como/consult

GFA Consulting Group

Loose Stone Check Dam Technology

Best Practice in Sustainable Land Management (SLM)

May, 2013

Addis Ababa, Ethiopia

Table of contents

1 General

Name of the technology: Loose Stone check dam.

2 Detailed description

2.1 Definition

A stone check dam is defined as an obstruction wall across the bottom of a gully to prevent the deepening and widening of the gully and to assist trapping of sediments.

2.2 Summery description

2.2.1 Criteria for selection as best practices

Loose stone check dam was selected as a best practice technology based on the criteria stated in the SLM Best Practices Concept & Manual by the consultant (it needs to be confirmed by the Task Force).

Table 1: Criteria for the assessment of SLM best practices example

Criteria	Points	Comments
Acceptance	3	Fundamental, at least 2 points
Effectiveness	3	Fundamental at least 2 points
Efficiency	3	Fundamental
Relevancy	2	
Sustainability	2	Fundamental
Replicability	3	
Total point	16	
Average rate	2,66	

NB

- **the criteria is at high degree (3)**
- **the criteria is at medium degree (2)**
- **the criteria is at low degree (1)**

The cumulative average rate should be at least 2,0 points to qualify for best practice.

According to the MoA report (MoA, 2010), 70 % of the land users in SLM areas are found to implement loose stone check dam technology, which indicates its high acceptance by the land users.

The technology is found to be effective and efficient in combating land degradation by reducing slope angle and slope length, increasing infiltration, maintaining water stored in soil and sediment harvesting and contributing to improvement of productivity.

2.2.2 Problem addressed

Inappropriate land use in association with high population growth and the demand for continuous extended farming has resulted in the clearance of trees and bushes and in the exposure of land to erosion including the formation of gullies. Stone check dam technology particularly addresses the problems related to gully erosion.

The process of integrating stone check dam technology with biological conservation measures such as planting of (fast growing) trees, green manure and shrubs, is of critical importance to restore degraded land and to improve its productivity in gully areas. The

gradient of the gully and the effective height of the check are factors to decide on the spacing of the check dams. This means: the steeper the slope of the gully is, the shorter become the check dams and the distance between the check dams. Loose stone check dam can have a submerged spillway. In practice, the bottom of the upper dam and the top of the next lower dam should be at the same level in order to reduce the run-off.

2.2.3 Purpose and detailed description

Loose stone check dam technology is mainly used to rehabilitate gullies and to modify landscape conditions to enhance production and productivity of food crops, fodder and tree crops.

A well-constructed loose stone check dam will be more durable than brush check dams. Stone dams also have the advantage of keeping contact to the bottom of the gully because of the flexibility and weight of the stones. Figure 1 shows a picture of a typical stone check dam.

Figure 1: Loose stone check dam

It is very important to extend the bottom and sides of the check dams about 15 cm into undisturbed soil, leave the center low for water to flow over, and construct an apron on the down-stream side of the dam to reduce the velocity of the overflow water and thereby reduce the hazard of water undercutting the dam. Building new check dams at higher elevations when sediments have filled the space behind the old check dams may gradually fill the gully.

2.3 Adaptation to different agro-ecological and socio-economic conditions

There is no agro-ecological limitation to use loose stone check dams. It only requires the availability of posts, stones and brushes. Gullies with different depths and widths require different technology to address the problem. Particularly those gullies with high length, high pick runoff rate and moderate rainfall require the construction of loose stone check dams.

Otherwise, if the rainfall is considered to be high, it needs gabion check dams or bricks check dams. This shows that loose stone check dam technology has a tremendous benefit at various levels in areas from moderate to low rain fall. It can also be applied in semi-arid and arid agro-ecological zones. It consists of the integration of structural, vegetative, agronomic and management measures. It is mostly practiced in the eastern escarpments of the Tigray region and in other parts of Ethiopia where rainfall is low and erratic.

3 Benefits and costs

3.1 Benefits

The following benefits are described for stone check dams (MoA, 2010):

Benefits on household level

- Improved water availability and fertility levels for crop production and diversification.
- Soil trapped provides more space for water to be stored.
- Reduce slope length by raising the gully bed.
- Fertility of soils to be increased by accumulated top soil from other areas.
- Improved soil quality and better drainage and percolation.
- Income generation activities, increased access to biomass for multipurpose use (firewood, fodder, fruits, construction amongst others).

Benefits on community level

- Lower land development costs.
- Reduced erosion, flooding and water logging.
- Increased overall agricultural productivity.
- Dependable clean water supply and recharge of aquifers and underground water.
- Converting waste land into productive land.

Benefits for the society at large

- Better conservation of natural resources and biodiversity.
- Fertility of soils to be increased by accumulated top soil from other areas.
- Less danger of floods to downstream to farmland.
- Reduced sedimentation of costly irrigation projects and protection of major infrastructure (roads).
- Increased water supply and improved health.

Productive advantage: The SWC activities that the farmers choose tare not only conserving resources. They create farmland and increase crop and animal production, already in the short term perspective. Areas, where stones are an obstacle on farmland, it also creates more ‘clean’ farm land, when the stones are removed and used for stone check dam construction.

3.2 Costs

Costs vary greatly depending on the availability of the material around the construction site, on the type of the soil and the agro-ecological conditions of the area as well as on the type of the check dam. Table 2 estimates the costs for the construction and maintenance of a loose stone check dam. The major costs in loose stone check dam construction are labor (stone

collection, transporting, digging, constructing, maintaining) and material costs (hoes, shovels and spades).

Table 2: Estimated costs of a loose stone check dam

(vertical interval of 1m, spacing of 8m, with 1m, length 5m, depth 0.3m and height 0.5-1.5 m)

Category	Input	Establishment cost			Recurrent cost per year		
		Quantity	Cost	%-share of Land User	Quantity	Cost	% share of Land User
Material	Stone (M3)	3315		100	331	-	100
Equipment	Tools[1]	20	120	95	5	30	100
Labor	Person day	6630	4625	90	663	624	100
Total	ETB	-	4750	95	-	654	100
	USD	-	470	-	-	65	-

Source: MoA, 2010, ETHIO-CAT, page: 19, adapted to the specific locality.

The information indicated in the above table may show variations in accordance with changing labor costs and exchange rates.

Labor, slope and depth of the gully, the width of the gully and availability of construction material are also factors affecting the costs. The mentioned costs consider the costs incurring during 15 years of construction, maintenance and upgrading.

4 Success, challenges and failures

4.1 Success

This technology is successful for the following reasons such as its benefit to reduce run off and stabilize gully for the better use of the land within short time, the technology can be applied everywhere with- out agro-ecological hindrance and the technology is cheaper as far as stone is available and farmers can do themselves without more professional involvements.

As the evidence in Eastern Tigray shows farmers have built loose stone check dams to catch the soil flowing down from the eroding highlands before it disappears into the Red sea. They have created stretches of level land to use as crop fields and pastures. Some of the dams are now over 10 m high, filled to the top with soil and drowning in width over the years. They also developed a technique of placing stones vertically in what they call the devil's tie' to resist the forced of the floodwater. They also dug channels to lead run-off water from the rocky slopes into the fields behind the check dams and beside the river courses.

Farmers observe how the rushing water behaves when it faces new barriers, discuss reasons for damage to structures or to surrounding land and exchange ideas what to do about it. They are constantly trying to improve their work, to maintain and improve existing structures and to create new ones. They grow cereals, mainly maize, sorghum and barley. They have been doing rain fed cropping for the last 2-4 generations, and are still experimenting with different techniques and crops. 'Ato Zigta', who is at the age of 58 years is still actively enlarging and improving his loose stone check dam.

In recent years, some people have made gardens beside the watercourses and have planted hot peppers, onions, tomatoes and fruits, mainly orange trees. They have also a

[1]Hoes, shovels, spades.

long tradition of bee keeping on stabilized check dams, the ‘white’ honey from Alitena is praised throughout Ethiopia.

4.2 Challenges

The quality, shape and size of the stones used in the construction of a check dam affect the success and life span of the dam structure. Stones that disintegrate rapidly when continuously exposed to water pressure will have a short life span. Furthermore, if only small stones are used, they can easily be removed by the first large water flow and the dam can be quickly destroyed. On the other hand, a check dam constructed by only using large stones will leave large voids in the structure and will offer resistance to the flow, which may create water jets through the voids, which can then be highly destructive if it is directed towards the unprotected parts of the gully.

Check dams need regular follow up and maintenance. When breaks are observed, it should be continuously upgraded to increase the height until the desired check dam height is attained. The establishment is a gradual process and continues until the check dam height allows maximum possible width for cultivation. Therefore regular maintenance and upgrading is required. Another challenge is the lack of adequate stones in some areas where stone check dam is vital to be constructed, and that stones are heavy to be transported when collecting them somewhere far from the construction site

5 Sustainability and chances for up-scaling

All land users, who have implemented the technology, have done it voluntarily without any other incentives than technical support. The trends towards spontaneous adoption of the technology and reclaiming gullies for agricultural land use (crop and livestock production) are very high. Local knowledge and skills are available as well as technical support to expand the technology within SLM areas. The technology is easy and can be replicated without high investment cost, as far the stones and the labor are provided and are available. Applying methods of soil improvement such as planting fast growing trees, green manure, trees and shrubs, helps to rehabilitate the land very fast and to further improve the productivity of the land.

What makes this technology superior is, that it is cheaper than any other check dam technology, for example gabion technology, and that farmers have all the skills to perform the activities by themselves. People find it worthwhile to invest in maintaining and managing their resources themselves. The villagers plan and implement the activities themselves, they choose the sites, they organize how to do the work and they monitor the condition of the structures and maintain them. Each ‘hamlet’ makes its own decision. They are proud of their independence and their visible achievements.

6 Conclusion and recommendation

Loose stone check dam technology is suitable for gullies of moderate slope with small or medium sized drainage areas. This physical SWC structure technology is a key measure to modify landscape conditions for the dual purpose of enhancing productivity while minimizing the force / velocity of erosion and to consere moisture. It is always linked to food security and livelihood improvement. A range of techniques is available and the decision which one to adopt depends on the objective, if it is to reduce velocity of runoff, to increase surface water storage capacity, and / or to safely dispose excess water. Physical structure methods are normally applied in conjunction with agronomic measures in the implementation and for long lasting sustainable improvement of the land.

7 Reference

ILEISA; News letter for low external input and sustainable agriculture, *July 97,Volume 13,* The Netherlands.

MoA; Sustainable Land Management Technologies and Approaches in Ethiopia, 2010, Addis Ababa, Ethiopia.