Soil and Water Conservation Techniques and Strategies for Food Security and Poverty Alleviation

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Abstract: A study was undertaken to assess the constraints to sustainable soil and water conservation interventions and develop effective strategies to the soil and water conservation program in Ethiopia. The methodology used in identifying the constraints were the collection of information from the beneficiaries and field staff across the country, analyzing results of field trials, observations and review of study reports and relevant documents.

Some of the major constraints identified were low awareness of the beneficiaries on the problem of soil erosion and the impact of soil conservation measures in combating the problem, lack of genuine participation on the part of farming population, ineffective technical packages fitting to local conditions, lack of policies etc.

Promoting participation, formulation of sound policies, proper livestock management, formulation of appropriate technological packages, pursuing watershed planning and implementation approaches and promotion of income generating activities were the strategies suggested to tackle these constraints.

1 Background and objective

Ethiopia for the last couple of decades has faced serious ecological imbalances because of large scale deforestation and soil erosion caused by improper farming practices, destructive forest exploitation, wild fire and uncontrolled grazing practices. This has resulted in a declining agricultural production, water depletion, disturbed hydrological conditions, poverty and food insecurity.

Over the past three decades, many governmental and non-governmental organizations have been involved in massive soil and water conservation activities. However, the results achieved in reducing soil erosion problem and improving agricultural productivity have been unsatisfactory.

This study was thus conducted to assess the constraints to sustainable soil and water conservation interventions and develop strategies leading to the achievement of effective conservation practices, which improve agricultural production, help in the attainment of food security and poverty alleviation.

2 Methodology

A field survey was conducted and information collected through structured and semi-structured questionnaire from farmers, field technical staff, and government officials at various levels including wereda administrative councils. About 650 farming households were interviewed from all the regions. Furthermore, information was gathered from focussed group discussions in selected villages. Review of reports and study documents, experience learnt from other organizations and countries through visits and study tours; and analysis of field trials made at representative conservation sites have all been used in the study.

3 Results and discussions

For sustainable development in soil and water conservation, attainment of food security and poverty alleviation the following tools, techniques and strategy directions have been identified. Hence the findings of the study need to be considered in the plan and implementation of conservation based development in Ethiopia.

3.1 Community participation, empowerment and awareness

3.1.1 Promoting participation of the beneficiary population

A methodology and mechanism has to be formulated that encourages the participation of the beneficiary population, which is an indispensable tool for sustainable management of natural resources. It was seen from experiences in the past that a genuine participation of the community was lacking (over 90% of the interviewed) in most of the areas except in few.

This is reflected in the reluctance to maintain conservation measures and protecting assets. Farmers attitudes in being unwilling to take responsibilities for maintaining development activities on their own, unless they are told to do so and even sometimes want to be paid for the maintenance (95% of the interviewed) is a serious problem which should be tackled.

However, it is worth mentioning, the attempts being made to make the public aware of the problems of land degradation and motivate the participation in conservation activities in the country as a whole. Yet, more work will need to be done to empower the community, foster further their involvement, and encourage them to establish local regulations and bylaws, which guarantee conservation activities and achievements. Furthermore, the procedures worked out and practiced in handing over development activities (about 50% are handed over) to the land users are a good experience to be adopted and further enhanced.

For this strategy to be recognized and effectively practiced, the awareness of the farming population should be raised through education and field visits to the level that they understand the problems of natural resources degradation, take the initiatives for identifying the problems, plan and implement conservation practices. Eventually they should assume the responsibilities for maintaining and proper utilization of the assets developed. A written document on the agreements made and the modalities for implementing the activities, maintaining protecting and managing assets created should be worked out and agreed by the beneficiary target groups. In addition to this, the formation of farmers' groups (men and women equally considered) in development teams is useful in making farmers work together to achieve better results and for the fact that conservation activities are labor intensive requiring a team effort.

3.1.2 Village conservation committee

For effective planing and implementation of soil and water conservation activities, the formation of a village conservation committee is needed. The committee will have an overall responsibility of coordinating conservation activities, organizing farmers groups, handling work tools and lead the planning of conservation activities. The committee is similar to the Planning and Development Team formed at the various localities, for project planning and implementation at WFP assisted projects.

3.1.3 Enhancing women participation in conservation activities

Women need to be involved in soil and water conservation activities right from the planning to implementation of activities. Experience shows that the involvement of women in soil and water conservation activities has in general been low in the majority of the cases, except in few places (for instance up to 60% in Chencha, Hossana and Tigray)

Lessons from other African countries (study tour to Kenya and Tanzania) show that development activities undertaken by women groups have in most cases resulted in sustainable development. Tree nurseries, garden vegetable growing and nurseries, water harvesting structures, woodlot plantations and income generating activities have shown successful results by women groups. This is because women in most cases face the problems of fetching water, fuel wood collection and also are solely responsible for

catering food to the family, compared to their male counterparts in the traditions of most African countries.

3.2 Policies, regulations and bylaws

3.2.1 Community bylaws

The absence of government endorsed policies for land use and conservation of natural resources in the country, has undermined the conservation endeavors at large and the proper management and utilization of land resources in particular. At present, however, the Ministry of Agriculture is in the process of finalizing the agricultural policy document, which the Government is to approve soon. Most striking in this respect is the situation where best conservation achievements, with remarkable results, have been removed regardless of the positive impact they have. Area enclosures in the process of rehabilitation have been grazed deliberately while the option for cut and carry does exist. Moreover, in some localities, farmers intervened into closed areas in clearing away the vegetation and put the land under cultivation before it has recovered to the level it can be used for cultivation. Empowering the community in a way that they assume the responsibilities of planning area enclosures, and in the mean time set bylaws providing for proper implementation of the plans and the protection of assets created would be of paramount importance.

3.3 Livestock management

According to the response of people interviewed, livestock interference owing to the prevailing free grazing practices in Ethiopia is among the major limitations to sustainable management of soil and water conservation measures. In the last three decades, a lot of effort was made to introduce a number of biological conservation techniques, but unfortunately suffered from the open grazing systems widely practiced in the country as a whole. On the contrary, in traditional farming practices, for instance in Konso, where livestock are stall fed, conservation practices are free from livestock pressure.

In the absence of the willingness from farmers to take similar actions and the active involvement of government and NGOs to introduce improved livestock husbandry and formulate livestock management policies, conservation interventions would never be sustained, no matter to what extent, the techniques are efficient and effective, and the approaches are relevant and accepted.

Field technicians and development agents at the frontline are advised to explain this situation to the beneficiary communities and persuade them to exercise zero grazing, controlled grazing and cut and carry method.. The ground for getting started with this approach does not seem to be conducive right away, however, it is worthwhile to begin with voluntary farmers. Incentives for practicing farmers would enhance the practicing of the techniques besides motivating others to learn from this.

Lessons from neighboring countries such as Kenya and Tanzania show that the strategies pursued to practice zero grazing have greatly helped in achieving sustainable development in conservation.

It is also to be noted that livestock interference is not only limited to vegetative conservation measures but it is also on structural measures such as stone and soil bunds that collapse when trampled by livestock during grazing.

In this connection, the District Enforcement Regulation and Village Conservation Committee in the SCAPA Arusha, Tanzania and similar organizations and laws in Machakos and other districts in Kenya are good examples to be sited for best conservation achievements through community empowerment and establishing of bylaws.

Similarly, the recent attempts in the northern part of our country (North Wello and Tigray) to distribute hillsides to individual land users for plantation purposes is a positive step forward with promising prospects for sustainable development in natural resources management and protection. Already remarkable achievements have been recorded and properly protected hillsides along the Dessie-Maychew road prove this.

The absence of Government set policies and regulations have seriously affected conservation sustainability in the country. On the other hand, however, if community and local governments set regulations and laws, which ensure and encourage the involvement of the public in conservation activities and protection of the assets created, there will certainly be a possibility to attain sustainable development in soil and water conservation.

3.4 Appropriate techniques and technologies

Choice of appropriate technologies and approaches:

Techniques and technologies to be used should be selected from a number of technical options depending on rainfall, farming practices, soils and other relevant features. Technical guidelines and manuals providing for a range of options are assumed to be available. However, in general, practices that remove excess water safely and dispose it to safe outlets are advisable to high rainfall areas. The use of level terraces (accounting to more than 80% of the SWC activities) in high rainfall areas should be avoided. Similarly, for low and medium rainfall areas conservation measures should allow maximum retention of rainwater.

Pursuing sound conservation principles, planning procedures and techniques

- The watershed principle will have to be essentially considered in the preparation and implementation of Conservation Based Land Development Programme. In this respect, the LLPPA plans for Conservation Based development interventions and the extension activities of the MoA would therefore be required to consider the natural hydrologic patterns (only very few at present) for efficient, effective and sound conservation interventions.
- Upstream catchment areas should be protected prior to other conservation activities downstream. Hence, hillside protection with plantations and supplementary structural measures are to be planned and implemented first. Structural measures for catchment treatment include, microbasin, trenches, cutoff drains and hillside terracing.
- The next step would be the stabilization of natural waterways, developing of artificial waterways and construction of cut-off drains and in general stabilizing disposal systems (extremely low achievements).
- The third step is the proper construction of farmland conservation measures. These include, level contour terraces for the medium and low rainfall areas, and graded contour terraces for the high rainfall areas. Farmers in the high rainfall areas have the traditional of making furrows for removing excess water, while in the low and medium rainfall areas they practice measures for retaining water. These traditional practices justify the appropriateness of the recommended measures.
- In the low rainfall receiving areas, there would certainly be the need to have trained technicians and development agents. Intense rains are expected in low rainfall areas and this makes it necessary the practicing of the techniques, particularly the design and construction of cutoff drains and waterways, at the appropriate locations and stabilize them with vegetation and structural measures.
- Proper attention needs to be paid in designing disposal structures such as graded terraces, cutoff drains and waterways. Graded terraces are to be laid out at a gradient of 0.2—0.5 percent. The gradient should not exceed 0.5 percent in order to avoid scour in the channels. Cutoff drains are essential mechanical structures to dispose runoff water coming from upslopes and hillsides at safe velocities and protect cultivated lands. For laying out cutoff drains a gradient of 0.5—1 percent is recommended. Field trials show that cutoff drains constructed at 2 percent gradient scoured the channel very rapidly. The use of scour checks is very effective in controlling channel scour on cutoff drains, with gradients exceeding one percent and waterways of gradient exceeding 4 percent (results of field trials). Short growing grasses can stabilize waterways of gradients less than 4%. Avoid planting trees on waterways.

Cutoff drains constructed on fallow and grazing lands are seen to have stable channels compared to those on cultivated lands. Choice of safe outlet is essential in the design of cutoff drains. This is why the lay out and survey of cutoff drains should start from the outlets. Enforcing of the outlet with short

growing local grasses or paving with stone is necessary. Avoid the use of small and friable stones because they are easily washed away. Results of field trials conducted at Hossana, showed that the use of *Gitcha* (Gicha), a local grass, performed better for stabilizing the outlets.

- The fourth step in sound SWC planning and implementation is the design and construction of water harvesting structures.

3.5 Inter-terrace/inter-structural/management practices

Constructing terraces alone is not an end to conservation but it is just the first attempt to control soil erosion and runoff from one strip to the other and it even does not control erosion-taking place within the strip. Nowadays, there is a growing awareness on the use of inter-terrace management practices and therefore it is possible to widely space terraces. Moreover, with the use of inter-terrace management practices it is possible to improve cultivation of terraces and minimize the complaints of farmers for narrow spacing.

- Inter-terrace conservation practices make possible maximum retention of rainwater besides controlling inter-terrace erosion. With the use of these measures, it is possible to get uniform crop growth all across the terrace. In areas of high rainfall, inter-terrace management practices help dispose off water more safely, while in low and medium rainfall areas they enhance maximum retention of rainwater.
- Inter-terrace management practices suitable for the low rainfall areas under Ethiopian conditions include ridge and furrow cultivation, contour farming, row plantation, tied ridging, stalk barriers, crop residue mulching, stubble mulching, basin and ridging, and runoff farming.
- For high rainfall areas inter-terrace management practices include ploughing in graded contours, drainage furrows of low gradients, strip cropping, cover crop, lye farming, planting in rows along graded contours etc.

3.6 Improving soil fertility

The improvement of soil fertility will have to be viewed from two perspectives in conservation. One aspect is from the point of view of improving productivity and the other is the building of soil resistance to erosion. When soil fertility is improved its structure is improved and it develops resistance to erosion because of soil particle aggregation. Biological conservation measures, agronomic measures and cultural practices, which improve soil fertility, are to be considered in this case.

- The ultimate goal of conservation interventions is to attain increased agricultural production through sustainable use of the resource bases. Viable conservation program should hence consider the fertility aspect in parallel with erosion control practices so that the objectives for sustainable agricultural production and protection of sound environment are simultaneously addressed.
- Measures considered in this include use of farmyard manure, compost, green manuring, alley cropping, mulching, crop residue farming, crop rotation etc. These practices would need to be essentially considered right from the initial planning to the implementation phases. It is only through this way that farmers will be convinced of the benefit of conservation interventions.
- Rate of soil nutrient mining is very high in the traditional farming practices in Ethiopia. Crop residues are totally removed for livestock feed and fuel. Livestock dung is collected and dried in cakes for household use as fuel or sold in the market for the same purpose. In the highlands of Ethiopia, in particular, animal dung is the main source of fuel and dominant fuel source found in the market (Debre Bithan and other northern town). The use of animal dung for fuel has seriously affected fertility of soils not only in the homesteads but it has equally affected grazing and farmlands as well because dung is collected from anywhere it is found.
- In the absence of strategies and education that discourage the use of animal dung for fuel, it will be extremely difficult to think of effective nutrient recycling processes for fertility maintenance. It is therefore high time now to take action to aware the farming community about this alarming situation in agricultural land management.

- Planting of fuel wood at villages and seeking alternate energy sources should be considered if crop production and pasture conditions are to be improved in the highlands of Ethiopia, with this problem unsolved and being the major development constraint, hitherto.
- Conservation priority to these areas should therefore take into account the plantation of fast growing trees for wood fuel and construction material. In the same way, crop residues are totally removed for fuel, livestock feed and house roofing /thatching/.
- Improving pastures and grazing lands should be equally considered as a priority in conservation endeavours. To achieve this a number of technical interventions recommended in the field technical documents could be referred.

3.7 Package approach

Conservation works should be based on a package of techniques aimed at improving / increasing / production. The isolated or single case approach so far observed in field experience has not satisfied the social, economical and environmental needs. For instance the construction of farm land structures or placing check dams in gully treatment or planting of a single tree spices was considered an end to conservation interventions. However, at present this approach is understood not to satisfy the requirements for conservation and thus does not qualify to be a package. Conservation is much more than a mere erosion control exercise but rather it has to have a wider scope of addressing productivity and production. Therefore it is compulsory that it has to be a package of techniques.

Purposeful and effective gully treatment: The plan for treatment of gullies should take into account the purpose for which the gully is to be treated. The choice of treatment measures will therefore have to be made on the basis of future intended use. This is means, if the gully to be treated is to be used for farming after treatment, then the type of structural and vegetative measures to be applied should be different from the ones to be applied for the gully treatment for forest grassland development. Gullies can further be developed for waterways in which case the treatments are different accordingly.

In case when the gully is to be developed for cultivation (mostly for the low lands), then it will be necessary to start with small check dam , which gradually increase in heights and widths. It is always preferable to start with small check dams closely spaced, which when filled up with sediment are raised to a given height, than to begin with higher check dams. Every other check dam gets lost each time an increase to the height of the next dam is made and the spacing for the dams get wider. The process of raising the height of the check dams continues until the desired size/ area of the land for cultivation is obtained.

In developing gullies for cultivated lands proper care in constructing check dams would be necessary. Adequate foundation, keying to the gully sidewalls, adequate spillways, proper apron and selection of quality construction material will have to be considered. The use of small stones that could be easily washed away by runoff water, placing of the check dams at curves, improper spillway location and shape should be avoided.

Spacing for small check dams should consider an effective height of 0.5 m (height of the spillway) at the minimum, which entails the spacing of the check dam to be VI of 0.5 m, from the principle that the spillway crest of the lower dam is at the same level with the bottom of the upper dam. As the dam gets filled with sediments the need to raise the height of every other dam would be essential.

In the process, every other check dam is silted up in between thus leaving wider area for cultivation. This development enhances the formation of farmable gully sections as more of the smaller dams in between are eliminated. It is also possible to start with higher check dams in height from the beginning but this would entail higher costs of construction and perhaps require the involvement of machinery. It is, therefore, advisable to go for smaller check dams, which can easily be constructed with locally available materials and require less human labor.

Appropriate spacing of structures: Appropriate spacing for soil and water conservation techniques is indispensable for efficient practices: It is advisable to avoid the use of very narrow and also very wider spacing. Methods for proper choice of spacing are given in field guidelines. A vertical interval of 1m can be used for slopes less than 10% and 1.5 m VI for slopes of 10%—20%

and a 2m VI for slopes greater than 20% but never exceed the 2.5m VI for spacing of conservation measures.

3.7.1 Area enclosure

Area enclosure is among the dominant soil conservation interventions(about 1 million ha closed) practiced in Ethiopia since the inception. Substantially vast areas of severely degraded areas have been rehabilitated with area enclosures in the past. HOWEVER, most of the areas (over 70%) have now been either cultivated or grazed owing to increasing livestock numbers and the increasing need for cultivated land. Area enclosure is often confused with hillside plantations. Protecting of hillside plantations from interference is entirely different from area enclosures. The two practices in fact have one thing in common, which is assigning of site guards to look after them. They are different in that, hillside plantations are undertaken in lands, which are not seriously degraded, and techniques such as micro basins, trenches and hillside terraces are used wherever necessary to ensure later survival of the seedlings. Area enclosure is a practice where severely degraded lands(lands that have lost potential for crop, grass or tree growing) are closed from the interference of livestock or human activities and left for nature to take care of the regeneration processes. It is not recommendable to practice intensive intervening with conservation practices in areas closed from interventions except few activities, which enhance the rehabilitation processes. These may include fencing, enrichment plantations and minor water retention techniques. How long should an area be closed? For what purposes should the area be used after it has recovered? Who should take the responsibilities for managing the area and protect it? What measures should be taken for enhancing the rehabilitation process are key questions to be answered when planting an area enclosure. Experience shows that area enclosures planned and executed by the community (peasant association or a village) have shown successful results and hillside plantations by individual land users have shown promising results (Experience from Wello and Tigray). It is highly advisable that once an area has rehabilitated to the extent that it can be used for intended use as planed. In some areas it is seen that area enclosures are kept for longer period without being used. This is not justifiable, as it stands contrary to the principles of conservation, which denotes wise use of resources. It should also be understood that area under closure could some time in the future be used for cultivation of grass production or tree production whichever land use system suits.

3.7.2 Water harvesting

Sound conservation plans consider the placement of water harvesting structures in their appropriate locations. Farm ponds, water tanks and small earth dams are among the major water harvesting structures considered. For sustainable and meaningful conservation based land development program, it is essential that the runoff water being disposed through cutoff drains and water ways is let into water harvesting structures for domestic use and minor irrigation activities. The construction of water harvesting structures is done when all catchment activities are properly implemented and the water to be stored is in reduced risk of being silted up. Thus prior to placing water-harvesting structures, the stabilizing of gullies, natural drainage courses and artificial waterways need to be carried out. In countries such as ours where rains are unpredictable and highly erratic, storing runoff water in farm ponds, water tanks (surface and underground) and minor earth dams is indispensable for assuring food security. Efficient water harvesting structures help in producing garden vegetables, managing tree nurseries and undertake other income generating activities.

3.7.3 Maintaining quality activities

This is an issue of great concern at present mainly with physical conservation measures. Physical conservation measures include, stone bunds, soil bunds, fanaya juu, check dams, micro basins etc. Performance is seen to be very poor owing to poor quality or below standard achievements. Low standard structures are easily damaged by livestock, collapse or washed away. The use of small sized and friable stones for structures is to be avoided.

Hence, technicians and development agents are advised to pay more attention for maintaining the quality of activities. This means that field structures would need to be properly laid out and built

according to the standards given in the field guidelines and manuals. The failure for most field structures to cope up with external pressure is mainly attributed to inferior quality work. It is desirable to have few hectares of well constructed terraces than to construct thousands of hectares with low quality terrace which disappear soon after construction, which often is the case with the so called campaign or mobilization activities. Poor quality conservation activities cause more harm than the advantages they give.

Farmland terraces on slopes >10% are to be spaced at 1m VI and should have a dimension of 0.65m height during construction and 0.60 meter after settlement. They should have a bottom width of 1m—5m. Proper compaction is necessary during construction, and terraces on slopes<13% are to be spaced at 1.5 m VI, the height after settlement shouldn't be less than 0.75m.

4 Conclusion and recommendations

In conclusion the findings of the study the key functions of conservation are: erosion control, safe runoff disposal, water retention and fertility improvement. Key strategies suggested to the attainment of sustainable soil and water management activities include: Community participation and empowerment, appropriate technology, issuing of policies, regulations and bylaws and considering of complementary strategies.