder check dam:
As mentioned above, if the plantation area has a deep gully or waterway running through, the same has to be protected. Reclamation of gully may involve diversion of runoff above the gully through a diversion drain, construction of a series of Agave checks or loose boulder check dams. Loose boulder check dams consists of the body wall, side wall/pitching and apron to safely convey the runoff down stream. A series of low height loose boulder check dams, when constructed along the nala help in grade stabilization in between two consecutive structures preventing soil erosion and encouraging vegetation and greenery to establish.

Rainwater management:
For successful crop raising, adequate water should be made available. However in rainfed agriculture/horticulture, crops experience moisture stress during rainless/drought periods affecting crop production. Therefore it is essential to plan for soil moisture conservation and life saving/supplemental irrigations during drought.

In situ conservation:
Various basic land treatments such as bunding and terracing will help in retaining more water within the watershed/plantation area. Water retention can further be enhanced by having what are called in-situ conservation practices. In situ conservation practices or inter-terrace land treatments aim at conserving soil moisture right near the plants by guiding, concentrating and retaining runoff. This is achieved by some kind of land configuration. In the case of fruit/tree plantations, basins, crescent bunds, diagonal bunds, contour trenching, etc can be adopted to intercept, guide and store runoff in the root zone of plants for its effective utilization

Another means of conserving soil moisture is by reducing the evaporation losses by mulching. Mulching usually consists of organic or inorganic material laid on the surface around the plant. Examples of organic material are: plant residues, stubbles, paddy husk, *Glyricidia,* etc. the advantages of organic material is that when decomposed, they improve the organic carbon in the soil and hence improve the fertility. However, the disadvantage is that some material may decompose fast and will be less effective as a mulch cover. Mulches will have to be applied frequently in such cases. Examples of inorganic material are: stone/pebble mulch, polyethylene sheets, etc .

Micro-site improvement:
In soils like alfisols with shallow top soil and soils with poor fertility, micro-site improvement can considerably enhance seedling/sapling establishment and plant performance. In this technology, pits of 1m x 1m x 1 m are taken and refilled with a mixture of top soil removed from the pit, sand and tank silt in equal proportion along with fertilizer supplements. Such pits have higher water holding capacity which in turn, helps in withstanding drought.

Ex-situ conservation:
It is not always possible to retain all the rainwater in the cropped area. Inevitable runoff from the area can be harvested and stored in suitable water harvesting structures such as farm ponds for its recycling and use for various purposes such as life-saving irrigation, drinking water for cattle in farming

systems approach, plant protection, recreation, etc. In rained areas, it is essential to plan for supplemental/life saving irrigation for successful establishment of plantations.

However, farm ponds dug in porous soils will have to be lined to control seepage and percolation losses. Small ponds can be lined with material such as HDPE or brick with cement plastering; the cost could be prohibitive. The seepage loss would reduce over a period of time when fine clay brought in by the runoff particles seal the pores and make the pond bed less permeable. It is often advisable to go for embankment type of pond rather than a dug out one to have a better storage/earthwork ratio, if suitable sites are available.

One of the major constraints in the adoption of farm ponds is that the quantum of water that can be stored is small in relation to the demand and its availability also is not always assured. The benefit cost ratio of farm ponds is therefore not always favourable. A conjunctive system of surface and ground water together with adequate ground water recharge structures could perhaps go a long way in the effective utilization of this scarce resource i.e. rainwater in drylands.

Sometimes, ponds/tanks are constructed with the sole purpose of recharging ground water. In such cases, percolation is an advantage and such structures are then called percolation ponds or percolation tanks. Here, the idea is to augment ground water and use the same through dug wells or bore wells.

Conclusion:

Soil and water conservation practices such as diversion drain, bunding and terracing, in-situ and ex-situ conservation practices can help control soil erosion, enhance water availability and increase productivity of Alternate Land Use systems. They also help in enhancing vegetation and greenery and overall improvement in the quality of environment.