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Review on Methods of Sustaining Soil and Water conservation in Ethiopia

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Abstract

Soil and water conservation interventions are first a response to the perceived land degradation problem. Physical Soil and water conservation measures, such as soil bunds with infiltration ditches, stone-faced soil bunds and stone bunds, should be designed to accommodate peak rainfall events. Furthermore, farmer's participation in conservation work is also considered important in improving the adoption of the recommended technology. The steeper the slope, the more needs the drainage system to be supported by terraces in order to reduce slope length and slope gradient but Bench terraces are level along the contour in dry to moist agro ecological zones, while Stone terraces useful in areas with steep slopes but high population density and scarce land. The combined use of biological and mechanical measures will help in improving and sustaining agricultural productivity. The erosion resisting crops protects soil from beating action of raindrops, reduces runoff velocity. Crop rotation was key principal of conservation agriculture because it improves the soil structure. The contours are simpler and cheaper than graded channel terraces for three reasons. From the types of agronomic practices, intercropping is commonly used in many tropical parts of the world particularly by small-scale traditional farmers.

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Introduction

Soil and water conservation was an international concern, since eroded, unproductive, poorly nourished and improperly (8). Used land was found in many countries thought the world and more people are becoming increasingly aware that their agricultural land must be kept permanently productive and that an essential prerequisite to this is a sound practical soil and water conservation program. The avoidance of soil loss by improved management and conservation of the natural resource is important to combat low agricultural production, food insecurity, and the rapid increase in levels of poverty (10). Soil and water conservation interventions are first a response to the perceived land degradation problem. It includes all forms of human actions to prevent and treat soil degradation (13).

In 2010, the Ethiopian government launched a land restoration program that aimed to double agricultural productivity through improving the management of natural resources and agricultural lands. Since then, physical and biological Soil and water conservation measures have been introduced in more than 3,000 watersheds that are managed by local communities (32). Researchers recommend that physical Soil and water conservation measures, such as soil bunds with infiltration ditches, stone-faced soil bunds and stone

bunds, should be designed to accommodate peak rainfall events, which cause considerable runoff and contribute significantly to annual sediment load. Further, it is important to understand how groundwater dynamics and soil types affect the efficiency of different soil and water conservation measures in order to successfully match specific measures to specific locations.

Soil conservation measures are playing an important role in enhancing the ecosystem services in the form of improving the suitability of the soils for most crops. Consequently, the efficiency and rationality of common-practiced soil conservation measures to introduce popular soil and water conservation measures and to obtain the maximum sustained level of production from a given area of land by preventing soil degradation and environmental pollution (36). Many of the projects sponsored by both the government and World Food Program were also criticized for putting emphasis only on structural conservation measures, most of which were unfamiliar to the farmers. The farmers were virtually considered ignorant of soil and water conservation practices and were largely excluded from the planning, implementation, and evaluation of these conservation measures (5). Only rare attempts were made to include indigenous experience and knowledge (3).The adoption of improved Soil and water conservation technologies in developing countries has attracted much attention from scientists and policy makers mainly because land degradation is a key problem for agricultural production (7).

Results and Discussion

Soil Conservation and Water Conservation Methods

There are always strong links between measures for soil conservation and measures for water conservation, Also are predominantly applied for the following purposes: to control runoff and thus prevent loss of soil by soil erosion, to reduce soil compaction; to maintain or to improve soil fertility, to conserve or drain water, to harvest excess water (23).

Many indigenous soils and water conservation such as ridging, terracing, multiple cropping, and fallowing were used in the pre-colonial era (14). The impact of mulching has been demonstrated in many field experiments, while, farmer's participation is essential not only for implementation of soil and water conservation activities like terracing, banding by food for work but also, farmers are closer to the real problems and therefore they are aware of issues that experts may miss, and their objectives are more practical for economic development (28; 18). Furthermore, farmer's participation in conservation work is also considered important in improving the adoption of the recommended technology (4).

Soil and water conservation are classified here by type: Physical also termed mechanical or technical measures Biological measures also termed vegetative measures Agronomic measures sometimes called best management practices (15).

In the north western and southwestern parts of Ethiopia, where drought risks are low and the productivity of soils is relatively high limited attention has been given to both Soil and water conservation development and research (17). There is clear evidence, however, of active erosion in regions other than the already highly degraded areas of northeastern Ethiopia. Furthermore, most of the research conducted to date has focused on sheet and rill erosion and gully erosion to a lesser extent. Sheet and rill erosion throughout the country, gullying in the highlands, and wind erosion in the Rift Valley and the peripheral lowlands have been identified as the most important present-day geomorphic processes in Ethiopia (24).

Physical Soil and Water Conservation Methods

Physical measures are structures built for soil and water conservation. Some principles should be considered. They should aim to increase the time of concentration of runoff, thereby allowing more of it to infiltrate into the soil divide a long slope into several short ones and thereby reducing amount and velocity of surface runoff; reduce the velocity of the surface runoff; protect against damage due to excessive runoff, however in most systems any physical measure can be built check dams or contour ditches (39).

In other case also, Stone /earth terraces, stone/earth bunds, check dams, contour ditches, retention reservoirs, dams, grassed waterways, planting pits.

When the supply of food-for-work was discontinued, most of the participating farmers became unwilling to participate in the new conservation projects or maintain those already established. Some farmers even removed the structures from their lands (33; 12). Researcher explained that only 25 % of the rehabilitation target has been accomplished and most of the physical soil conservation measures and community forest plantations

were destroyed in Ethiopia (5). Permanent erosion control technologies such as terraces were built in Maku near Udi-Nsukka (14).

Terraces

Terraces are earthen embankments installed at right angles to the steepest slope to intercept the surface runoff. An embankment usually consists of two parts: an excavated channel and a bank or ridge on the downhill side of the channel which is formed with the material excavated from the channel (19). The steeper the slope, the more needs the drainage system to be supported by terraces in order to reduce slope length and slope gradient. A terrace usually contains a drainage ditch and a dam of low height. The most common types are reverse or inward sloping terraces, outward sloping terraces, contour level terraces and graded terraces faster drainage. Terraces can be constructed in one go, or they grow slowly using sheet erosion processes as a "constructor" (progressively developing terrace). In the year of initiation, only small ditches and dams are constructed. With Development of Soil and water conservation Technologies Sustainable Land Management and the construction material can be stones, soil or other materials (20).

Bench Terrace

Bench Terrace was 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. It is practiced on areas of steep slope, however 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 agro ecological zones (16)**.** Building only walls that reduce slope length is not sufficient here to reduce the power of the runoff. The original ground will be converted into level, Suitable on slopes up to 55% While, Stone terrace is Stone terraces useful in areas with steep slopes but high population density and scarce land. The terrace risers are made of stones collected from the land (16)**.**

Biological Soil-Conservation Measures

Biological measures are economically feasible and environmental friendly; also improve soil properties along with the conservation of soil and water resources. Further, the combined use of biological and mechanical measures will help in improving and sustaining agricultural productivity. it is reduce the surface run off, increase the infiltration and reduce soil erosion for the reason that low cost Contour farming, crop rotation, strip cropping, choice of crops, mulching, cover crop, reforestation, mixed crop, wind breaks are major biological soil conservation methods (6).

Strip Cropping

Strip cropping is a cropping practice where strips of two or more crops are alternately placed on the contour for erosion control. This practice reduces the runoff velocity and checks erosion processes and nutrients loss from the field (27; 22). The erosion resisting crops protects soil from beating action of raindrops, reduces runoff velocity, and thereby increased time of concentration which results in a higher volume of soil moisture and increased crop production (34). In strip cropping, erosion takes place from the strips of row crops and the soil removed from these strips is trapped in the strips planted with soil conserving crops Trials of adapting this system in Tunisia are reported by (9). Strip cropping is practiced for controlling the run-off and erosion and thereby maintaining soil fertility.

Crop Rotation

Crop rotation is a practice of growing different crops one after another on the same piece of land, season after season or year after year. The depletion of soil nutrient and the decline in crop yields is minimized. Forage legumes and grasses provide good ground cover that protects soil erosion and enriches the soil with organic matter, which in turn improves the structure and biological activities (30). In other way, Crop rotation is a practice of rotating /changing the type of crops in field each season or year and also it is a key principal of conservation agriculture because it improves the soil structure and fertility and it also helps to decrease the infestation and outbreak of diseases and pests Soybean-corn rotation has been recommended as a good cropping practice for soil quality and crop productivity improvement (26). Accordingly, this rotation system has been focused and further examined under Ethiopia's agriculture and the environmental conditions.

Mulching/crop residue management

Mulching is the covering of the soil with crop residues such as straw, maize or sorghum stalks or standing stubble. Soil mulch significantly increases the yield of Arabica coffee and sustains its productivity over years

(35). The cover protects the soil from raindrop impact and reduces the velocity of runoff. Mulching is one of the most effective methods to minimize erosion. It also encourages insects and worms to take holes into the ground, thus increasing the permeability of the soil (30).

Contour Cultivation

Contour cultivation and planting is a practice of ploughing land and planting crops along a contour line. The contours are simpler and cheaper than graded channel terraces for three reasons. First there is no need to set them out on a precise gradient. They should be more or less on a level contour, but small errors are not as important as in the case of graded channel terraces. Secondly, where water is to be led off the land, then the spacing between the terraces has to be calculated, because each channel terrace has to handle the water from a given area. If the object of structures on the contour is to store the total run-off then they must be designed to do this, as in the case with fanya juu terraces in Kenya (29).

Agronomic Practices

Agronomic measures are the third type of soil and water conservation measures explained in this soil and water conservation measures. Agronomic conservation measures function by reducing the impact of raindrops through interception and thus reducing soil erosion and increasing infiltration rates and thereby reducing surface runoff and soil erosion (23). Agronomic or biological measures utilize the role of vegetation in helping to minimize the erosion by increasing soil surface cover, surface roughness, and surface depression storage and soil infiltration (37). Also, agronomic practices are measures undertaken within the cropping area for crop production purposes and include practices such as intercropping, contour cultivation, minimum tillage, mulching, manuring, etc., which are usually associated with annual crops, are repeated routinely each season or in a rotational sequence, are of short duration and not permanent, do not lead to changes in slope profile, are not zoned and are independent of slope (38).

Intercropping

Intercropping is a practice of growing two or more crops at the same time on the same piece of land. The aim of intercropping is to increase productivity of the land and to protect the soil against erosion. Various types of intercropping were known and presumably employed in ancient Greece about 300 B.C. Theophrastus, among the greatest early Greek philosophers and natural scientists, notes that wheat, barley, and certain pulses could be planted at various times during the growing season often integrated with vines and olives, indicating knowledge of the use of intercropping (25). Today, intercropping is commonly used in many tropical parts of the world particularly by small-scale traditional farmers (1). Traditional multiple cropping systems are estimated to still provide as much as 15-20% of the world's foods supply (2).The physical and chemical properties of the soil are improved. This, in turn, makes the soil less susceptible to erosion and more conducive to plant growth (21).

Types of intercropping

Intercropping can be included: annual plants with annual plants intercrop; annual plants with perennial plants intercrop; and perennial plants with perennial plants intercrop (11). The intercropping is divided into the following four groups.

Row-intercropping

Growing two or more crops simultaneously where one or more crops are planted in regular rows, and crop or other crops may be grown simultaneously in row or randomly with the first crop.

Mixed- intercropping

Growing two or more crops simultaneously with no distinct row arrangement. This type of can be suitable for grass-legume intercropping in pastures.

Strip-intercropping

Growing two or more crops simultaneously in different strips wide enough to permit independent cultivation but narrow enough for the crops to interact ergonomically.

Relay- intercropping

Growing two or more crops simultaneously during part of the life cycle of each. A second crop is planted after the first crop has reached its reproductive stage but before it is ready for harvest (31).

Farmer's participation in conservation work is also considered important in improving the adoption of the recommended technology. Bench terraces type is

practiced on areas of steep slope. The impact of mulching has been demonstrated in many field experiments allowing were used. The literature review and the interviews both show that mulching, crop management, and conservation tillage are appropriate technologies for conserving the soil. The contours are simpler and cheaper than graded channel terraces for three reasons. A combination of traditional biological and physical land management practices should be practiced for effective cropland improvement.

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