CHAPTER VII

EARLIER STRATEGIES OR MEASURES IN CONSERVATION OF SOIL AND WATER

INTRODUCTION :

The soil conservation is not entirely unknown in Darjeeling Himalayas including the study area . A large number of soil conservation strategies or measures are in vogue for quite some time . Some of these techniques , especially those used by farmers , are age old and based on common sense . Others have some scientific backgrounds though they do not always incorporate the latest developments in the fields of soil conservation . The earlier strategies discussed in detail relate to those adopted by different Government Departments , by individual farmers and by tea garden managements . Different schemes by Government aimed at conservation of soil and water , too , have been discussed in detail .

By and large , Government Departments are the most important agencies taking up works of soil and water conservation and the strategies adopted by them are discussed.

7.1 GOVERNMENT MEASURES FOR SOIL AND WATER CONSERVATION :

Two departments of State Government taking up soil and water conservation works in a big way are, the Departments of Agriculture and the Department of Forests . The former takes up such works in agricultural lands whereas the latter in the forests and , occasionally , in the fringes . Some soil conservation works , especially river bank protection works are also taken up by the Department of Irrigation .

7.1.1 JHORA TRAINING :

Among all the soil conservation measures taken up by the Government Departments , the jhora training is probably the most common. A large number of jhora and rivulets , looking completely dry during summer become torrential during rains in high rainfall humid tracts of eastern Himalayas . The volume of water flowing down the drainage lines as runoff is quite substantial . The intensity of the flow is further abated by the fact that rains are highly concentrated during 4 - 5 months when monsoon is active . For example , in the study area , during the period 1990 - 1995 , a little more than 92 percent of total rainfall (4122.70 mm out of 4459.3 mm) has occurred from May to

September . In terms of number of rainy days , more than 83 percent (109.5 days out of a total of 131.1) have occurred during the same period (Table 1.2) . This combined with high relief makes jhora and rivulets quite violent . Rock outcrops jutting out of beds , debris of huge boulders or interlocking miniature spurs , make the drainage lines pass through a tortuous course . Water flowing at a high velocity in steeply descending narrow channels sets up an appreciable tangential stress acting on the bed of the channel (Riedl , 1984) . This water flow sets in motion compacted detrius , boulders , gravels , pebbles and disintegrated products of weathered rocks . This causes lots of damage of banks by way of scouring and erosion of channel bed with bank failures or slumps . This is specially serious when jhoras pass through rock formations which are softer . The danger of such jhora shifting themselves always exists . This is precisely to take care of such shifting that jhora training is necessary .

The technique for training of jhoras in the study area is by making permeable gabion drop and guide structures . The guide walls are provided along the banks in descending steps . The slope in the bed of the jhora is broken by providing gabion drops across it . Care should be taken that top of the following drop is at the same level as the bottom of the preceding one . Several such drop and guide structures are seen as one passes through the Hill Cart road . Many of them have been constructed by the Public Works (Roads) Department , Govt. of West Bengal .

While there are a few such drop and guide structures which have failed on account of excessive flows spilling over the provided section , there are large many which are dry or have very meagre flow even during the strongest rain storm . It appears that proper hydraulic assessment has not been done while constructing resulting in wastage of resources . Absence or inappropriate hydraulic computation of possible peak flow in the jhora for a reasonable period of recurrence interval coupled with the apprehension that it might fail , usually results in the structure , more often than not , over - designed . Such jhora training has been done in Bangla khola, Rinchintong, and several others between Sonada and Rongbull. Khola just before Sepoydhura has also been treated with this measure.

The maintenance of the drop and guide structures is the most neglected aspect in jhora training works in the study area . Lack of maintenance often results in the entire thing getting washed down . Another menace for such structures is the theft of wire netting and stone boulders . The problem of theft has aggravated after the political turmoil in the hills in later half of 80s . Drop structures , over the years , accumulate fine sand and silt behind them where lots of weeds and bushes come up restricting the flow . The flow then spills the guide walls , scours the banks beyond them . Many a structures in the study area have failed this way .

7.1.2 CATCHWATER DRAINS :

The catchwater drains are constructed with the basic purpose of diversion of run-off from sites likely to get damaged comparatively more to ones where it shall be little or none . This is because of the fact that wherever the natural drainage are interfered with , they attempt to redesign themselves for adjusting to changed flow characteristics . This is also , however , true that some locations become so fragile on account of continuing defective land management or hydraulic practices that , unless the run-off is completely excluded from them , they may soon degenerate into mass movement . Comparatively speaking , diverted run-off shall do a lesser damage elsewhere .

One of the main areas where catchwater drains are used extensively is the treatment of landslides . The head of any landslide along with its banks on higher reaches is the most active . Surface run-off enters the head making it progress further uphill . As the debris material slides down slope , banks slump , widening the slide scar progressively . Besides overland flow , landslides , especially in wet eastern Himalayas get profuse sub-terranean flow of water . A high rate of 5 - 12 mt per hour of the sub-surface flow even during springs has been observed (Froehlich et al , 1991) . Water seeping down scores of meters uphill of the landslide , might be getting its way to the landslide . To eliminate such eventualities , the catchwater drains are utilised . Usually a series of catchwater drains are needed above the head of the landslide . All of them should run parallel to one another , should have non- erosive gradient ,

should preferably be lined with cement mortar and should be directed in any jhora having stable bed and bank . This helps remove surface flow quickly from the site upslope of slide head . This prevents rainwater from entering slide either as a surface flow through head or brims of slide or as a sub-surface flow down below . In highly permeable rock formations , higher concentration of catchwater drains are needed to cut seepage of water as much as possible .

Besides landslides , surface run-off is also needed to be kept away from sinking zones . Such zones are associated with highly fractured rock material characterised by high density parallel drainage lines . Here , too , a series of catchwater drains running parallel to one another are used for diversion of run-off and to cut out seepage of water .

In the study area, it is seen that proper hydraulic computation for the dimension of the catchwater drains is not done . The dimension of a catchwater drain is a function of its catchment area , the material which it is made of , gradient provided to it , and the rainfall intensity for the recurrence interval the structure is designed for . Improper designing makes some overflow with the mildest of storms and others underflow even with the severest ones . In both the cases resources are wasted ; in former by failure , and in latter by under-utilisation . Besides defective dimensions , gradients , too , are some times improper . Catchwater drains constructed with cement mortar are , some times , provided steeper than permissible gradients realising little that every construction material has an

erodibility . This results into failures . Many an ill-designed catchwater drains , even with cement mortar , have ended up in deep eroding gullies .

7.1.3 RETAINING WALLS AND BREAST WALLS :

Retaining walls and breast walls have been the chief gravity structures being used quite extensively along the roads in the study area. A retaining wall is a wall built to resist the pressure of earth filling deposited behind it after it is built . A breast wall (or face 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 stability of bank slopes depends on several factors . Safe slope of a bank with granular material does not decrease as the height increases because its shearing strength increases as the banks become higher (due to additional weight) . The safe slope of a clay bank becomes flatter as the height of the bank increases because its shearing strength does not increase to resist the corresponding increase in the height . The steepness of the safe slope of an embankment depends on the shearing strength of soil . The natural , the strongest and the ultimate form of the earth slope is a concave curve with the flattest portion at the bottom . In constructing slopes the reverse of this form is most often made , which invites landslips . Straight or convex slopes continue to slip until the natural form is attained (Khanna , 1982) . In cutting, concave slopes should be formed to avoid slips .

Large number of retaining and breast walls have been constructed for protection of road benches in the study area . Besides roads , protection to homestead lands , bridle paths , buildings and other structures , too , has been given by the protection walls . The terrain in the study area being quite steep and rugged coupled with high rainfall (in terms of quantity as well as intensity) , it is impossible to build any large structure without retaining or breast wall . In most cases, these gravity structures depend solely on their weights to resist the thrust of the back fill . This is because often bed rock is not economical to find to anchor the foundation of such structures . This makes them quite vulnerable to overturning and sliding (Plate 11).

It is seen that materials likely to slip are not removed and slopes not trimmed and flattened before constructing the retaining walls . In some instances , absence of inadequacy of weepholes is the cause of failure (Plate 12). The fact that under poor drainage conditions , the tendency of backfill to slip is very much increased when the material gets saturated with water is often ignored .

7.1.4 RIVER TRAINING :

The training of rivers involves construction of revetments , spurs and jetties (retards) to confine the flow and protect the bank from scouring . This may also include training walls , made of flexible semi-permanent materials used in double rows , parallel to banks , to facilitate settling

PLATE 11 : RETAINING WALL ABOUT TO SLIDE

(GOETHAL'S RESUME FOREST)

PLATE 12 : A MASSIVE RETAINING WALL WITH SCANTY WEEPHOLES (DILARAM)

down of silt and growth of vegetation . Temporary or permanent structures are needed to be constructed in steeper sections for facilitating siltation and for stabilisation of grades .

Erosive scouring of the banks at the outside of the bend tends to increase as the curvature and the length of arc increases , the greatest scouring occurring just behind the point where radius of curvature is the smallest , and continuing for a distance approximately twice the width of the channel at the water level (Riedl , 1984 A) .The smaller the radius , the deeper is the scouring . Both , the length and the radius of the rivers bend are very important in shaping of the channel .In natural water courses meanders are of common occurrence . These develop most rapidly during flash floods when erosion at bends is the greatest , the flow being strongly deflected from the outside bank of the curve back to the inside bank , thus bringing about a gradual change in , both , the length and the curvature of arc .

The study area being hilly and quite steep , most rivers , except in very little of their lower reaches , are torrential in nature . Some river training and stream bank protection works have been done in these parts by tea garden management as most of such stretches of rivers pass through one or the other tea garden . In the higher reaches , where forests are located , no such works are seen . It is seen that the designs of spurs or groynes is defective . The locations of groynes , too , has not been done as per standard principles of the hydraulics of torrential flow in channels . Often continuous bank protection is

given even on the straight stretches . These structures are not protected by retards against scouring by the flow . This results in scouring of foundations of these gravity structures leading to their failure (Plate 13) . Sometimes rooting of groynes inside bank is not properly done resulting in dislodgement of the structure . If retards and groynes are not placed as per the hydraulic requirements of bank protection , streams scour banks behind their roots resulting in failure . At some places , retards have been made in such a way that they interfere with the channel itself . The fact that the retards must be erected as elements of an integral system providing a smooth line of flow along their heads , is often overlooked . It is not difficult to find existence of flow in between two retards . This is highly undesirable . This defeats the entire purpose and renders total expenditure wasteful . That the retards should usually slope downwards from their roots to head , is often neglected .

7.1.5 CHECKDAMS :

The most important device to control the torrents and gully erosion is the construction of checkdams by Govt. Departments. They are mostly used in series . The basic purpose of construction of checkdams is 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 (and hydraulic radius) by widening the river bed . The checkdams are mostly endangered by scouring . Foundation depth and the spill way size

PLATE 13 : SCOURING OF FOUNDATION AND FAILURE OF TRAINING WALL

have , therefore , to be selected taking scouring into consideration .

Because of highly fluctuating discharge in , and very steep gradients of , rivers checkdams are not very popular in the study area . Most of the rain fall in this region is concentrated between June and September with occasional very severe rain storms . A dry river during off monsoon period , turns turbulent and torrential in monsoon . In addition , steeper gradient and fragile embankments , too , discourage use of checkdams as a soil conservation tool in the study area . Heavy discharge makes wide spill way imperative to keep hydraulic radius of flow low to ward off scouring . The rivers flowing in narrow deep gorges often do not allow such opportunity . This might be another reason for non - utilisation of checkdam technology for soil conservation in the study area .

Yet another reason for non - application of checkdam technology is chronic failure of aprons in most hydraulic structures in these parts . Since the flows are quite turbulent , snaking their way through deep gorges containing huge pleistocene boulders in their beds , one menacing feature of flow in these parts is the rolling boulders . Any boulders which is loose and gets completely inundated in swiftly flowing water starts moving down stream . As soon as a checkdam is encountered , velocity of flow lessens and the bed load fills the back of such structures . The gradient of river reduces and , consequently , velocity lessens , depth of flow and its hydraulic radius increase . This inundates even larger boulders which start moving even with

reduced velocities . As the average rock material has a specific gravity of about 2.65 , in the water it has considerable buoyancy , and a rock loses from half to third of its weight in air when entirely submerged (Raistrick , 1973) . This enables very large masses of rocks to be moved , which , even if moving with low velocity , acquire enormous kinetic energy and become powerful tools for breaking down other obstructions , including checkdams , and for grinding other rocks . In many cases , such rolling boulders fall on the apron of the checkdam and other hydraulic structures damaging them . Once the apron is gone , the rest of the structures follows the same course soon .

Yet another reason for absence of checkdams could be the effect of swelling water behind the checkdams . Because of fragile rock formations , sloughing of banks is a strong possibility after the river bed is raised by checkdams.

Some stream sections in the study area have milder gradients and offer possibilities of construction of checkdams with wider spillways . In few of them, checkdams have , however , been constructed and are operating successfully . One such prominent checkdam is located about 100 mt downstream of Dilaram tea garden factory on Rinchintong river . This has a small spillway which alone conducts water during periods of lean flow . During storms , water spills over the entire checkdam . This structure is working effectively for quite some time . There are several such sites in the study area , especially in lower reaches of streams , where checkdams could be very effectively used to ease out river gradients and to reduce the velocity of flow .

Checkdams have been very effectively used in similar conditions world over and there is no reason for them for not being effective in these parts , given that adequate precautions are taken in accordance with local flow conditions .

Rubble checkdams with boulders , constructed in series , have , however , been extensively used in the study area for control of moving debris in smaller landslides . The surficial landslips have huge quantity of loose debris on their surface which move down slope , particularly during monsoon . Dry rubble checkdams of smaller dimensions are erected to control such movements . It is often seen that design and location of such dry rubble checkdams are defective . Proper batter is not given to the face of the structure and selection of size of boulders , too , is defective . This leads to their failures . The most serious flaw of this technology as practised in the study area by various Govt. Departments is highly inadequate maintenance of these structures . Since these are not anchored in the bed rock , they are pure gravity structures depending on their own weight for stability . Slight damage in one structure , if not mended quickly , leads to failure in a series of them down below .

The cheap and effective (on a short term basis) brush wood checkdam technology , too , has not been used in the study area . This can be used to a great advantage .

7.1.6 PALISADES AND WATTLING :

Palisades and wattlings are two important modes of soil conservation in controlling gullies , landslips and slides in the study area. The structure is erected mostly with locally available materials . Due to this , they are quite well suited for such soil degradations located in inaccessible areas . Both , 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 , also called as balli (pole) terracing , are constructed on steeper slopes , the basic aim being to increase the debris holding capacity of the slip . Palisades are , by and large , mechanical in nature . The biological measures of stabilisation follow after the moving debris is established by covering the entire slip by palisades . Palisades are usually applied on slopes steeper than 30 degrees . Hard wood bullies 10 cm in diameter and 1.7 to 2.0 mt long are fixed vertically along contour , are spaced 50 cm apart and are fixed 80 to 110 cm below the ground 90 cm being above it (Govt. of West Bengal , 1995 A) . Usually seven such posts should be fixed making a 3 mt long palisade as a single unit . The above ground parts of posts are woven with brushwood material or with splitted bamboo .

Wattlings , on the other hand , are resorted to on milder slopes (less than 30 degrees) and are more biological than mechanical in nature . The posts in the palisades are replaced by 8 - 10 cm thick , 90 cm long cuttings of sproutable

species and are fixed with 30 cm of it being above ground . To break the slope and for lowering down of the water table , 30 cm wide and 60 cm deep discontinuous staggered contour trenches are made . The sproutable cuttings are fixed on the down slope edge of the trenches and the upslope part of the trench is partly (about 40 cms) filled with brush wood bundles and rest with boulders . A brushwood net is woven around the above ground part of the sproutable posts . Wattles , too , are made in discontinuous lines to make any subsequent failure localised . Good soil binder species are planted in the inter - wattle area (Govt. of West Bengal , 1995 A) .

In respect of palisade and wattling it is seen that long line of them are made and failure at one point due to excessive debris disrupts the entire structure . Sometimes , in palisades , improper or inadequate embedding of posts results in overturning of structures. It is also seen that palisades are made on very mild slopes leading to wasteful expenditure of resources . Similarly wattling is made on steep slopes with actively moving loose debris . In no times wattles are overwhelmed by the moving debris and the sproutable species , before they could sprout and provide protective cover to soil , are buried under them . All the soil binder species planted in inter-wattle area, too, meet the same fate. For effectiveness , palisades should be made so that top of the lower tier is at the same level as the bottom of upper tier . This is often not true in field conditions , probably , for reasons of economy as , going by that rule , large

many tiers , specially on steeper slopes , shall be needed . But it is never economical in long run .

The palisades and wattles are temporary cheap soil conservation structures meant to stabilise the soil with planting of some seedlings as an aid to the nature´s attempt to reclaim the land . These temporary structures need be effective till nature has provided sufficient stability to the soil . More often than not , this is not so . Once constructed , these structures are forgotten , altogether . This is not difficult to locate these structures of previous years broken down here and there and having had lost their effectiveness to a very great extent . These structures , which should be maintained at least for five years , are not maintained at all. Theft of palisade material for firewood is another problem which plays havoc with these structures in localities closer to human habitations .

Since , both , palisades and wattlings aim at speedy establishment of vegetation , there is a need to look at the loose or partially stabilised debris as a medium of growth for plants . This is never done . It is usually taken for granted that once some seedlings are put in , and some sproutable cuttings planted , they will grow howsoever impoverished the growth medium is . This is probably the most serious flaw in this technology as applied in the study area . There is a need for getting soil samples of such sites tested , and in accordance with the result of that , soil amended . Since it is wished to establish the vegetation with most possible quickness , the growth medium should be the optimum . The soils in

the study area being subjected to high degree of leaching , manure have to be organic .

The early or delayed planting of sproutable cuttings , too , sometimes cause failure . They either rot or dry out failing to sprout . There is a need to optimise the period cutting for each species for better results. The palisades and wattles , despite some defects in designs , have done commendable job in eastern Himalayas . But except a few Govt. Departments (Forest , Border Roads Organisation) , none have adopted these techniques . No private individual is seen practising this . There is a need to streamline the technique , remove the defects and disseminate this information to people at large .

7.2 SOIL CONSERVATION MEASURES BY INDIVIDUALS :

Progressive reduction of productivity of land exposed to eroding forces has put man on guard against soil erosion . A farmer knows the malady by his experience . The traditional corrective measures , too , are evolved that way only . Some common sense soil conservation measures have been adopted by individual farmers in the study area for ages . The chief among such soil conservation practices adopted by individual farmers is the terracing of land, protective vegetation belts, mulching, etc.

7.2.1 LAND TERRACING :

That , in hills , any land put to plough has to be essentially terraced for its sustained long term productivity , the farmer knows by his experience . There is no way out but to abandon an unterraced agricultural land after a few years as cultivation becomes highly uneconomical . Farmers terrace their fields in narrow strips , with risers made of dry rubble masonry . In due course of time , these risers get covered with thick mat of grass giving it perfect sealing from the effect of beating rains .

It is seen that terraces are maintained quite well wherever paddy cultivation is in vogue . This is because paddy cultivation in these parts is done through impounding of water for which level or inward sloping terraces with well maintained and well sodded risers are an essential requirement . This is not so where maize or other coarse grained crops or vegetables are raised . In such localities, the terraces almost always slope outwards instead of inwards as they ideally should do . Outwardly sloping terraces form a potential threat for enabling run - off to overtop risers . This results in gullying and degradation of a productive field .

Construction and maintenance of a good terraced field is quite expensive . It is not always affordable by small and marginal farmers . This is especially so on steeper slopes where terraced fields are much narrower , and number of risers per unit area much higher , than those on milder ones .

Besides , on steeper slopes , risers are much higher and cost of masonry works needed per unit area for their erection ,too , is much more . Steeper the slope , higher shall be the maintenance cost , too . Overall cost of production of agricultural products shall , obviously , be higher and returns lower on steeper slopes . The break even point for agricultural production on steeper slopes is likely to be so delicately balanced in favour of profit that any marginal decline in productivity makes cultivation of such lands commercially unviable . This is because of this that the agricultural lands on steeper slopes are the first to be abandoned . Conversely , the steepest slopes of farmer's field shall be the last to come under plough . In fact it is seen that lots of agricultural fields have been abandoned in the upper zones of almost all river basins in the study area .

As important as terracing itself , is the safe disposal of water from the terraces . It is seen that in many places , water is not given a safe passage down to jhora having stabler bed .

7.2.2 PROTECTIVE VEGETATION BELTS :

Traditionally , individual farmers have relied more on vegetation to provide protection to soil than on mechanical ones . In the study area , large number of farmers have raised private grove of trees on their homestead lands . The species planted are local with emphasis on fodder trees . Among the major tree species planted are Amla , Ambake , Arkaula , Arupate, Buk, Mithe Champ, Gamari, Jamun , Kapasi , Dalne Katus , Sungure

Katus , Chiple Kawla , Lapche Kawla and Utis. Among the fodder tree species Pipli , Nebharo and Gogun are the prominent ones . Besides this , farmers also plant good soil binding perennial grasses which yield fodder and other useful by products . Amlisho and Narkat are two such prominent species of grasses . While both yield fodder during fodder scarce winter months , former yields " Phul Jharu " from its spikes which sells at about Rs 10 to 15 a kg and the latter firewood from its stems . Amlisho is an excellent cash crop as well as a very good soil binder with highly fibrous root systems .

These protective vegetation belts are often planted on steeper terrain in small compact blocks . It is seen that terrace risers contain very few trees . This is probably because of fear that shade of such trees shall diminish productivity . That should not be so given right selection of species . It is also seen that trees are haphazardly planted , without proper mix of species . Often the crown cover is not optimum . The perennial grasses are planted in clumps instead of in protection belts along the contour which could be much more effective against sheet washing from the area .

7.2.3 MULCHING :

On account of high rainfall and intense rainstorms , splash erosion in worked soil is quite damaging . To minimise this loss mulching is very potent tool . Layers of dry or green straw is laid over the bare surface . The mulch intercepts the shooting rain drops and protects soil

particles against it . Traditionally , while harvesting maize , paddy or other crops , a substantial part of straw is left in the field as stubble .This acts as a mulch to some extent . With passage of time , stubble decay from the collar region and tumble down on the surface , enhancing its mulch effect .

It is seen that wherever the stubble mulch , instead of being left standing upright , are cut and sprayed on the ground , their effectiveness as mulch increases . This is also seen that mulch is not used immediately after soil working . It is during this period that splashing is most violent and far more intense than during normal soil conditions . Mulches need be provided whenever soil is worked during monsoon .

7.2.4 MISCELLANEOUS :

Among other soil conservation measures adopted by individual farmers , boulder strewn waterways for safe disposal of water are important . These small jhoras dispose off excess water from the fields . The farmers have learnt by long experience not to remove boulders and pebbles from the beds of these channels flowing through their homestead lands . It is easy to find a number of such passages meant for safe disposal of excess water . Boulders , besides protecting the soil beneath and on sides , create natural obstructions in flow , reduce the velocity and the erosivity of flowing water .

Besides this, in some areas , it is seen that catchwater drains , too , have been made by farmers .

They are mostly lined by dry rubble masonry and are used to direct run-off away from unstable zones . They are often ill maintained , and in many cases , abandoned with deleterious effects. Dry rubble walls have been used by farmers in construction of dwelling houses as well as in erection of risers . They are often with improper batter and , usually , with excessively thick cross sections .

In addition to these soil conservation measures adopted by various Govt. Departments and by individual farmers , a number of schemes exclusively meant for soil and water conservation have been operative in the study area.

7.3 DIFFERENT SCHEMES OF SOIL AND WATER CONSERVATION :

With a view to checking soil erosion , soil and moisture conservation programmes were launched , both , under State as well as Central Sectors during the five year plans . Major soil and water conservation schemes executed in the study area are Operation Soil Watch (OSW), National Watershed Development Programme For Rainfed Agriculture (NWDPRA), and Integrated Afforestation and Eco-Development Project Scheme (IAEDPS).

In general , the main components of soil and water conservation schemes have been bunding , terracing , land sloping , levelling , contour cultivation and planting , water escapes and outlet for removal of excess water in

agricultural lands , and closures , afforestation , raising of utility trees , plantations , grass land development , contour terracing and stone walls in non-agricultural lands . The components of engineering measures were water harvesting and silt detention structures , treating gullies , stream banks , landslides and slips , mine spoils in , both , agriculture and non-agriculture lands .

7.3.1 OPERATION SOIL WATCH (O S W) :

Operation Soil Watch started in the year 1980-81 was a scheme of soil , water and tree conservation in the Himalayas . The objectives of the scheme were to provide stability to the fragile and vulnerable Himalayan eco-system through engineering as well as vegetative methods of soil and water conservation . The scheme aimed at giving integrated production treatments to selected catchments mostly within the reserve and other forest lands . The programme was spread over in the entire Himalayan range covering parts of 14 states including West Bengal . The main components were afforestation , pasture development , stabilisation of slips , gullies , torrents and terracing of critically eroding agriculture lands .

In the study area , programme continued up to the year 1989-90 and an area of 475 ha was afforested under this scheme in Ghoom-Simana , Senchal , Mahldram and Dhobijhora forests (Govt. of West Bengal , 1995 B) . Large number of jhora training works with guide and drop structures were taken up on sides of Hill Cart road . Two landslides were treated

with engineering structures in the Rongbong forests . A series of catchwater drains were constructed to divert water from the head of the slides . Catchwater drains were also constructed in and around Sukiapokhari . Few jhoras in the Upper Balason catchment below Sukiapokhari bazzar were treated with massive drop and guide structures .

7.3.2 NATIONAL WATERSHED DEVELOPMENT PROGRAMME FOR RAINFED AGRICULTURE (NWDPRA) :

The NWDPRA was started in 1986-87 with an objective to conserve and upgrade , both , croplands and cultivable waste lands on watershed basis ; to stabilise and increase crop yields from rainfed farming ; to augment the fruit , fodder and fuel resources through appropriate alternate land use systems ; to develop and disseminate technologies for proper soil and moisture conservation .

The scheme was restructured and expanded during 1990 to create models of scientific land use through development of integrated farming systems on the principles of watershed management in each development block where less than 30 percent arable area is under assured means of irrigation .

The objectives of the scheme , too , were made more broad based and were directed to achieve the twin goals of sustainable production of biomass and restoration of ecological balance in the vast tracts of rainfed areas in the country . The objectives would , specifically , focus on followings (Govt. of India , 1991) .

i. Conservation , upgradation , and utilisation of natural resources like land , water , plant , animal and human resources in a harmonious and integrated manner leading to perpetual availability of food , fodder , fuel , fibre , timber and biomass through diversified landuse .

ii. Generation of massive employment in the backward rainfed areas during and after the project period for under-privileged sections of rural population like small and marginal farmers , landless labourers , tribals etc.

iii. Improvement production environment through scientific management of land and rain water by introduction of in-situ moisture conservation , advanced production systems , ground water recharging devices and appropriate cash crops according to agro-climatic potentials .

iv. Reduction of inequality in productivity of irrigated and rainfed areas leading to the reduction in large scale migration from rural areas to cities .

v. To enhance cash flow to the rainfed farmers and landless agricultural labourers through increased casual employment , growing of cash crops etc. in suitable areas.

In the study area , the Department of Agriculture , Govt. of West Bengal , is taking up NWDPRA works and , in most cases , work is being done in agricultural lands . Since extent of agriculture land in the study area is quite meagre (substantial area being under tea cultivation) , the size of the project is quite small .

7.3.3 INTEGRATED AFFORESTATION AND ECO-DEVELOPMENT PROJECT SCHEME (IAEDPS) :

The scheme IAEDPS , started in 1989 , was earlier known as Integrated Wasteland Development Project Scheme (IWDPS) and was renamed so to reflect better its eco-development nature . IAEDPS was an important scheme of the National Wasteland Development Board (NWDB) which provides the necessary framework for attainment of the goals of restructured wastelands development programmes . The components of the scheme include checking land degradation , putting wastelands to sustainable use , increasing biomass availability , especially fuel wood and fodder , and restoring ecological balance (Kapoor , 1992) . The scheme envisages enlisting people's participation , harnessing science and technology inputs and ensuring inter-disciplinary co-ordination . Since its inception large number of projects have been taken up all over the country through the state forest departments and the District Rural Development Agencies (DRDA) in selected districts through approved microplans . Research institutes , universities and voluntary organisations , too , have been associated with the execution of the project .

In Darjeeling district in foothills , the scheme has been executed , inter alia , in some vast bouldery tracts devoid of all top soil due to long persisting land degradation specially deforestation. All that remained was bouldery river grit material with copious amount of sand. There was no organic matter in soil . Finer particles had either leached down or had been washed away with surface run-off . Since the top soil

was completely lost , carried earth from outside the area was brought and utilised for filling up of the planting pits (Patel , 1992) . To augment the organic carbon in soil , cow dung manure was applied to the planting pits . The area , which was lying barren for decades , has been successfully regenerated through riverine species , namely , Sisu (Dalbergia sisoo) and Khair (Acacia catechue).

7.4 MISCELLANEOUS :

Besides the measures discussed earlier by Govt. and by individuals , tea gardens , mostly owned by corporations , companies or firms , have also practised some soil conservation measures in the study area .

Mulching has been practised by all the tea gardens in young tea plantations where canopy cover is less than optimum . Tea bushes are periodically pruned during winter months . The pruning material comes quite handy for the purpose of mulching of the exposed soil . Some gardens are seen to stone practise stone mulching , too , in younger tea plantations.

In some tea gardens , entire area is very well terraced . Dry rubble boulder masonry walls have been used to erect risers . The risers are kept well maintained . In steeply sloping parts of tea gardens, soil working is not very intense , especially during rains . Most tea gardens maintain a

good protective belt of trees around the jhora banks . Trees of local species and large number of bamboo clumps are meticulously maintained in such protective belts . Catchwater drains , breast and retaining walls are also seen in the tea gardens .

The scrub lands , landslides , or seriously eroding stream banks , which make major soil erosion centres in many of the tea gardens , are , however , hardly paid any attention . Since tea gardens are commercial ventures operating on lands leased to them with provision for periodic renewal , they are averse to investing money unless it produces quick returns . Long term planning for soil and water conservation is often lacking . There is hardly any agency which monitors this aspect and erring tea gardens often go scot free . Severely sheet washed scrub lands are often seen around tea gardens , especially on steeper slopes on higher reaches of the study area . With scrubby vegetation , exposed rock outcrops and highly overgrazed condition , such tracts contribute a lot for soil degradation .

CONCLUSION :

Thus it is seen that , in previous years , a number of soil and water conservation measures are have been in vogue in the study area . Among the measures adopted by various Govt. agencies , jhora training is one of prime importance . It is seen that design is often defective - the structures being over-designed or under-designed causing wastage

of resources in any case . The maintenance of structures is yet another severely neglected aspect . The next soil and water conservation measure of previous years has been construction of catchwater drains . Here , too , dimension as well as gradient are inappropriate leading to their failure . Construction of retaining walls and breast walls have been the next important soil conservation measures adopted by Govt. agencies , particularly along the roads . In construction of such walls, improper fashioning of slopes before construction and improper provision or complete absence of weepholes has been a major cause of failure of many such structures . Similarly , river training works have been done in lower reaches of streams . Placement of groynes , their design and inadequate rooting in the banks are found as the major defects in design of such structures . Lack of adequate protection on sites likely to develop potholes has often resulted in scouring of foundations leading to failure . Checkdams with dry rubble masonry has been extensively used by Govt. agencies for treatment of landslides . Improper face batter and lack of regular maintenance are major defects in design . Checkdams in river beds have not been very popular , though they could have been utilised very well in flatter sections of streams . Palisades and wattlings , too , have not been used in suitable slope conditions besides being very poorly maintained . Manuring of slopes aimed to be protected through quick establishment of vegetation has been completely neglected . Among soil conservation measures adopted by individual farmers , land terracing is of prime importance. Most of them slope outwards , do not have provision for safe

disposal of excess water and are not maintained regularly . Protective vegetation belts raised on homestead lands are quite noteworthy , though most of the risers in the terraced fields do not have any tree . They could have been easily utilised for raising trees without hampering agricultural production . Mulching has been utilised in a very primitive way by leaving stubble of maize or paddy straw standing in the field . This could have been used more efficiently . Among various schemes of soil and water conservation , Operation Soil Watch (OSW) , National Watershed Development Project For Rainfed Agriculture (NWDPRA) and Integrated Afforestation and Eco-Development Project Scheme (IAEDPS) are the major ones with a number of soil and water conservation components including afforestation . Tea gardens have practised soil conservation through terracing , mulching , catchwater drains , jhora training etc. though they have often shirked away from long term capital intensive soil and water conservation measures .

Various soil and water conservation strategies adopted by Government and individual farmers in the past and inappropriateness in their approach brings failure. So appropriate suggenstions regarding different soil and water conservation measures are urgently necessary in the study area.