

Natural Resources Conservation and Development

Level-I

**Based on March, 2022 (V- I) Occupational standard
(OS)**



**Module Title: -Identifying and maintaining Indigenous
Soil and Water Conservation Practices**

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Introduction to the Module

This module covers the knowledge, skills and attitude required to identify and undertake maintenance of indigenous soil and water conservation measures specified on plans. It also covers the process of construction/installation and maintenance of a range of modern and indigenous soil and water conservation measures specified on plans.

LG #40	LO #1- Explore Indigenous soil and water management practices
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Instruction sheet
<p>This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:</p> <ul style="list-style-type: none"> • Identifying accessing Relevant information sources • Exploring Indigenous soil and water management practices • Defining issue related with the practice • Consulting appropriate people • Issues related to Contemporary indigenous soil and water management practices • Documenting details of consultation/research <p>This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:</p> <ul style="list-style-type: none"> • Identify and access Relevant information sources • Explore Indigenous soil and water management practices • Define issue related with the practice • Consult appropriate people • Issues related to Contemporary indigenous soil and water management practices • Document details of consultation/research
Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks

Information Sheet 1

1.1 Identifying, accessing and utilizing information

1.1.1 Identifying information

Identifying, accessing and utilizing relevant information sources for Indigenous soil and water management practices are important. Sources of Information may be organizational rules, regulation and guidelines; Internet, related books and related materials; Technical manuals, Work place guidelines.

Information can be gathered from many sources depending on the organization and the types of information being dealt with:

- A supervisor
- Co-workers
- Customers
- Telephone messages
- E-mail messages
- Diaries
- Calendars
- Databases
- Record systems
- Policy and procedure manuals
- Electronic and paper files
- Journals and newspapers
- Newsletters and magazines
- The internet

1.1.2 Accessing information

In your workplace environment, you will be presented and will have access to a substantial amount of information. This information will be communicated to you from numerous sources. As the receiver of information, you will be required to interpret information or messages and comprehend it in the way that the sender has intended. You have learnt that there is several ways

in which the communication process can break down. If you can avoid these situations, then you will be able to effectively and clearly interpret and comprehend any information being communicated to you.

1.1.3 Utilizing information

How can you ensure that workplace information is only used for authorized purposes? Utilizing information for authorized purposes as follows: once the required information is gathered, it needs to be prepared or processed before it is passed on. The way it is prepared will relate to the method used to relay the information, and the equipment you use. For example, perhaps you are answering the telephone, writing down message details and e-mailing messages to staff. Alternatively, you could be preparing a letter to send to a customer, based on information your supervisor has given you verbally.

1.2 Outlining contemporary indigenous soil and water management practices

Soil and water Conservation

It is a combination of practices used to protect the soil from degradation. First and foremost, soil conservation involves treating the soil as a living ecosystem. This means returning organic matter to the soil on a continual basis.

Soil conservation can be compared to preventive maintenance on a car. Changing the oil and filter, and checking the hoses and spark plugs regularly will prevent major repairs or engine failure later. Similarly, practicing conservation now will preserve the quality of the soil for continued use.

Indigenous soil and water conservation

It is used to describe a practice or an idea which has either been generated locally or which has been introduced and then transformed and incorporated by the local people into their system to improve their livelihood.

Indigenous knowledge refers to the perception that farmers have about their natural and social environment, which they use to adopt, adapt and develop technologies to their local context. The rationale for undertaking certain traditional practices among others is recognition of problems by the local people. Indigenous practices are aimed at arresting the local priority problems. Although they survived the challenges of changing bio-physical and socio-economic environments through a continuous responsive changes and adaptations, indigenous practices are not perfect. But, in general it is possible to provide this indigenous knowledge's that clearly

portray the active role that rural communities in Africa (Ethiopia) and other parts of the world which have played a tremendous role.

Indigenous practices are aimed at arresting the local priority problems. Although they survived the challenges of changing bio- physical and socio-economic environments through a continuous responsive changes and adaptations, indigenous practices are not perfect

Indigenous soil and water conservation (SWC) practices For quite a long time, soil and water conservation has been considered a more or less technical issue, based on years of dominantly biophysical problem-oriented research on factors such as climate, soils, topography, vegetation, etc. Consequently, many SWC guidelines were published with dominantly technical character. Much less information is available concerning solution-oriented research including that addresses, among other things, also negative side effects, about the compatibility of technical solutions with prevailing socio-cultural and economic settings of a specific area, and about the process of adapting SWC to such settings.

What is indigenous knowledge?

As quoted by the World Bank (1997), Warren (1991) and Flavier (1995) present typical definitions by suggesting: Indigenous knowledge (IK) is the local knowledge – knowledge that is unique to a given culture or society.

Why is indigenous knowledge important?

In the emerging global knowledge economy a country's ability to build and mobilize knowledge capital, is equally essential for sustainable land management as the avail-ability of physical and financial capital (World Bank, 1997). The basic component of any country's knowledge system is its indigenous knowledge. It encompasses the skills, experiences and insights of people, applied to maintain or improve their livelihood.

Significant contribution to global knowledge have originated from indigenous people, for instance in human and veterinary medicine, with their intimate understanding of their environments, local people had developed knowledge systems that contributed to modern medicine and health care. Indigenous knowledge is developed and adapted continuously to gradually changing environments and passed down from generation to generation and closely interwoven with people's cultures and values. Indigenous knowledge is also the social capital of the poor, their main asset to invest in the struggle for survival, to produce food, to provide for shelter or to achieve control of their own lives.

Farmers Indigenous Knowledge on Soil Conservation Mechanisms

Some of the most important indigenous soil conservation mechanisms of the Konso farmers are the following:-

A. Terracing. The Konso Cultural Landscape is characterized by extensive dry stone terraces which witnesses hundreds of years of persistent human struggle to harness the hard, dry and rocky environment, which has resulted in the beautifully outlined rows of dry stone terrace. The terraces retain the soil from erosion, collect maximum water and discharge the excess, and create terrace saddles that are used for agriculture. The terraces are the main features of the Konso landscape and the hills are contoured by the dry stone terraces that could reach at some places up to 5 meter high. The dry stone walled towns (Paleta) of the Konso are located on high hills selected for their strategic and defensive advantage. These towns are circled by, between one and six rounds of dry stone defensive walls, built using locally available rock.



Fig 1.1 terrace

B. Contour Ploughing- In several cases, farmers applied different methods of soil conservation. Cultivating crops on the contour where the slope was steep is one of them. Most of the farmers, as I observed, used contour ploughing in order to minimize runoff and erosion.



Fig1.2. contour ploughing

C. Crop Rotation- the use of crop rotation is another widespread phenomena in the area where maize, ground nut and sorghum grown rotationally. Crop rotation is used by the farmers important for different reasons including soil fertility, thereby improved crop yield. The farmers of the area know that as of the scientific method improved soil fertility can be achieved by alternating high residue producing crops with the growing low residue producing crops.

D. Fallowing- Fallowing is applied with a very limited extent since land scarcity is stated to be a major constraints to production in the area. This partially aggravated by the topography of the area. Thus, it seems likely that the extent of fallowing and limited periods involved is a consequence of the agricultural land in the finding.

E. Mixed Cropping- mixed cropping is widely practiced in the area. Farmers used to inter planting two or more crops together with some root edible plants. The great majority of the cases are a mix of maize and groundnuts. Mixed cropping in the area helped the potential to reduce erosion by having a crop on the land for a longer period of the year. Also, it served for them to cultivate different crops at one time on a single farm land. However, the crops in the area are widely similar growing seasons and thus the potential for this benefit is not as such. Nevertheless, the inclusion of leguminous plant may improve its nitrogen fixation process for cereal crops.

F. Surface Mulching- Most farmers is using surface mulches on their fields, thus providing a protective cover at a time when crop cover is not present. Some farmers left crop residue while others used by branches. The benefit of protective covering was widely appreciated, as was the improved infiltration rate afforded by the techniques and reduced evaporation rate. Further stated objective is the addition of nutrients to the soil through the decomposition of the organic matter. However, the density of mulch viewed in many fields was below the level required to be most

effective as protective cover since the use of residence as animal food was witnessed in many households of the area.



Fig 1.3 surface mulching

G. Fertilization- Fertilization is the other widely practiced activity of indigenous soil conservation mechanism in the area. This is because the area is known in having continuous cropping activity. Thus, farmers used it to retain the fertility of the soil. This importance is reflected in the very high frequency with which both inorganic and organic fertilizer used to apply in this area. But according to informants the most widely used forms of fertilizers are manure, house hold garbage and humus because of lack of capacity to buy modern fertilizer and fear of long term consequence of modern fertilizers in the land by most farmers. This also shows that farmers have highly inclined to use their own indigenous fertility maintaining mechanisms than the modern one.

H. Agro Forestry- the use of agro forestry for soil conservation is the most widely practiced activity in the area. It is very common to see different types of small and big trees inside and just outside the farm land of Konso. The best example is *Moringa stenopetala* (locally also called to be Moringa) which has several purposes; used for shade, it has a very high nutrition quality. Moringa leaves serve as their main diet and is used as a medicine for various diseases. Other tree species in Konso are: *Juniperus procera*, *Euphorbia spp* *Terminalia browenii*, *Olea africana*, *Ficus sori*, *Cordia africana*, *Sterculia africana*, *Accia abysinica*. Among these, *Juniperus procera* has a high significance in Konso's rituals. At usual, these trees are naturally occurring once. In fact, the protection of these big trees in the area is also for ritual practices and shading services for some sort of meeting to the local community. Thus, it seems that in addition to trees role for indigenous soil conservation practices in agro forestry form, it has strong attachment the society cultural practices.

I. Field Boundaries- It is also common to see ridge covered with grasses between plots of farm land. The dividing line, boundary, and the land before and after the ridge is the property of two different individuals. This structure is important for soil conservation which can reduce the intensity of erosion in the farm fields. But the uses of this structure are not noticed by most farmers. In short, all the above indigenous soil conservation mechanisms, gained through experience by the local community, are the basis for self-sufficiency and self-determination and effective alternatives

1.2.1 Agents/processes of erosion and sedimentation

Soil Erosion

Soil erosion is the detachment and movement of soil material. The process may be natural or accelerated by human activity. Depending on the local landscape and weather conditions, erosion may be very slow or very rapid.

Natural erosion: - has sculptured landforms on the uplands and built landforms on the lowlands. Its rate and distribution in time controls the age of land surfaces and many of the internal properties of soils on the surfaces. The formation of Channel Scablands in the state of Washington is an example of extremely rapid natural or geologic, erosion. The broad, nearly level inter stream divides on the Coastal Plain of the Southeastern United States are examples of areas with very slow or no natural erosion.

Accelerated erosion: - is largely the consequence of human activity. The primary causes are tillage, grazing, and cutting of timber.

The rate of erosion can be increased by activities other than those of humans. Fire that destroys vegetation and triggers erosion has the same effect. The spectacular episodes of erosion, such as the soil blowing on the Great Plains of the Central United States in the 1930s, have not all been due to human habitation. Frequent dust storms were recorded on the Great Plains before the region became a grain-producing area. "Natural" erosion is not easily distinguished from "accelerated" erosion on every soil. A distinction can be made by studying and understanding the sequence of sediments and surfaces on the local landscape, as well as by studying soil properties.

Agents and related processes of soil erosion

Soil erosion by water is the wearing away of the earth's surface by the force of water and gravity, and consists of soil particle dislodgement, entrainment, transport, and deposition. Soil erosion occurs naturally by wind or harsh climatic conditions but human activities include overgrazing, over utilization and deforestation.

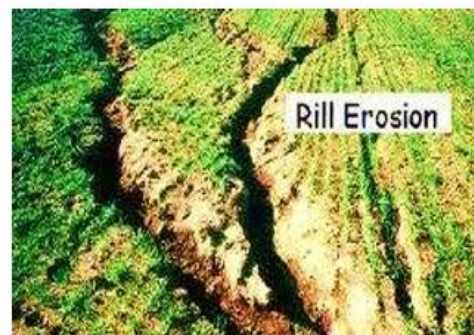
Water Erosion

Water erosion results from the removal of soil material by flowing water. A part of the process is the detachment of soil material by the impact of raindrops. The soil material is suspended in runoff water and carried away. Four kinds of accelerated water erosion are commonly recognized: sheet, rill, gully, and tunnel (piping).

- **Sheet erosion:** - is the more or less uniform removal of soil from an area without the development of conspicuous water channels. The channels are tiny or tortuous, exceedingly numerous, and unstable; they enlarge and straighten as the volume of runoff increases. Sheet erosion is less apparent, particularly in its early stages, than other types of erosion. It can be serious on soils that have a slope gradient of only 1 or 2 percent; however, it is generally more serious as slope gradient increases.
- **Rill erosion:** - is the removal of soil through the cutting of many small, but conspicuous, channels where runoff concentrates. It is intermediate between sheet and gully erosion. The channels are shallow enough that they are easily obliterated by tillage; thus, after an eroded field has been cultivated, determining whether the soil losses resulted from sheet or rill erosion is generally impossible.
- **Gully erosion:** - is the consequence of water that cuts down into the soil along the line of flow. Gullies form in exposed natural drainage-ways, in plow furrows, in animal trails, in vehicle ruts, between rows of crop plants, and below broken man-made terraces. In contrast to rills, they cannot be obliterated by ordinary tillage.



Sheet erosion



Rill erosion



Fig 1.4 Different types or stage of water erosion

Wind Erosion

- **Suspension:** Fine particles less than 0.1 mm in size is moved parallel to the surface and upward into the atmosphere by strong winds. The most spectacular of erosive processes, these particles can be carried high into the atmosphere, returning to earth only when the wind subsides or they are carried downward with precipitation. Suspended particles can travel hundreds of miles.
- **Saltation:** Movement of particles by a series of short bounces along the surface of the ground, and dislodging additional particles with each impact. The bouncing particles ranging in size from 0.1 to 0.5 mm usually remain within 30 cm of the surface. Depending on conditions, this process accounts for 50 to 90% of the total movement of soil by wind.
- **Soil creep:** The rolling and sliding of larger soil particles along the ground surface. The movement of these particles is aided by the bouncing impacts of the saltating particles described above. Soil creep can move particles ranging from 0.5 to 1 mm in diameter, and accounts for 5 to 25% of total soil movement by wind.

The process of soil erosion is made up of three parts:

- Detachment: This is when the topsoil is actually “detached” from the rest of the ground.
- Transport: This is when the topsoil is relocated to another area.
- Deposition: Where the topsoil ends up after this process.

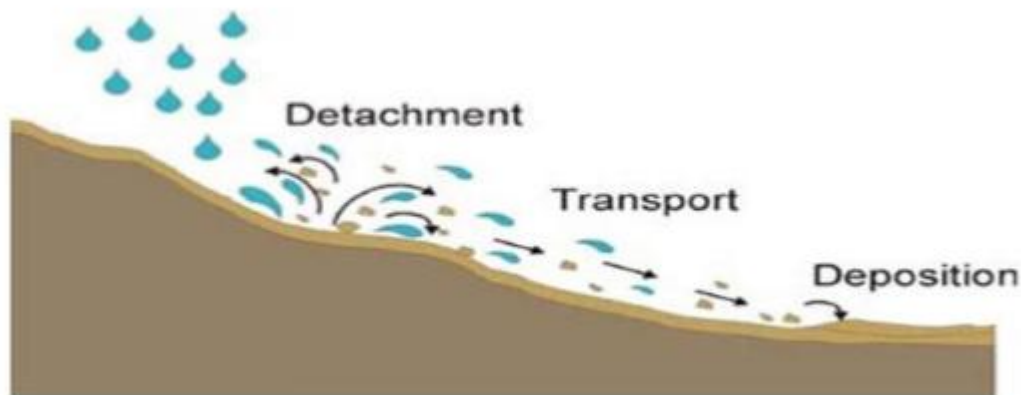


Fig 1.5 Water erosion process by the impact of raindrops. (Source: [www .landfood .ubc .ca](http://www.landfood.ubc.ca))

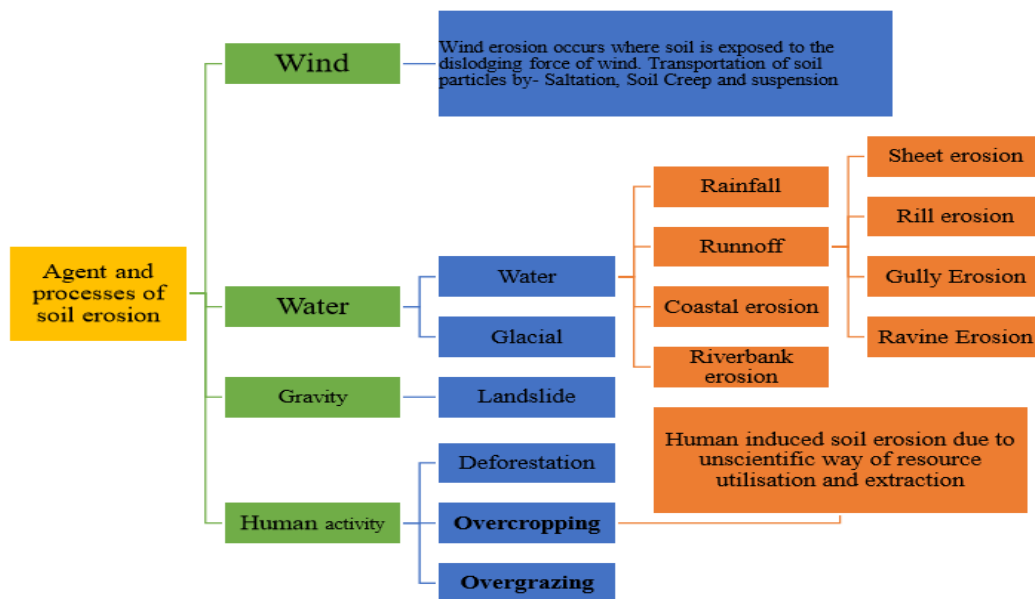


Fig 1.6. Agents of soil erosion, its processes and effects (Sources: Das, 2000)

1.2.2 Basic catchments issues related with the practice

This section discusses what is the main consideration while implementing indigenous soil and water conservation measure. So in order to effectively implement the practice the following biophysical parameter need to be considered. Climate, geology, topography, hydrology, soils, land use and other factors influence watersheds and the streams that flow through them.

Climate

Climate is the major force shaping the land and controlling stream flow. The climate of an area is determined by the area's latitude, elevation, vegetation, topography and nearness to the oceans or other large water bodies. Together these factors determine temperatures, humidity, wind, precipitation and evaporation in a watershed. Weathering factors, such as rain, snow, wind, glaciers and temperature changes, erode soil and rock formations and change the topography of the watershed. Climate also affects stream flow, which creates and changes stream channels.

Geology

The geology of the chachment is important because it influences topography, direction of water flow, shape of the drainage basin, stream bed materials, water quality and biological productivity. Geologic forces cause the earth's surface to rise or fall and, along with weathering, determine the topography of the watershed. Geology affects where and how water moves in a watershed. The geology determines the types of bedrock formations, or parent materials, and the associated soils of the watershed. The parent materials and the soils produced from them help determine the water quality, biological productivity and aquatic life of a stream. By supplying the materials that make up the bottoms and banks of channels, parent material and soils also affect how vulnerable a stream is to erosion.

Topography

Topography is the shape and physical features of land. The topography of a stream channel and its catchment reflects the geology of the watershed. In turn, watershed topography helps produce the pattern and distribution of stream channels. Topography of a watershed also determines the Steepness of the land surface and stream channels. We also know this steepness as slope, grade or gradient. The height and steepness of the hills, floodplains and channels contribute to the erosive power of the water in a watershed and its stream channels. Steep slopes allow the force of gravity to quickly accelerate the speed of flowing water. The faster water flows the more energy or power it has to erode and move soil, sand, gravel, boulders and debris.

Hydrology

Hydrology is the science that deals with the properties, distribution and circulation of water in the atmosphere, on the land and underground. Short-term and longterm climatic conditions affect how much precipitation is available to shape and develop the features of a watershed. The amount, type and timing of precipitation directly affect erosion and deposition in a watershed. Hydrology of a watershed is greatly affected by how much precipitation and temperature vary over time.

Soil

The most important features of soils are their ability to soak-up, hold and transport water, support plants and cycle nutrients. Soils directly affect the kinds of vegetation that can grow along a stream, on floodplains and in the watershed. Soils can reduce water and air pollution by buffering agricultural fertilizers and pesticides, organic wastes and industrial chemicals. Many physical, chemical and biological properties determine the quality of a soil. Soil depth, texture, water-holding capacity, porosity, nutrient and mineral levels, organic matter content and actions of organisms like moles, earthworms and bacteria all affect soil quality.

Vegetation and Land Use

The more vegetation there is in a watershed to intercept and transpire water, the less runoff there will be. The amount and type of vegetation in a watershed influence the rates of runoff and erosion in that watershed. A forested or native grass watershed typically delivers its runoff slowly so soil and channel erosion are usually not severe. Runoff rates and amounts are usually excessive in watersheds with too much timber clearing, row cropping, grazing, paving, urbanization and other types of development. Runoff increases in these situations because less water is allowed to infiltrate to groundwater or return to the atmosphere through transpiration.

1.2.3 Characteristics of soils with an emphasis on erodible soils

Soil characteristics influencing erosion by rainfall and runoff are those properties which affect the infiltration capacity of soil and those which affect the resistance of the soil to detachment and transport by falling or flowing water.

1. **Soil Texture:** (particle size and gradation): If soils clay and organic matter content of these soils increase, the erodibility decreases. Clay acts as a binder for soil particles, thus reducing erodibility.

2. **Organic Matter Content:** Organic material is the “glue” that binds the soil particles together and plays an important part in preventing soil erosion. It also influences the infiltration capacity of the soil.

3. **Soil Structure:** The way soil particles are held together, affects the soil's friability, the ease with which soil particles are detached by raindrops and runoff, and the resistance of the soil to the growth of roots and shoots.

4. **Soil Permeability:** Permeability is the soil's ability to transmit air and water. Soils that are least subject to erosion from rainfall and surface runoff are those with high permeability.

1.3 Defining issues connected with the practices

Indigenous knowledge has a wide range of roles in a society, which ensures the achievement of livelihoods, including not only technical knowledge in production but also knowledge with respect to institutions, health and security.

The identified relevant issues and concerns may include the following:

- The nature of ISWM practices
- Public opinion, environmental interest groups
- Contact with public agencies
- Proximity of sensitive receiving waters
- Regulatory environment.

1.3.1 Why Indigenous and Formal Knowledge's are concerned in soil erosion?

Scientists and farmers address the soil erosion problem in different ways, even though they have the same goal. This difference has far-reaching consequences for finding the method to achieve the solution. Scientists perceive soil erosion as a process of three steps: the detachment of particles of soil by wind and water from the surface, the transportation of the particles and the deposition of these particles in another place. But others point out that farmers see the movement of soil from place to place as a result of deposition, and could see small rills. They observe the development of gullies merely by water erosion.

Indigenous SWC methods are often constructed with local labor exchange groups that shift the direct immediate cost to the community. When the practices have to be undertaken individually, they always tend to space the financial and physical burdens over time.

Generally, farmers' responses to externally imposed SWC methods are highly shaped by their indigenous practices that are embedded in their local institutions and culture.

Indigenous technologies: Technologies evolved as a result of a gradual learning process and emerge from a knowledge base accumulated by rural people by observation, experimentation and a process of handing down across generations' peoples' experiences and wisdom. Apparently the technology is dynamic and not static in nature, frozen in time or stuck in history.

An indigenous SWC technology clearly indicates that farmers are aware of soil erosion and have developed effective means to control it.

- However, the fact remains that most farmers do not undertake sufficient measures to control erosion effectively. In order to become effective:-Farmer clearly perceives soil erosion and believes that it reduces yields. They are more concerned about the loss of water and nutrients associated with soil erosion than reduced depth of the soil itself.
- Farmers' investments fall as the opportunity cost of their time and other resources rise: other activities may have a higher return than conservation investments. This is commonly the case for farmers with substantial off-farm income.
- Farmers invest more if they have more resources at their disposal, other things being equal: those with bullocks and healthy family labor are more likely to invest than those without.
- The tenure arrangements under which farmers operate affect investment levels: those who cultivate their own land are much more likely to invest in soil conservation than those renting or sharecropping someone else's land. Likewise, landlords leasing out their land do not appear to invest much in soil conservation.
- Land quality also determines investment levels. Most farmers have more than one plot, and they invest in their most productive plot first. Those who have irrigated land invest less on their dry land plots than those without irrigated land.
- Where it is technically feasible, farmers invest in soil conservation in a stepwise manner, strengthening structures annually as needed. This reduces the initial investment and postpones costs to the future.
- Farmers prefer to invest in soil conservation individually or in cooperation with an adjacent farmer rather than in large, cooperative groups.

1.4 Consulting people

Consulting relevant and appropriate people according to community guidelines and cultural protocols helps to towards conserving their natural resources. Each community has its own guidelines and protocols towards conserving their natural resources by indigenous knowledge. These guidelines and protocols may not be put in a written form. They know that what they are going to do, where they are going to do and when they are going to do. In some community, there are some influential elders that lead their community. Farmers who think that soil and water conservation increases crop production and who think that soil and water conservation is the farmers' responsibility hold a more favorable attitude towards soil and water conservation than those who think that farmers should be paid for such work or that it is the responsibility of some other agency.

Each community has its own knowledge which needs to be transferred and implemented. Thus, accessing those knowledge requires identification and consultation of authorized person (relevant and appropriate people) or individuals to whom certain information or knowledge can be disclosed without disregarding cultural code of conduct (rules of correct or appropriate behavior of a community) and rights to that knowledge according to community guidelines and cultural protocols.

Therefore, a better understanding of the farming system in the area and the farmers' opinion on tackling agricultural constraints should be considered. Moreover, further evaluations and improvement work need to be done. Thus, integrating the traditional with modern developments may lead towards a sustainable management of the ever-increasing problem leading to a comprehensive advancement of the production system

1.5 Contemporary indigenous soil and water management practices

Contemporary Indigenous land and water management practices refers to existing practices characterized by distinctively modern in style. The following are soil and water conservation structures implemented in modern style.

A waterway is a natural or artificial channel along the steepest slope or in the valley used to accommodate runoff. Artificial waterways as discussed here need to be paved with grasses or stone. Traditional waterways need improvement according to the technical standards given. On cultivated land with graded structures, waterways must be placed every 250 m to avoid graded

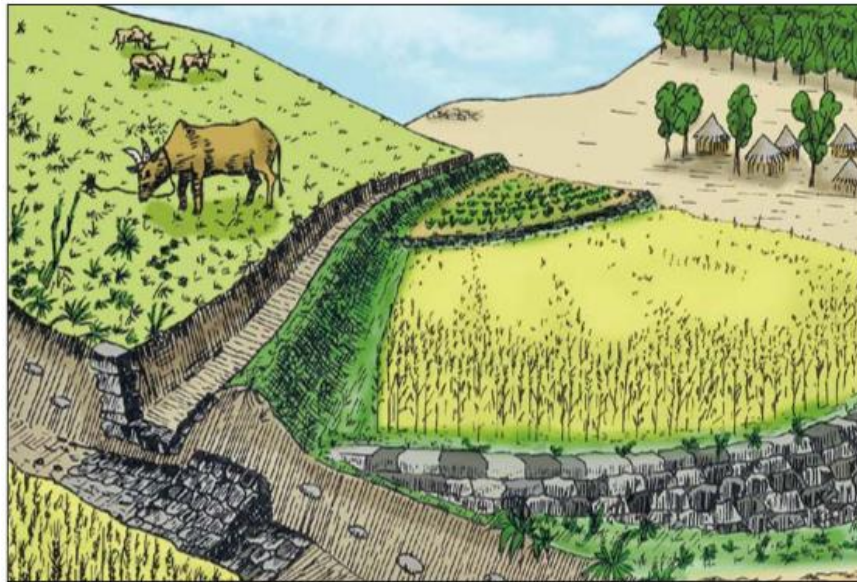
ditches that are too long. Waterways must always be constructed and grass developed on them one year before graded structures are applied on the land. If there is enough land, cross-sections of waterways should be gentle, as shown below. Waterways enable runoff water that is not stored behind bunds or does not infiltrate on the land during a storm to be drained safely to the next river.



This is a typical artificial waterway in an area with land scarcity. Therefore, it has been dug deep into the soil, with steep borders and a stone pavement with intermittent small checkdams at the bottom. At the top, a cutoff drain leads into the waterway from the left side, while, graded bunds are led into it from the cultivated land, alternating from each side.

Fig.1.6 waterway

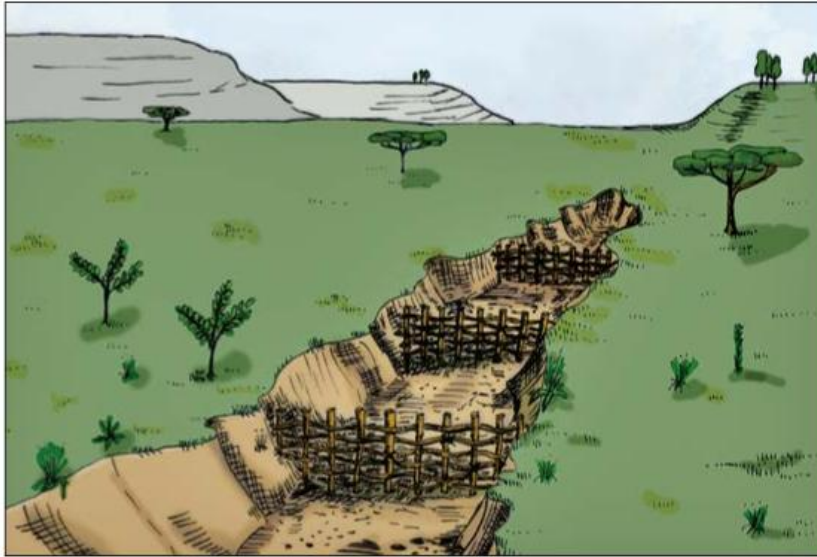
B. Cutoff drain is a channel used to collect runoff from the land above and to divert it safely to a waterway or river, thus protecting the land below from excessive erosion. Cutoff drains usually protect cultivated land from upslope forestland or grassland. it protects downslope land from upslope runoff and erosion.



This cutoff drain protects the terraced cultivated land to the right from excessive runoff from the grassland to the left and above, where controlled grazing is used with tied cattle. At the point where the cutoff drain enters the waterway, stone protection is needed and a checkdam has been constructed in the waterway just below the entry point, as shown. Cutoff drains have to be covered with much more vegetation than on the recently constructed embankment shown here.

Fig.1.7 cut off drain

C. check dam is an obstruction wall across the bottom of a gully or a small river to reduce the velocity of the runoff and prevent deepening or widening of the gully. Checkdams can be made of any material available locally, such as stones, live or dead branches, wooden poles, gabions, etc. Check dams prevent the widening and deepening of a gully, and help to fill it up with sediment. They reduce the velocity of runoff in the gully. The potential energy is absorbed below the vertical drops of the overfall. Sediments are deposited behind the check dams so that the slope gradient of the gully is also reduced.



This gully has been treated with a checkdam, which in this case consists of brushwood. This can be very effective, particularly for smaller gullies, which are refilled with soil over a longer period. The structures should not be too far apart.

Fig.1.8 check dam

D. **Trench** is a short ditch dug along the contour (i.e. across the slope) to trap runoff water in dry and moist areas. The trees will be planted in a planting pit in the centre of the trench. Trenches are particularly useful to help rehabilitate degraded lands. The trenches trap water that would otherwise run down the slope and be lost. The trench allows the water to seep into the soil. Trenches are good places to plant trees, particularly in dry places, due to the water they collect



The sketch shows alternating trenches. Note that the level of the soil left in the centre of the planting hole is slightly lower than the trench!

Fig.1.9 trench

E. **Hillside terrace** is a structure along the contour, where a strip of land is levelled for tree planting. Hillside terraces are up to 1 m wide and constructed at about 2–5 m vertical intervals. Hillside terraces are only applied if there is a strong reason to justify their construction. Hillside terraces help to retain runoff and sediment on steep sloping land and to accommodate tree seedlings planted on them. They are also effective for conserving water on badlands and in areas with low rainfall.



On these heavily degraded slopes, hillside terraces were necessary. Trees were planted just recently, while terrace construction was done in the previous year to support soil formation around the pits. Spacing between trees is 2 m, and the vertical interval between terraces is also 2 m. The area between two terraces is undisturbed and used for forage production.

Fig1.10 hillside terrace

1.5.1 Erosion control structures/ measures/ practices

For both water and wind erosion, the first objective is to keep soil on the field. The easiest and often most effective strategy to accomplish this is to reduce soil detachment. Detachment occurs when water splashes onto the soil surface and dislodges soil particles, or when wind reaches sufficient velocity to dislodge soil particles on the surface. Crop residues (e.g. straw) or living vegetative cover (e.g. grasses) on the soil surface protect against detachment by intercepting and/or dissipating the energy of falling raindrops. A layer of plant material also creates a thick layer of still air next to the soil to buffer against wind erosion.

Keeping sufficient cover on the soil is therefore a key erosion control practice. The implementation of practices such as conservation tillage also preserves or increases organic matter and soil structure, resulting in improved water infiltration and surface stability. In addition, creation of a rough soil surface through practices such as surface roughening will break the force of raindrops and trap water, reducing runoff velocity and erosive forces. This benefit is short-lived, however, as rainfall rapidly decreases effectiveness of surface roughness. Reducing effective wind velocities through increased surface roughness or the use of barriers or changes in field topography will reduce the potential of wind to detach soil particles. Practices which increase the size of soil aggregates increase a soil's resistance to wind erosion. The following practices can be used to reduce soil detachment:

- **Chiseling and sub soiling:** - Loosening the soil without inverting and with a minimum of mixing of the surface soil to improve water and root penetration and aeration.
- **Conservation cover:** - Establishing and maintaining perennial vegetative cover to protect soil and water resources on land retired from agricultural production.
- **Conservation crop rotation:** An adapted sequence of crops designed to provide adequate organic residue for maintenance or improvement of soil tilt.
- **Residue Management:** Any tillage or planting system that maintains at least 30% of the soil surface covered by residue after planting to reduce soil erosion by water; or, where soil erosion by wind is the primary concern, maintains at least 1,000 pounds of flat, small-grain residue equivalent on the surface during the critical erosion period.
- **Contour orchard and other fruit area:** Planting orchards, vineyards, or small fruits so that all cultural operations are done on the contour.
- **Cover crop:** A crop of close-growing grasses, legumes, or small grain grown primarily for seasonal protection and soil improvement. It usually is grown for 1 year or less, except where there is permanent cover as in orchards.
- **Critical area planting:** - Planting vegetation, such as trees, shrubs, vines, grasses, or legumes, on highly erodible or critically eroding areas (does not include tree planting mainly for wood products).
- **Seasonal Residue Management:** - Using plant residues to protect cultivated fields during critical erosion periods.

- **Windbreak/shelterbelt establishment:** - Linear plantings of single or multiple rows of trees or shrubs established next to farmstead, feedlots, and rural residences as a barrier to wind.
- **Windbreak/shelterbelt renovation:** Restoration or preservation of an existing windbreak, including widening, replanting, or replacing trees.
- **Mulching:** Applying plant residue or other suitable material to the soil surface.
- **Irrigation water management:** Effective use of available irrigation water to manage soil moisture, reduce erosion, and protect water quality.
- **Prescribed Grazing:** The controlled harvest of vegetation with grazing or browsing animals, managed with the intent to achieve a specified objective.
- **Cross wind ridges/strip cropping/trap strips:** Ridges formed by tillage or planting, crops grown in strips, or herbaceous cover aligned perpendicular to the prevailing wind direction.
- **Surface roughening:** Roughening the soil surface by ridge or clod-forming tillage.
- **Tree planting:** Establishing woody plants by planting or seeding.
- **Waste utilization:** Using agricultural or other wastes on land in an environmentally acceptable manner while maintaining or improving soil and plant resources.
- **Wildlife upland habitat management:** Creating, maintaining, or enhancing upland habitat for desired wildlife species.

Practices to Reduce Transport within the Field

Sediment transport can be reduced in several ways, including the use of crop residues and vegetative cover. Vegetation slows runoff, increases infiltration, reduces wind velocity, and traps sediment. Reductions in slope length and steepness reduce runoff velocity, thereby reducing sediment carrying capacity as well. Terraces and diversions are common techniques for reducing slope length. Runoff can be slowed or even stopped by placing furrows perpendicular to the slope, through practices such as contour farming that act as collection basins to slow runoff and settle sediment particles. By decreasing the distance across a field that is unsheltered from wind and by creating soil ridges or other barriers, sediment transport by wind will be reduced.

- ✓ **Contour farming:** Farming sloping land in such a way that preparing land, planting, and cultivating are done on the contour. This includes following established grades of terraces or diversions.

- ✓ **Field wind break:** Establishment of trees in or adjacent to a field as a barrier to wind.
Grassed water way : A natural or constructed channel that is shaped or graded to required dimensions and established in suitable vegetation for the stable conveyance of runoff.
- ✓ **Contour strip cropping:** Growing crops in a systematic arrangement of strips or bands on the contour to reduce water erosion. The crops are arranged so that a strip of grass or close-growing crop is alternated with a strip of clean-tilled crop or fallow or a strip of grass is alternated with a close-growing crop.
- ✓ **Herbaceous Wind Barriers:** Herbaceous vegetation established in rows or narrow strips across the prevailing wind direction.
- ✓ **Field strip cropping:** Growing crops in a systematic arrangement of strips or bands across the general slope (not on the contour) to reduce water erosion. The crops are arranged so that a strip of grass or a close- growing crop is alternated with a clean-tilled crop or fallow.
- ✓ **Terrace:** An earthen embankment, a channel, or combination ridge and channel constructed across the slope
- ✓ **Contour Buffer Strips:** Narrow strips of permanent, herbaceous vegetative cover established across the slope and alternated down the slope with parallel, wider cropped strips.

Physical soil conservation structures: - are permanent features made of earth, stones or masonry, designed to protect the soil from uncontrolled runoff and erosion and retain water where needed.

Selection and design of structures depend on:

- Climate and the need to retain or discharge the runoff
- Farm sizes
- Soil characteristics (texture, drainage, and depth)
- Availability of an outlet or waterway
- Labour availability and cost
- Adequacy of existing agronomic or vegetative conservation measures.

Below are some of the physical conservation measures:

- **Cut – off drains.** Cut-off drains are dug across a slope to intercept surface runoff and carry it safely to an outlet such as a canal or stream. They are used to protect cultivated land, compounds, and roads from uncontrolled runoff, and to divert water from gully heads.
- **Retention ditches** these are dug along the contours to catch and retain incoming runoff and hold it until it seeps into the ground. They are an alternative to cut-off drains when there is no nearby waterway to discharge the runoff. They are often used to harvest water in semiarid areas.
- **Infiltration ditches** this is a structure designed to harvest water from roads or other sources of runoff. They consist of a ditch 0.7-1.5m deep, dug along the contour, upslope from a crop field. Water is diverted from the roadside into the ditch, which is blocked at the other end. Water trapped in the ditch seeps into the soil.
- **Water-retaining pits** Water-retaining pits trap runoff and allow it to seep into the soil. A series of pits are dug into the ground where runoff normally occurs. The soil from the pit is used to make banks around the pits. Furrows carry excess water from one pit to the next. The size of the pit depends on the amount of runoff: a typical size is 2m square and 1m deep.
- **Broad beds and furrows** in a broad bed and-furrow system, runoff water is diverted into field furrows (30cm wide and 30 cm deep). The field furrows are blocked at the lower end. When one furrow is full, the water backs up into the head furrow and flows into the next field furrow. Between the field furrows are broad beds about 170cm wide, where crops are grown.
- **Terraces** - Fanya Juu, Fanya Chini, Bench terraces, Stone terraces Fanya Juu (Converse) terrace Fanya juu terraces are made by digging a trench along the contour and throwing the soil uphill to form an embankment. The embankments are stabilized with fodder grasses and in between cultivated portions. Over time, the fanya juu develop into bench terraces. Useful in semi-arid areas to harvest and conserve water. The measure is suitable for soil too shallow for level bench terracing and moderate slopes below 20%. However, they are not applicable on stony soils.

1.6 Documenting details of consultation/research

Documenting details of consultation/ research refers to collecting relevant research/ consultation details together as evidence or as reference material. Documentation will facilitate the process of providing written details or information about Indigenous land and water management practices.

The decision-maker does not close his/her mind from all the processes gone through to arrive at the decision. The original situation is always re-visited by comparing it with the new situation by referring the documented evidences. Social learning plays its role by showing what others do in similar situations. What have they gained or lost? Such questions run through the decision-maker's mind with repercussions to the ongoing practices depending on his or her attitude and through references.

When the decision maker's evaluation is consistent with previous evaluative frames of reference, s/he will choose to continue with the new practice or idea. Otherwise, it may be modified to suit his/her needs, or rejected altogether, going back to the original practice. Similar action is taken for emerging issues that are related to this decision-making.

The Konso people live in south-western Ethiopia, in the former Gomu Gofa province. They are well known for their stone terraces that are believed to have existed for over four hundred years. In spite of external interventions, the system has maintained its characteristics, albeit, with its own pace of dynamism. Documentation of research and consultation about the system will also help in keeping the system for the future generation. In appreciation of their contribution to natural resources conservation, the United Nations extended an award to the Konso people. In addition, Ethiopian Scientists (mainly, Anthropologist/Sociologists) and their associates registered as are World Cultural Heritage centre.

After consultation or research all the important data and information should be documented and Make ready for further implementation and reference.

Organized documentation of any indigenous SWC practice and management including:

- Participant stake holder Involvement of beneficiaries
- Investment option
- Local Experience
- Detail Specification

- Allocated resource are documented and filed to transfer the technology

Self-check 1	Written test
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Name..... ID..... Date.....

Directions: Answer all the questions listed below accordingly

Test I: Choose the best answer (4 point)

1. Which one of the following is the best source of information on indigenous SWC?

A. Databases B. Record systems C. Policy and procedure manuals D. all

1. From the given alternative which one is the best indigenous soil and water conservation practice in Ethiopia?

A. Terracing B. drainage structure C. Area closure D. all

Test II: Short Answer Questions

1. What are the sources of information? (5points)

2. Define indigenous knowledge? (3points)

3. Describe the two schools of thoughts about indigenous SWC practices. (10points)

4. List the most common examples of indigenous conservation technologies in Ethiopia you know. (7points).

5. An indigenous SWC technology clearly indicates that farmers are aware of soil erosion and have developed effective means to control it. However, the fact remains that most farmers do not undertake sufficient measures to control erosion effectively. In order to become technology effectively control erosion what are the parameters farmers do understand? (20points)

6. How do you access those indigenous knowledge requires? (10 points)

7. What are external factors could enhance or inhibit farmers' decisions on land and water management? (5points)

8. Who are those institutions typical routes for external intervention (through research and extension services) in rural communities in SWC in Ethiopia? (10 points)

9. Why documentation? (5points)

10. Why the United Nations extended an award to the Konso people? (5points)

Note: Satisfactory rating - 5 points

Unsatisfactory - below 5 points

You can ask you teacher for the copy of the correct answers

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LG #41	LO #2- Establish role of group in community
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Instruction sheet
<p>This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:</p> <ul style="list-style-type: none"> • Identifying Potential roles of program to community • Managing Interaction with community • Establishing and maintaining consultation processes • Maintaining Image of group and program in community <p>This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:</p> <ul style="list-style-type: none"> • Identify Potential roles of program to community • Manage Interaction with community • Establish and maintaining consultation processes • Maintain Image of group and program in community
Learning Instructions:
<ol style="list-style-type: none"> 1. Read the specific objectives of this Learning Guide. 2. Follow the instructions described below. 3. Read the information written in the information Sheets 4. Accomplish the Self-checks

Information Sheet 2

2.1 Identifying Potential roles of program to community

Definitions of terms

Culture: -

- Is the quality in person or society that arises from a concern for what is regarded as excellent in different things?
- The arts and other manifestations of human intellectual achievements regarded collectively.

Community Values:-

- A community's most deeply held shared ideas and beliefs that serve as guiding principles.
- Community values are the foundation for a community's vision and action plan.

Attitude:-

- A settled way of thinking or feeling typically reflected in a person's behavior.

The community: In pursuing their interest in their domain, members engage in joint activities and discussions, help each other, and share information. They build relationships that enable them to learn from each other. A website in itself is not a community of practice. Having the same job or the same title does not make for a community of practice unless members interact and learn together. The claims processors in a large insurance company or students in American high schools may have much in common, yet unless they interact and learn together, they do not form a community of practice. But members of a community of practice do not necessarily work together on a daily basis. The Impressionists, for instance, used to meet in cafes and studios to discuss the style of painting they were inventing together. These interactions were essential to making them a community of practice even though they often painted alone.

2.1.1. Identify role of range of groups

The role of range of groups in a community as of indigenous SWC development concerns may be as:-

- **Task roles:** the initiator, the Information seeker, the opinion seeker, the information giver, the elaborator, the coordinator, the energizer, the procedural technician and the recorder.
- **Maintenance Roles:** The encourager, the harmonizer, the compromiser, the gate keeper, the standard setter, the group observer, the summarizer, and Reality tester.
- **Blocking roles:** The aggressor, the blocker, Recognition seeker, Self –confessor, the playboy-playgirl, the dominator, Help seeker and the special interest pleader.

2.1.2. Identify range of groups use in group/project/ activities

Program activities may include, but not limited to form and/or develop a community group, Promote solutions or explain issues relating to the environment or other government, Program, project activities, and fund raising and submissions.

Working with groups

Range of groups may include, but not limited to: Formal or informal groupings based on social activities and interests, family and community history Cultural backgrounds including ethnicity, Sex and age. Development agents do a lot of their work with, and through, groups of farmers or other rural people. These groups may be formal or informal, large or small, traditional or modern. The group may already exist, or the development agent may help form it. It may be open to anyone in the community, or just to certain people. The group may have many functions, or it may have only a single purpose. It may be long lived, or may disband after it has completed its task.

Advantages of working with groups

- A group enables people to do things they could not achieve by themselves. For example, a group can get difficult things done quickly, or can overcome labour shortages at a critical time, such as harvesting.
- The group can pool its resources and skills, for example, members of a revolving credit group lend each other money so that one member can buy something could not afford alone.
- The group can become empowered. The weight of numbers and support of friends may give people confidence to try new things out, challenge the status or pressure for change. Groups can generate a sense of ownership and can help sustain development efforts.

- The group members can share resources equitably and use scarce resources efficiently. For example, they may agree to share irrigation water in a way that avoids conflicts, or buy a lorry to transport produce to market.
- The group may be able to access services that are not open to individuals, such as credit, training, or extension advice. It is impossible for development agents to contact every farmer individually, by working with groups; the agent can serve a much larger number of people. A wide variety of groups exist in Ethiopia. Almost every one belongs to one or more groups. Here are some examples both traditional and modern.
 - ✓ Debo
 - ✓ Edir and equub
 - ✓ Saving and credit associations
 - ✓ Service cooperatives
 - ✓ Grazing land users association
 - ✓ Water users association
 - ✓ Interest groups

2.2. Managing interaction with community

A Community Interaction Committee (similar to the Committee for Academic Planning and the Research Committee) is constituted of faculties, DAs and other experts. The committee offers a participatory forum for all sectors of the community development and functions as sanctioning and coordinating body for community interaction strategies and policies. The committee is responsible for policy implementation, quality control and resource allocation, where applicable. It is also responsible for creating the opportunity for communities in society to have active participation in all stages of implementation equally.

Communities should have their own management frameworks for all their interactions on the development. These management frameworks are important things for the implementation of any community development programs, to participate community members actively on the implementation of the program plan. Communities should have Representatives or committee which has a role of organizing and facilitating all the development programs on behalf of the whole community.

Monitoring and Evaluation of Community Service

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- All community projects or programmes are monitored and evaluated both before and after registration of the project/programme.
- Annual progress, outcomes and financial management reports must be submitted in respect of all projects/programmes.
- The evaluation of projects/programmes may be done by the community representatives and development agents at the site level. This evaluation may progress beyond site level.

2.3 Establishing and maintaining consultation processes

Consultation processes involve complying with values and respecting cultural authority, addressing issues that may impact on values, including discussion where relevant with communities and groups on natural resource and environment management.

Consultation is important for any implementation, so before start any development program you should establish consultation processes with relevant peoples and organizations. Whenever there is a potential that a stakeholder may be affected in relation to a trail project, consultation will be required. There are two consultation processes that are available: a) Communication Only and b) Communication and Consultation. A decision should be made during the early stages of planning for the trail to determine if stakeholder issues are likely to have an impact on the outcome. This will then determine the most appropriate process of consultation.

The Communication Only process should be adopted when the stakeholder has no, or minimal ability to influence the decision or outcome. However, it will be important to get a message across in a consistent way ensuring that a stakeholder is kept informed. This will assist in building a positive relationship that may impact favourable on future activities.

The combined Communication and Consultation Process should be adopted when it is important or necessary that stakeholders have input which may influence a decision or outcome. Stakeholders may test ideas or options and in some cases, may contribute to a mutually acceptable outcome. It will be important to use a combination of effective communication and consultation techniques to ensure that a positive result is achieved. The degree of sensitivity of potential stakeholder impact displays the impact the stakeholder issues are likely to have on the project.

Communication and consultation techniques

Provide information using

- Advertisement / Media

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- Letter / Phone call
- Newsletter / Brochure
- Internet
- Signs / Maps / Models
- Public Display / Exhibition
- Meetings with key individuals
- Submissions from stakeholders
- Telephone Hotline
- Surveys
- Presentations to existing groups
- Local community group meetings
- Public meetings
- Community event
- Open day information session
- Maintain awareness / Updating information
- Identify concerns and issues
- Develop objectives / Issues
- Develop option

Methods of organizing the community

There are different methods that you might be able to use in order to organize the community in which you work. You may be able to organize the community according to:

- Their place of work
- Common characteristics of the people
- The issue addressed
- Location or geography.

Look carefully at the list above. It shows some of the methods that you may be able to use to organize groups in your community. Think of examples from your own work for each item, where the community has been organized in this way.

Self-check 2	Written test
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Name: _____

Date: _____

Short Answer Questions

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What is the role of range of groups in a community? (5points)
2. What are formal or informal groupings depend on? (4points)
3. Mention at least two advantages of working with group. (6points)
4. Why community management frameworks are important? (10points)
5. What are the two consultation processes available? (5points)
6. How do you maintain Image of group and program in community? (5 points).

Note: Satisfactory rating - 5 points Unsatisfactory - below 5 points

You can ask you teacher for the copy of the correct answers

LG #42

LO #3- Prepare for implementation of indigenous soil and water conservation measures

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Observing and following OHS procedures
- Matching indigenous soil and water conservation works
- Identifying survey pegs and site indicators.
- Matching equipment and tools
- Verifying work readiness of equipment and tools
- Selecting materials in line with construction schedule

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Observe and follow OHS procedures
- Match indigenous soil and water conservation works
- Identify survey pegs and site indicators.
- Match equipment and tools
- Verify work readiness of equipment and tools
- Select materials in line with construction schedule

Learning Instructions:

5. Read the specific objectives of this Learning Guide.
6. Follow the instructions described below.
7. Read the information written in the information Sheets
8. Accomplish the Self-checks
9. Perform Operation Sheets
10. Do the “LAP test”

Information Sheet 3

3.1 Observing and following OHS procedures

During construction of ISWC practices care has to be taken for workers (OHS) and property (tools and equipments). Observing and following OHS procedures may include, but not limited to:-

- The use of Personal Protective Equipment (PPE) and clothing
- The use of safety and first aid equipment
- Forest pest and disease fighting measures
- Hazard and risk control
- Elimination of hazardous materials and substances
- Appropriate fitness for the task
- OHS hazard identification,
- Risk assessment and control procedures for dealing with hazardous events

3.2 Match indigenous SWC plan and schedule with site conditions

Introduction to Soil and Water Conservation in Ethiopia

Prior to the 1974 revolution, soil degradation did not get policy attention it deserved. The famines of 1973 and 1985 provided an impetus for conservation work through large increase in food aid (imported grain and oil). Following these severe famines, the then government launched an ambitious program of soil and water conservation supported by donor and non-governmental organizations. The use of food aid as a payment for labor replaced voluntary labor for conservation campaigns.

By most performance measures, soil and water conservation effort of the country ended up in remarkable failure. A large sum of money has been spent in the name of encouraging environmental protection, encouraging and coercing farmers to adopt conservation measures. Nevertheless, the implementation was very poor. Few structures persisted causing erosion rather than preventing it.

As pointed out earlier, to adopt the approach of integrated development, the SWC system is used as the detailed planning and subsequently the development unit. In order to execute the plan and to make as practically as possible the size of SWC area should not be too large. As a guide an area ranging from 1000-5000 ha is ideal.

The SWC planning requires many factors to be considered or studied.

E.g. climate, topography and slope, soil properties, availability of water, crop and livestock production (i.e. in depth analysis of socio-economic features, etc. To assess the general condition situations and standard-living conditions.

It is important to note that these factors should not only be studied as individual component but also their interactions. Analyses of these factors leads you to ask if there is a need for improvement of the SWC area.

It should be stressed that the involvement of the local population on the planning and implementation of SWC development is the key factor for the success. Past experience, shows that purely technical solution to the problem without adequate participation of the local farmers are bound to meet with failure.

Sequences in planning soil conservation

Soil conservation programs must be well designed if they are to reduce erosion effectively and not fail. The planning is important to identify major areas of erosion and to select suitable conservation measures so that the farmers are willing to implement it.

Brief sequences in planning soil conservation:

- Beginning with through assessment of erosion risk using techniques of erosion hazard assessment such as, rainfall aggressiveness, erodibility, topography or practices.
- Followed by land use plan by adopting land classification methods, so that the land is used in accordance with its capability. This enables to identify which area is suitable or not for particular purpose under present or proposed economic, social and production technology. At this stage you could be able to identify where erosion is likely to occur etc.
- Once the appropriate land use has been determined, the conservation measures proposed must be relevant to the farming system, and the nature of the erosion problem.
- The final stage is to quantify the impacts of the proposed land use and associated conservation strategy on the crop production and environment. Ideally economic evaluation can be made, but the benefits related to minimizing adverse environmental impacts are difficult to quantify.

The sequence of events to be considered in planning a soil conservation strategy, suggested by perrens and trustrum (1984) is given as under;

A. land and water resource inventory

I. land resource inventory

- ✓ erosion and present land use
- ✓ Physical factors; soils, geology, rainfall, slope, vegetation, micro relief, drainage pattern.

ii. Water resource inventory

- ✓ existing development and use
- ✓ Physical factors; stream flow, floods, water quality, sedimentation.

B.land capability assessment and erosion sedimentation index

I. land capability assessment

- ✓ assessment of capability and suitability of landscape units;
- ✓ mountain
- ✓ steep lands
- ✓ hill lands
- ✓ flat lands

ii. Erosion/ sedimentation index

- ✓ identification of sources of erosion hazard and fate of sediment
- ✓ Rank of landscape unit and elements based on erosion and sedimentation sources and sinks.

C. potential land use and suitability and conservation needs

I. potential land use suitability

- ✓ based on resource capacities and constraints

• Forestry, agro-forestry, grazing, extensive cropping & grazing and intensive cropping

ii. Conservation needs

- ✓ Consider socio economic factors and integrate soil conservation with land use.

D. conservation needs with land use potential

- ✓ protection forestry
- ✓ production forestry
- ✓ gully controlling works
- ✓ contour cultivation and strip cropping
- ✓ zero or minimum tillage

E. options and priorities

- ✓ use economic analysis (benefit cost analysis) to judge the alternatives

e.g.

- ✓ reserve A and E for forestry
- ✓ develop farming system for D
- ✓ improve productivity of B
- ✓ develop cropping and tillage system for C

F. management actions

- ✓ Sheet erosion, wind erosion, sedimentation, flooding, landslides, gullies, stream banks

G. quantify impacts on landscape and productivity

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- ✓ loss of top soil (B, C, D)
- ✓ Sediment yield from stream bank (C, and D)
- ✓ Sediment deposition on land (C)
- ✓ Increased flood height
- ✓ Declining crop productivity
- ✓ Declining range land productivity
- ✓ Water quality changes
- ✓ Decreased water yield
- ✓ Reduced reservoir output due to sedimentation

H.Evaluate impacts

- ✓ Cost of erosion control
- ✓ Benefits of increased yield
- ✓ Value of more irrigation water.

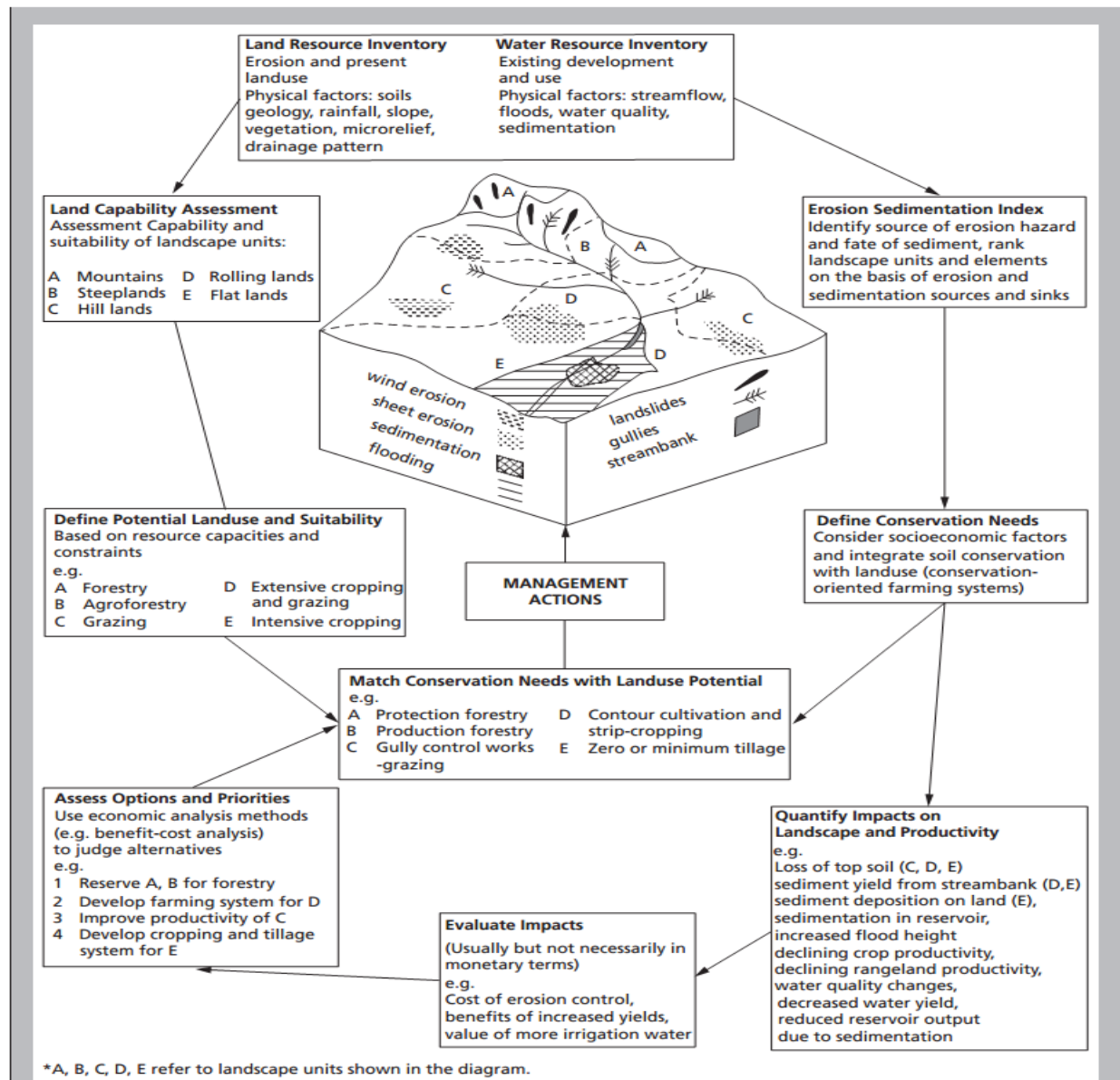


Fig.3.1 process of erosion control mechanism

3.1.1 Preparation for SWC System development planning

Having identified the SWC System for development, the next stage is collecting the above mentioned basic information of the SWC area. Some of the required information may be obtained from maps and aerial photographs if available. However, much of the information will have to be collected from the map, report, interview and field reconnaissance. SWC development planning should refer to multi-disciplinary approaches. It is not only conservationist interest but also other sectors of economic development. Mainly agronomist, extension promotes, forester, soil scientist, range land manager, sociologist may be required. But in many situations all these disciplines may not be available. So that the core disciplines can be sufficient.

Information required about SWC area include:

- **Assessment of bio-physical particularly climatic conditions**
 - ✓ Knowledge of **climatic conditions** likely to occur in SWS area is basic requirement. The amount distribution and intensity of rainfall is a particular importance. This is useful for the design of many soil and water conservation structures. In addition the knowledge of rainfall and temperature is essential for selected a suited vegetation erosion control species. This information may be obtained from metrology stations, National Atlas of Ethiopia supplemented by local people information.
 - ✓ Information about topography, slope and vegetation condition of the area are also required.
- **Socio-economic survey**
 - ✓ The socio-economic survey must reflect the conditions and important characteristics of SWC area. Socio-economic survey of the SWC area is a fundamental requirement and is useful to identify farmer's problems, requirements priorities and also helps to identify where development potentials exist to improve living standard of the farmers.

3.1.2. Matching site conditions with the plan and schedule of works

Matching indigenous and introduced soil and water conservation plan and schedule of works with site conditions helps us for successful implementation of the plan.

The format of the development plan consists:

a) The development map: The location of the development measures are shown on this map. The extension worker therefore can easily locate on the ground where various soil and water conservation measures to be built. In addition any development work that has been previously implemented (which has been indicated on the present land use map) should be also recorded on this map

b) A table of inputs: After completing the development map the next step is preparing the table of inputs to determine the appropriate inputs required for implementing the plan. The volume of inputs required can be estimated from the extent of the work, specification, availability of tools, materials, labor and others.

c) **The time table:** A time table for the development measure should be prepared. The time table is used when to implement the various development measure and quantity of labor and other material required.

3.2. Identifying survey pegs and site indicators

Contour lines are horizontal lines across a slope, linking up points at the same elevation. It is important to mark contour lines as preciously as possible when building barriers such as level bunds and bench terraces that protect the soil from erosion. A simple way of marking contour is line level.

The line level




A line level consists of two wooden poles of the same height (usually 2 m) with a string 10 m long joining them. The poles have marks every 10 cm. a sprit level is tied exactly in the middle of the string.







You will also need sticks or pegs to mark the contour on the ground (about 20 pegs per 100 m), and a stone or hammer to drive the pegs in to the ground. Three or four people are needed to mark contours using a line level.

3.2 Matching equipment and tools

Matching **equipment and tools** to program works and terrain on site for successful implementation of indigenous SWC work is necessary.

Table3.1. Tools, their purpose and image

Tools	Purpose	Image
Pix axes	A tool for breaking hard surfaces, with a long wooden handle and a curved metal bar with a sharp point.	
Shovel	Shovels are used for digging and lifting loose soil or other substances.	
Meter	Used to measure distance between two points	

Pegs	Used to mark appoint on the ground	
Hammer	Used to install peg on the ground. It also used for driving and pulling out nails	
Range pole	Used to layout contour or gradient line	
Water level	Used to determine the point of the same elevation on the ground	
Rope	Used to keep straight line between two points	
A frame	Also used to mark contour like line level	

In order to match **equipment and tools** to program works and terrain on site for ISWC works, identifying constraints that may enhance or hinder the program works has to be assessed.

A. Identify constraints

Before opening a site, the site manager should make survey of local conditions and site reconnaissance for the following information:

- **Major natural constraints** eg. Information on climatic conditions such as time of rainy season, excessive heat or frost, etc. time of problems of sanitary conditions, risk of any epidemic, peak flow should be collected and analyzed.
- **Technical constraints and economic constraints:** **Site access** - existing roads and tracks, their distance from the construction, need for the construction of new access routes. **Supplies of materials** - examining the potential of existing quarries quality of the materials they supply, delivery capabilities and prices. **Supplies of equipment**- It is necessary to assess the number of tools and machines required on the site: conditions for the purchase of new equipment, local resources and the condition of available second-hand material.

3.3 Verifying work readiness of equipment and tools

Work readiness of selected equipment and tools are verified as directed by supervisors. Verifying work readiness of selected equipment and tools if they are maintained and ready for work needed (Clean tools, apply oil to prevent rust, remove rust with a wire brush, sharpen tools for peak efficiency grind battered tools into shape); checking sufficiency through inventory if new or additional purchase needed, security clearance for transport, etc.

Self-check 3	Written test
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Name: _____

Date: _____

Short Answer Questions

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What are OHS procedures may include? (3points)
2. Mention a brief sequences in planning soil conservation works. (10points)
3. SWC development planning should refer to **multi-disciplinary approaches**. What does a multi-disciplinary approach mean? (5points)
4. What are the two Information required about SWC area? (5points)
5. If the top and bottom width of a trapezoidal diversion ditch is 60cm and 40cm and has a depth of 0.6m, what is the volume of earthwork of 900m long diversion ditch? (5 points)
6. If work norm of question two above is 0.7m³/PD, how many persons are required to accomplish the work in one day? (4 points).
7. What are the constraints that may enhance or hinder the ISWC program works? (5points)
8. List equipment and tools needed for ISWC works. (5points)

Note: Satisfactory rating - 5 points Unsatisfactory - below 5 points

You can ask you teacher for the copy of the correct answers

Operation Sheet -3

3.1 Techniques of mark contours

A. Tools and equipment

- String rope
- Water level
- Ranging pool

B. Procedures

1. Always starts laying out contours at the top of the slope (not the middle or bottom), or immediately below the cutoff drain (if you have dug one). Drive a peg in to the ground where you want the first contour to begin.

2. One person holds the first pole upright at this first peg. The other person walks roughly level with the other pole until the string is tight. The third person checks the spirit level in the middle of the string, and directs the second person to move the pole up or down the slope until the bubble is in the middle of its run. Drive a peg in to the ground next to the second pole.

3. The two people holding the poles then both move forward until the first pole is at the second peg. Keeping the string tight, the second person again moves his or her pole up or down the slope until the line is again level. Drive a third peg in to the ground here. Repeat the process until the whole contour line is marked out.

4. To start a second contour line further down the slope, find a starting point by measuring the vertical interval you want. Then repeat the process for the new contour line.

In difficult topography, it might be inconvenient to measure 10 m at a time. Try to use half of the string (5 m).

1.2 Techniques mark graded line

A. Tools and equipment

- String rope
- Water level
- Ranging pool

Graded are lines of constant gradient (usually 1% or 2%), going across a slope. They are used to plan conservation structures, such as cut-off drains and graded terraces that need to slope gently so they allow water to drain away.

Mark graded lines

You can use the same line level as for marking contours, only you have to fix the string differently. The string on a standard line level is 10 m long.

First, decide the gradient you want to mark. For a 1% gradient, the height difference over 10 m equals 10 cm. tie the string on one pole at a height of 110cm. on the other pole, tie it at 100 cm. when the bubble is at the centre of the sprit level, the string will be level, but the bottom of the second pole will be 10 cm higher than the bottom of the first pole.

For a 2% gradient, tie the string at 120 cm on the first pole, and the other end at 100 cm. For a 0.5% gradient, tie the string at 105 cm on the first pole.

B. Procedures

Mark graded lines

1. Start marking graded lines at their lower end, for example, where you want a graded drainage line to meet a natural stream. Mark this place with a peg, and stand the pole with the string tied higher up (e.g., at 110cm) here.
2. Move the other pole (tied at 100 cm height) roughly level and slightly upslope until the string is tight (10 m away).
3. Check whether the bubble is in the center of the sprit level. Move the second pole up or down the slope until the bubble shows the string is exactly level. Mark this point with another peg.
4. Move both poles forward until the first pole is at the second peg (this pole must always be lower down, nearer the start of the line). Move the second pole until the string is tight, then move it up and down the slope until the string is level. Mark this point with a third peg. Repeat this process until you have marked out the whole graded line.
5. To start a second graded line, find a starting point by measuring the vertical interval you want. Then repeat the process for the new line.

1.3 Techniques mark slope gradients

A. Tools and equipment

- String rope
- Water level

- Ranging pool

Measuring vertical intervals and slope gradients

A 'vertical interval' is the distance in height between two objects, such as two terraces contour bunds. Conservation structures should be built at a small enough vertical intervals to prevent erosion.

Measuring vertical intervals with a line level

Procedures

1. To measure a vertical interval of 1 m, fix the string on one pole of the line level at 100 cm. you can unite the string from the other pole; you will not need it.
2. Have the person with the free end of the string hold it on the ground at the top of the slope.
3. A second person with the pole and string attached moves straight down the slope. The first person pays out enough string to keep the string taut. The third person watches the bubble in the spirit level.
4. When the bubble is in the center of its run, the string is level. The pole is exactly 1 m below the free end of the string. Mark these two places with pegs or stones.

On gentle slopes, the string may be too short. Try measuring the vertical interval in two steps of 50 cm each.

To mark a larger vertical interval of, say, 1.5 m, you can measure a 1 m vertical interval, then one of 0.5 m.

A rule of thumb for spacing structures such as check dams and bench terraces:

- On slopes less than 15%, use a vertical interval of 1 m.
- On slopes steeper than 15%, use a vertical interval 2.5 times the depth of the soil. For example, if the soil is 50 cm deep, space check dams at a vertical interval of 125 cm.

LAP TEST-1	Performance Test
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Name..... ID.....

Date.....

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 1:30 hour. The project is expected from each student to do it.

- Task 1. mark contours line
- Task 2. Mark graded line
- Task 3. Determine slope gradients

LG #44

LO#4-Implement and maintain Indigenous erosion control structures

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Constructing indigenous conservation practices
- Implementing Erosion control regulations and manuals
- Reporting breaches of erosion control regulations and manuals
- Applying industry practices for erosion control
- Implementing site works maintenance inspection schedule

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Construct indigenous/introduced soil and water conservation practices
- Implement Erosion control regulations and manuals
- Note and report breaches of erosion control
- Apply Industry practices for erosion control
- Inspect maintenance schedule

Learning Instructions:
<p>11. Read the specific objectives of this Learning Guide.</p> <p>12. Follow the instructions described below.</p> <p>13. Read the information written in the information Sheets</p> <p>14. Accomplish the Self-checks</p> <p>15. Perform Operation Sheets</p> <p>16. Do the “LAP test”</p>

Information Sheet 4

4.1. Constructing indigenous SW conservation practices

Characteristics of ISWC measures

The following major features characterize most of the indigenous SWC technologies:

- **Site specificity:** due to the heterogeneous nature of the farming plots (soil, micro-climate, slope, etc.) owned by an individual farmer, different technologies and techniques are applied in each locality.
- **Flexibility and dynamics:** in a single plot usually different supplementary technologies and techniques are applied (agronomic, vegetative and structural). The techniques are also changing with the seasonal rainfall pattern; they can be permanent and temporary.
- **Multi-functionality:** the measures applied are not only confined to SWC but also to different other functions. For example, structures can serve as a fence; can improve fertility by accumulation of top soil, safe drainage of excess water, etc.
- **Combining both short- and long-term benefits:** production and protection elements are systematically integrated. For example, “moving” bunds and permanent bunds constructed within a plot have a synergy effect: short-term increase of production and long-term soil protection.
- **Integration in to the farming practice:** ISWC technologies are integrated to the farming system, and thus do not face problems of viability and acceptability, as introduced practices. For example, traditional ditches and grass strips are constructed during plowing. The construction of traditional bunds is integrated in other farm activities, such as plowing and weeding, and does not cause tremendous extra costs.
- **Reduced risks:** consequently, ISWC as part of the regular farming operation using local tools and materials implies a lower risk than introduced technologies.
- **Involvement of local institutions:** in most of the farming and conservation activities local institutions (self-help groups, neighborhood) are involved in both labor mobilization and application of rules and regulations.

Generally, the indigenous SWC technologies are coined to harmonize ecological benefits (minimizing soil loss and run-off), economic benefits (sustaining and increasing production), and social benefits (preventing out-migration and brain drain). Nevertheless, unequal distribution of indigenous knowledge within the community is one of the fundamental limitations of indigenous technicalities.

Potential roles of ISWC programs/projects to community are:

- More income
- Reduced vulnerability
- Improve food security
- Increase well-being
- More sustainable use of natural resource base

Common Indigenous ISWC practices category

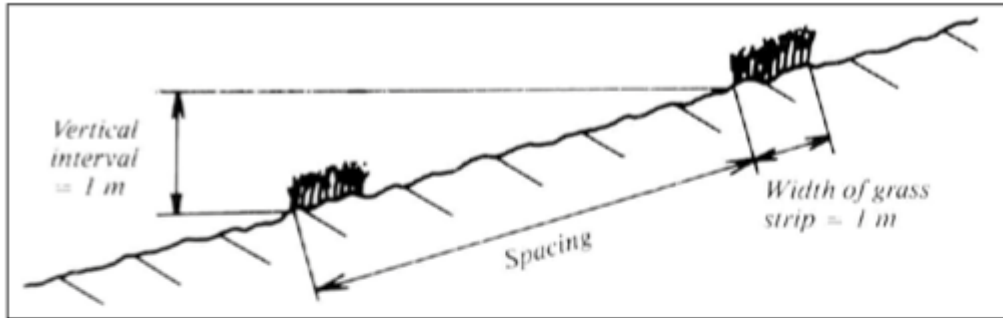
A. Biological (Vegetative and agronomic) practices

- **Grass Strip**

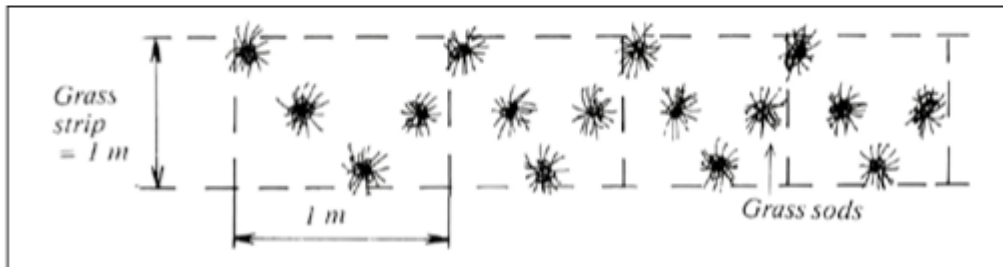
A grass strip is a ribbon-like band of grass laid out on cultivated land along the contour. Usually, grass strips are about 1 m wide and spaced at 1 m vertical intervals. They are mainly used to replace physical structures on soil with good infiltration (sandy, silty) on gentle slopes. Cattle must be excluded from this measure all year long to provide for sufficient length of the grasses to slow runoff and retain soil sediment.

Specifications

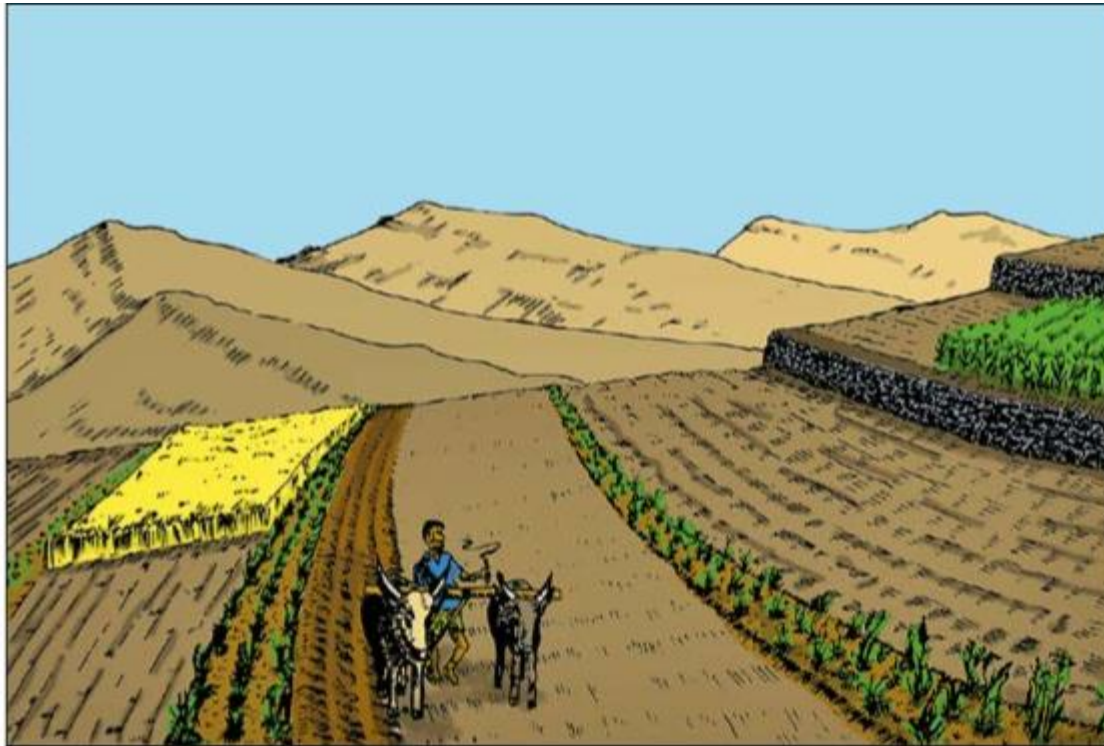
Cross-section:



View from top:



Grass strips are planted along the contour or along **Cutoff Drain**. Spacing with 1 m vertical interval means that on a 3% slope, grass strips will be 33 m apart, and on a 15% slope, only 7 m apart, still sufficient for ploughing between the strips.



Grass strips are used on gentle cultivated land to the left. On the steeper slopes to the right, terrace development is needed. The farmer automatically ploughs parallel to the strips, a measure which reduces erosion further. The individual sods of grass planted into the strip can still be seen. To the right, the grass strip has already developed into a small terrace.

Fig.4.1 grass strips

Mulch

Applying mulch means covering the soil with crop residues such as straw, maize and sorghum stalks, tree leaves, or other plant material, or standing stubble. The cover protects the soil from the hot sun and from the impact of raindrops, minimizing soil crusting, erosion and runoff. Maintaining crop residues or mulch on the field reduces soil erosion and has a considerable potential for the restoration and maintenance of soil fertility.

Specifications

Applying mulch is of the most practical use with row crops such as maize and so ghum, and for widely spaced perennial fruit trees such as mango, avocado, citrus, inset and banana. What to use as mulch: Large amounts of organic materials are needed to get the full benefit of mulching. Any organic debris (straw, prunings from hedgerows, weeds removed from the fields) can be used. Research findings show that using mulch on maize increased biomass production so much that it compensated for the mulch used and the remaining crop residues were still enough to feed

the cattle. There, farmers were first worried about not having enough fodder for their animals when mulching.

When to use mulch: Under conventional tillage: plough under the mulch before planting the main crop to incorporate it into the soil. Under conservation tillage: keep the mulch on the field while the crop is growing so the mulch controls weeds

such as contour plowing (retain water and reduce surface run-off), fallow (fertility improvement and source of fodder), crop rotation (fertility improvement and pest and disease control), manuring (soil fertility maintenance and the challenge of competition with fuel wood), mixed cropping, grass strips, trash lines (sorghum / maize straw and stubble), Agro-forestry, perennial plants such as coffee, chat and multi-purpose trees such as moringa are planted at the foot of the bunds.



Mulch is a system in which part of the crop residues are spread over the field after harvest instead of being removed. This retains soil moisture and softness, so that direct seeding is possible, unless the material is ploughed into the soil to improve humus content. Post-harvest grazing should be avoided if possible.

Fig4.2 mulching

B. Structural (mechanical or physical) practices

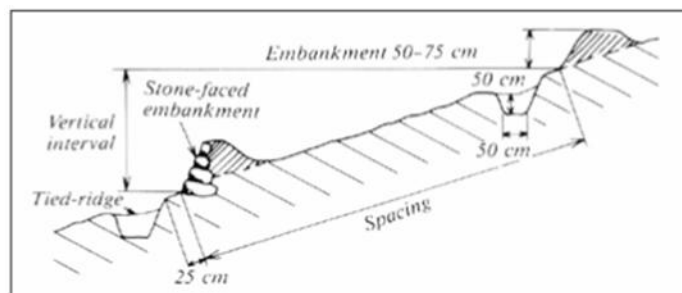
Fanya Juu

A level Fanya Juu ('throw uphill' in Swahili language) is an embankment along the contour, made of soil and/or stones, with a basin at its lower side. The Fanya Juu reduces or stops the

velocity of overland flow and consequently soil erosion. By contrast with the Level Bund the soil in a Fanya Juu is moved upslope for construction. The water retention basin is thus at the lower side of the wall. Tied ridges about every 10 metres are also used here to prevent runoff from flowing sideways.

Specifications

The vertical interval between two bunds is 1 m for slope gradients of less than 15%. For steeper slopes, the vertical interval must be two-and-a-half times the depth of reworkable soil. Contours are lined out as shown on page 111. The height of the Fanya Juu is 50–75 cm, and the ditch is about 50 cm deep. The space between the ditch and the berm is at least 25 cm. The width of the ditch depends on soil fertility. On fertile subsoil, it may be very wide and crops can be planted in the ditch. A cross-section through a Fanya Juu looks as follows:



About every 50 m, a gap can be left open to allow oxen pulling ploughs to cross and reach their land.



The level Fanya Juu in the foreground shows how the ditches are placed below the embankment. Tied ridges here also stop the runoff from flowing sideways to the deepest point where it would overflow. The embankments still need revegetation for better stabilization. The farmer ploughs along the contour between two Fanya Juus, helping them to develop a Bench Terrace.

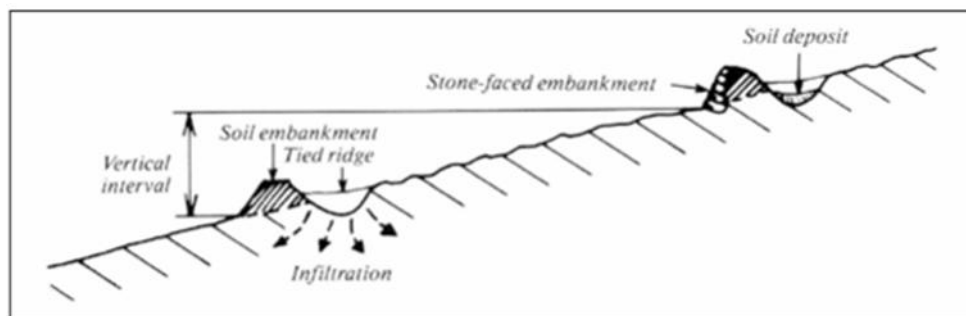
Fig 4.3 level fanya juu

Level bund

A level bund is an embankment along the contour, made of soil and/or stones, with a basin at its upper side. The bund reduces or stops the velocity of overland flow and consequently soil erosion. Level bunds are about 50–75 cm high and have a bottom width of 100–150 cm and a water retention basin on their upper side. Usually, tied ridges, placed in the basin about every 10 m help to prevent runoff from flowing sideways and to concentrate overflow at one point along the bund.

Specifications

The vertical interval between two bunds is 1 m for slope gradients of less than 15%. For steeper slopes, the vertical interval must be two-and-a-half times the depth of rework able soil. Contours are lined out as shown below. A cross-section through bunds looks as follows.



About every 50 m, a gap can be left open to allow oxen pulling ploughs to cross and reach their land.



The level bund in front of the slope follows a horizontal line. The basins behind the bund are separated by tied ridges about every ten metres. The newly constructed embankment still needs more revegetation. For this gentle slope, a 1 m vertical interval was used because the slope gradient is less than 15%. In the background, parallel bunds which allow cattle to cross the land during ploughing are set up with some alternating gaps between them.

Fig4.4 level bund

Bench terrace

A bench terrace is a conservation structure where a slope is converted into a series of steps, with a horizontal cultivated area on the step and steep risers between two steps. In Ethiopia, a bench terrace is usually developed from bunds and Fanya Juus over a period of 5–15 years through careful maintenance and buildup. Bench terraces are level along the contour in dry to moist agroecological zones. In moist to wet agro ecological zones, they are graded to drain excess runoff sideways to the next river or waterway.

Specifications

Bench terraces must be spaced with a vertical interval, which is two-and-a-half times the depth of reworkable soil. If the soil is 1 m deep, the vertical interval is 2.5 m horizontally, level terraces are lined out with the line level and graded terraces are lined out as shown on below. The width of cultivated area on a bench terrace is determined by the slope gradient and the soil depth, as shown in the Table below. Measure the slope gradient and the average soil depth and check the table for the width of cultivated land you can expect when using a vertical interval of two-and-a-half times the soil depth.

Slope gradient	Soil depth (cm)					
	25	50	75	100	125	150
20%	2.80 m	5.60 m	8.40 m	11.30 m	14.10 m	16.90 m
30%	1.80 m	3.50 m	5.30 m	7.10 m	8.90 m	10.60 m
40%	1.30 m	2.50 m	3.30 m	5.00 m	6.30 m	7.50 m
50%	0.90 m	1.90 m	2.80 m	3.80 m	4.70 m	6.60 m

Table: Width of cultivated land on bench terraces in metres for variable slope gradients and soil depths.



The bench terraces shown here are slope slightly outwards. They have been developed from stone-faced bunds still visible in the middle of the riser slope. Above and below the stone wall, there are grasses and legumes which can be used for fodder. Ploughing is automatically along the contour. Erosion from such terraces is reduced to almost zero.

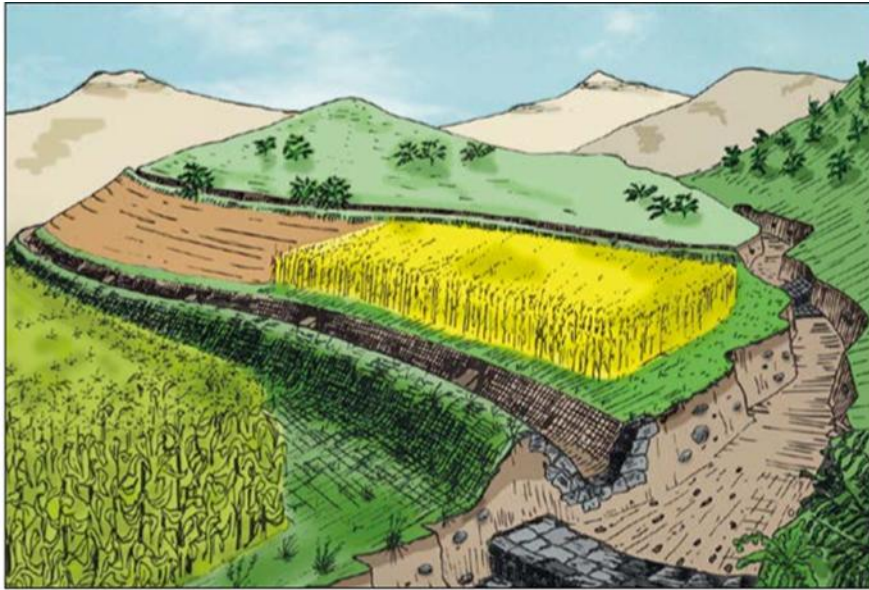
Fig 4.5 bench terrace

Graded bund

A graded bund is defined similar to a Level Bund with the only difference being that it is slightly graded sideways, with a gradient of up to 1%, towards a waterway or river. Such a gradient is for surplus runoff to be drained if the retention of the bund is not sufficient. Tied ridges with top heights lower than the bund height serve to retard such flow and to provide small basins for water storage.

Specifications

The vertical interval between two bunds is 1 m for slope gradients of less than 15%. For steeper slopes, the vertical interval must be two-and-a-half times the depth of reworkable soil. Gradients of 1% are lined out. For a typical cross-section, refer to Level Bund because it is not different from this. No gaps can be provided for ploughing oxen to cross (as for level bunds) because the graded bund serves as a drainage line which cannot be interrupted. Whenever possible, use and improve traditional waterways in the area where you intend to apply graded bunds. Discuss with farmers the measures lined out before you implement them. Make the waterways one year before the graded structures to stabilize them before use. If the bunds are long, the basins behind them must be increased towards the waterway, as more and more runoff will have to pass during storms. The size of the ditch can be 25 cm deep by 50 cm wide at the beginning of the bund, but 50 cm deep by 100 cm wide after about 100–150 m when the bund reaches the river or the waterway.



The graded bund in the foreground enters a natural drainage channel which has been protected with a checkdam just below the entry point of the graded bund. The basin behind the bund still has small tied ridges to prevent runoff from flowing too fast and creating erosion behind the bund. Earth bunds are stabilized with revegetation and their outlets reinforced with stones.

Fig.4.6 graded bund

Micro- basin,

Locally by konso people named “*kaha*”, is constructed within the stone terraces during the land preparation activities, for the purpose of harvesting and concentrating water nearer to growing plants.

specifications

Micro-basins, half moons and other micro catchment technologies are mainly used in dry areas for water conservation. In semi arid and sub humid areas micro basins are mainly found in forest areas and on steep slopes or very shallow soils. Such structures are often constructed manually, using earth and stones, outlined in lines of staggered formation. Runoff water is collected within the basin from the area above and impounded in the structure. Excess water is discharged around the tips and is intercepted by the next row of micro basins. Normally the semi-circles are of about 4-12 m in radius with a height of about 30 cm and a base width of about 80 cm. The percentage of enclosed cultivated area depends on the rainfall regime of the area.



Fig 4.5: micro-basin

Diversion ditch / cut-off drain: a graded channel with a supportive ridge or bank on the lower Side. It is constructed across a slope and designed to intercept surface runoff and convey it safely to an outlet or waterway.

Waterways: are needed to conduct runoff safely from hill slopes to valley bottoms where it can join a stream or river.

Retention / infiltration ditch: large ditches designed to catch and retain all incoming runoff and hold it until it infiltrates into the ground.

Sediment / sand trap: device (either an above ground barrier or a dam wall) built specifically to trap sand or sediments moving in the wind or in water flow.

Dam / pan: blockage of watercourse or excavation at a low spot of land to collect water for Various purposes.

C. Any combinations of the above measures: e.g. Terrace (structural) with grass strips and trees (vegetative) and contour ridges (agronomic).

D.Management measures: change of land use type (e.g. area enclosure); change of management / intensity level (e.g. from grazing to cut-and-carry); major change in timing of activities; control / change of species composition.

4.2. Reporting breaches of erosion control regulations and manuals

Erosion and sedimentation can result in impacts to public infrastructure such as creating both nuisance and larger scale problems when streets, streams and storm drains are clogged with sediment and are then prone to flooding. These impacts can result in problems that affect public safety and result in permanent infrastructure damage such as road failure and pipeline damage, as well as environmental impacts. Uncontrolled erosion is costly; violates state and Federal pollution laws; and exposes developers, contractors, and landowners to legal liabilities.

Natural erosion is generally considered to be due to the influence of climatic forces on the surface of the earth. While we can learn from the processes of natural erosion, the practice of erosion prevention is usually limited to sites where human activities accelerate this natural process.

Erosion problems can be accelerated by a variety of human activities, including unrestricted development, overtaxed resources, removal of surface cover (such as vegetation), increased imperviousness (such as paving and rooftops) that increases runoff, and poor stewardship. Accelerated erosion as man-induced, land-disturbing activities that result in increased sediment delivery to down slope/downstream water bodies. Sedimentation impacts on in-stream and off-stream water quality are illuminated along with other resource base, agricultural and air quality impacts. Consequently, it brings economic and environmental destruction. Therefore, such kind of activities should closely followed, noted, reported and treated according to erosion and sediment control legislations.

Breaches (Violations) of erosion and sediment control legislations refers to: an act of disregard /contrary of erosion and sediment control legislations such as a law, contract, or agreement, especially in a way that produces significant effects; disturb or interrupt something in a rude or violent way; treat something sacred with a lack of respect. Somebody who fails to respect erosion and sediment control legislations will be sentenced accordingly which will be allocated/imposed a punishment to somebody convicted of a crime, usually stating its nature and its duration.

Therefore reporting and noting violations of erosion and sediment control legislations would help to bring somebody who convicted of a crime against erosion and sediment control activities will in turn reduce the incidence of crime and correct the person who had convicted of a crime.

4.3. Applying industry practices for erosion control

1.3.1 Erosion and sediment impact

Damage from **sedimentation** is expensive both economically and environmentally.

Sediment deposition has the following impacts:

- ✓ destroys fish spawning beds
- ✓ reduces the useful storage volume of reservoirs
- ✓ clogs channels and streams
- ✓ May carry toxic chemicals, and requires costly filtration for municipal water supplies.
- ✓ Suspended sediment can reduce in-stream photosynthesis ecology.
- ✓ damage to infrastructures and buildings e.g fill culverts, damage bridges

Many environmental impacts from sediment are additive, and the ultimate results and costs may not be evident for years. The consequences of off-site sedimentation can be severe and should not be considered as just a problem to those immediately affected.

On-site erosion and sedimentation can cause costly site damage and construction delays. Lack of maintenance often results in failure of control practices and expensive cleanup and repairs.

While sedimentation is off-site effects of erosion, on-site effects include the following:

- ✓ Soil loss
- ✓ Reduction of soil depth
- ✓ Reduction of soil fertility
- ✓ Reduction of crop yield
- ✓ Dissection of farm lands, etc.

1.3.2 Erosion & sediment control principles

The following principles are not complex but are effective. They should be integrated into a system of control measures and management techniques to control erosion and prevent off-site sedimentation.

I. Fit the development to the existing site conditions

Ensure that development features follow natural contours. Steep slopes, areas subjected to flooding, and highly erodible s well-drained areas offer few restrictions. Any topography requires protection from erosion and sedimentation.

II. Minimize the extent and duration of exposure

Scheduling can be a very effective means of reducing the hazards of erosion. Schedule construction activities to minimize the exposed area and the duration of exposure. In scheduling, take into account the season and the weather forecast. Stabilize disturbed areas as quickly as possible.

III. Protect areas to be disturbed from storm water runoff

Use dikes, diversions, lined channels, waterways and temporary slope drains, etc to intercept runoff and divert it away from cut-and fill slopes or other disturbed areas. To reduce on-site erosion, install these measures before clearing and grading.

IV. Stabilize disturbed areas

Removing the vegetative cover and altering the soil structure by clearing, grading, and compacting the surface increase an area's su measures as soon as possible after the land is disturbed. Plan and implement temporary or permanent vegetation, mulches, or other protective practices to correspond with construction activities. e.g seeding, mulching and matting, etc.

V. Keep runoff velocities low

Increasing vegetation cover and/or the surface roughness and reduces runoff velocities and volumes. Use measures that break the slopes to reduce the problems associated with concentrated flow volumes and runoff velocities and diverting stormwater at non erosive velocity to safe disposal area.

VI. Retain sediment on the site

Whenever possible, plan and construct sediment traps and basins before other land- disturbing activities.

VII. Inspect and Maintain

If not properly maintained, some practices may cause more damage than they prevent. For example, a large sediment basin failure can have disastrous results; low points in dike can cause major gullies to form on a hill slope. Always evaluate the consequences of a measure failing when considering which control measure to use, since failure of a practice may be hazardous or damaging to both people and property. It is essential to inspect all practices to determine that they are working properly and to ensure that problems are corrected as soon as they develop.

4.4. Inspecting and maintaining SWC measures

4.4.1. Applying maintenance schedule

Maintenance schedule will be set based on the kind of SWC measures and season of the year.

4.4.2. Re-establishing operating effectiveness of indigenous SWC measures

Land owners must establish and maintain vegetative cover and structural practices in accordance with the Conservation Plan on file at the SWCD. Conservation plan maintenance includes any necessary replanting of vegetative cover and repair of structures. Amendments to the conservation plan must be agreed to by the landowner, the SWCD and the State.

Establishing the conservation practices identified in the Conservation Plan is arguably the single most important component of the easement process. The care taken to ensure the conservation practices are properly installed and maintained will provide healthy vigorous stands of vegetation and properly functioning engineering practices.

Any willful action by the landowner that is not in compliance with the Conservation Plan is considered a direct violation of the conservation easement.

Maintenance activities are very important in keeping each conservation practice identified on the easement area in good condition. Maintenance begins after successful development of the conservation practice and continues for the duration of the practice. Maintenance activities are the responsibility of the landowner.

The owner must ensure that all erosion and sediment control practices and all post-construction storm water management practices identified in the SWCD are maintained in effective operating condition at all times.

For construction sites where soil disturbance activities have been temporarily suspended (e.g. winter shutdown) and temporary stabilization measures have been applied to all disturbed areas.

Self-check 4	Written test
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Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

Test I: Choose the best answer (4 point)

- Which one of the following SWC measure implemented on area which have high run off problem
A. water way B. soil bund C. stone bund D. all
- From the given alternatives which one is agronomic soil and water conservation measure?
A. stone bund B. soil bund C. mulching D. all

Test II write short answer

- List the physical ISWC practices in Ethiopia. (3points)
- The combined physical and biological SWC effective than physical measures alone. Why? (10 points)
- What does (Violations) of erosion and sediment control legislations mean? (10 points).
- List erosion & sediment control principles (10points)
- Describe impacts of erosion (on-site) and Sedimentation (off-site). (10points)
- Why is Inspecting and maintaining SWC measures? (10point)

Note: Satisfactory rating - 5 points Unsatisfactory - below 5 points

You can ask you teacher for the copy of the correct answers

Operation Sheet -2

2.1 Techniques/Procedures/Methods of constructing Level bund

A. Tools and equipment

- frame or line level,

- digging tools,
- stones for stone bunds.
- To stabilize the bund, you will need suitable grasses, legumes and tree seedlings.

B. Procedures/Steps/Techniques

1. Work out the gradient of the slope.
2. Decide on the spacing of bunds. Use pegs to mark out where to begin building each bund down the slope.
3. At the top of the slope, mark out a contour line (a line running at the same height across the slope) where you want to build the first bund.
4. Scrap the soil from either side of the contour line, remove the grass so the soil can be compacted and pile soil and stones up to form an embankment running along the line.
5. Compact the embankment and shape it so the top is level.
6. Move down the slope to where you want to build the next bund and repeat step 3-5.
7. Plant the grasses, fodder legumes and trees with the bunds to stabilize them and make them productive.

2.2 Techniques/Procedures/Methods of constructing Graded bund

A. Tools and equipment

- To make a graded bund You will need an –frame or line level, digging tools, and grasses, legumes and tree seedlings.

B. Procedures/Steps/Techniques

1. Measure the gradient of the slope and check the soil type. These will determine the safe gradient for the bund (see the previous page) and the spacing between the bunds (see next page). You can measure the slope gradient using a line level.
2. Go up water way or channel you want the bund to drain into, to the top of the slope. Starting here, use the line level to mark out where to build the bund.
3. Scrap the soil from either side of the line you have marked, remove the grass so the soil can be compacted and pile soil and stones up to form an embankment running along the line.
4. Compact the embankment and shape it so the top is level.
5. Move down the slope to where you want to build the next bund. Repeat steps 2-4.

6. Plant the grasses, fodder legumes and trees with the bunds to stabilize them and make them productive.

2.3 Techniques/Procedures/Methods of constructing a micro-basin

A. Tools and equipment

- To make a micro basin you will need an –frame or line level, digging tools, and grasses, legumes and tree seedlings.

B. Procedures/Steps/Techniques

- Decide where to plant the trees. Mark a pattern on the ground, staggering the basins on a slope to control runoff.
- Dig a shallow basin around each planting site, piling the soil in to a ridge around the down slope side, 15 cm from the edge of the basin. Make the ridge 30-50 cm high and 60-90 cm wide.
- Plant the seedling. In dry areas, plant it in the middle of the basin. In moist areas, plant it in the ridge of soil you have built on the lower side of the basin so it does not get waterlogged.

2.4 Techniques/Procedures/Methods of constructing level bench terrace

A. Tools and equipment

- To make a You will need an –frame or line level, digging tools, stone

B. Procedures/Steps/Techniques

- Measure the gradient of the slope using a line level. Check how deep the soil is. Using the table below, decide how wide the bench terrace should be.
- At the top of the slope, use a stick mark where to build the first terrace wall, by using line level.
- Measure the width of the bench and mark where to build next wall (point B in the diagram). Mark out a contour line from this point. Repeat this process to mark out the location of all the walls down the slope.
- Measure half the distance between between the first and second lines Remove all the top soil from the whole area to be levelled, and pile it at a convenient place to one side

2.5 Techniques/Procedures/Methods of constructing check dams

Task 1 How to make wooden check dams

A. Tools and equipment

- Water level, wood, stone, digging hoe, spade, shovel, string

B. Procedures/Steps/Techniques

- Make a set of wooden posts, 5-10 cm in diameter and 1.5-2.5 m long. Sharpen one end of each post to make it easy to hammer in to the ground.
- Hammer the posts 0.5-1 m apart, at least 60 cm deep in to the floor of the gully. The spacing between the posts depends on the height of the check dam: the higher the dam, the looser the posts. For a double row check dam, make two rows of posts, 50-60 cm between the rows.
- Weave thinner branches between the posts to form a wall.
- Dig the branches 50 cm or more in to the side of the gully.
- Pack brush and other debris behind the wall (or between the rows in a double-row dam).
- Tie the top of the structure with wire or rope, and anchor it to the ground using brushwood.

Task 2 How to make stone check dams

A. Tools and equipment

- Water level, wood, stone, digging hoe, spade, shovel, string,

B. Procedures/Steps/Techniques

- Dig a trench 40 cm wide and 40 cm deep across the gully, and extend it 40 cm in to the gully banks on both sides.
- Put large stones in to the trench you have dug.
- Use more stones to build a wall 1 m high and 1 m thick. The sides of the wall should be higher than the middle, so that water can flow over the middle.
- Put more stones against the downstream side of the dam to break the flow of water falling over it

Task 3 How to make stone check dams

A. Tools and equipment

- Water level, wood, stone, digging hoe, spade, shovel, string, gabion box

B. Procedures/Steps/Techniques

Gabion boxes come in two standard sizes: 2 m long × 1 m wide × 1 m high, and 2 m long × 1 m wide × 0.5 m high.

- Dig a trench 1 m deep in the gully floor. The trench must be as wide as the gully and should be dug in to the wall to stop water from eroding around the sides of the dam.
- Place gabion boxes in to the trench fill them with stones and tie them with wire.
- Add another layer of gabions on top to raise the height of the dam. Make the sides of the dam higher than the middle.

LAP TEST-2	Performance Test
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Name.....

ID.....

Date.....

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **4:30** hour. The project is expected from each student to do it.

Task-1 How to make wooden check dams

Task-1 How to make stone check dams

Task-1 How to make stone check dams

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