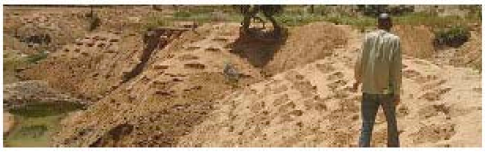
WAHARA - Report Series

Global compilation of WH technologies

Authors: H. Sawadogo, E. Yazew, A. Chomba, M. Ouessar



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SEVENTH FRAMEWORK PROGRAMME

WAHARA

WATER HARVESTING FOR RAINFED AFRICA

DELIVERABLE 2.1
Global compilation of WH technologies

Authors
Hamado Sawadogo, Eyasu Yazew, Arthur Chomba, Mohamed Ouessar

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1 Introduction

This document is a compilation of water harvesting technologies (WHTs) described by the different teams of WAHARA. There is a wide variety of water harvesting technologies well known in the different countries. Some of them are innovative, while other are indigenous and are already being used by local people. The aim of this review is to give an opportunity of each country to look for others technologies which can be useful for the farmers through the documentation in the WOCAT (World Overview of Conservation Approaches and Technologies – www.wocat.net).

The description of WHT with the WOCAT questionnaires is part of the overall selection procedure that was followed in WAHARA. This selection procedure for WHTs included the following steps:

- Find out what stakeholders think about WHT. Whether they are familiar with it, what they would like to achieve with it etc. This was done in WP1
- Select some technologies to describe with WOCAT questionnaires in each country.
- Search the WOCAT database for any other technologies that seemed promising for the study sites, based on the aims the stakeholders have. Generally, each practice should have an impact on yield of crops; on livestock; economics or vegetation
- Select representants of farmers; pastoralists; women and other group in the village for participation to a high level (region; province; district, State)
- Organization of a stakeholder meeting to select WHT according to the methodology specified in deliverable 2.2. Stakeholders always included local land users, but also (in varying degrees between sites) provincial or communal extension services; political leaders; local authorities; researchers and farmers organisations. A synthesis of the stakeholder workshops is given in deliverable 2.3.

2 WOCAT questionnaires

WOCAT is an established global network of Soil and Water Conservation (SWC) specialists, contributing to Sustainable Land Management (SLM) and WHT. WOCAT's goal is to prevent and reduce land degradation through SLM technologies (including WHT) and their implementation approaches. The main objective of SLM is to make human coexistence compatible with nature in the long term (Liniger et al, 2013). The WOCAT network provides tools that allow SLM specialists to identify fields and needs of action and share their valuable knowledge in land management. The tools aim to assist these specialists in their search for appropriate SLM technologies and approaches and support them in making decisions, both in the field and at the planning level, as well as when up-scaling identified best practices. WOCAT is increasingly being used to describe SLM technologies and to share knowlegde about these worldwide, see e.g. Schwilch et al (2012). Currently, the WOCAT databases contain about 470 technologies and 240 approaches from all continents, but especially from Africa and Asia (Liniger et al., 2013).

As described by Schwilch (2009), the WOCAT questionnaires provide a framework for documentation and evaluation and they guide users through all relevant aspects of SLM. Although not focussed on WHT, the questionnaires are suitable to describe WHT too. By filling in the questionnaires the contributor not only documents knowledge and establishes a database, but also reviews and evaluates the WHT. The know-how is tapped from several sources and interaction is stimulated during the documentation and evaluation process. WHT to be documented consist of technical measures as well as implementation approaches. The questionnaire on technologies addresses the specifications of the technology (purpose, classification, design and costs) and the natural and human environment where it is used. It also includes an analysis of the benefits, advantages and disadvantages, economic impacts, acceptance and adoption of the technology. SLM Approaches are ways and means of support that help to introduce, implement, adapt and apply SLM technologies and WHT on the ground. An SLM approach consists of all participants (policy-makers, administrators, experts, technicians, land users, i.e. actors at all levels), inputs and means (financial, material, legislative, etc.), and know-how (technical, scientific, practical). Questions focus on objectives, operation, participation by land users, financing, and direct and indirect subsidies. Analysis of the described approach involves monitoring and evaluation methods as well as an impact analysis. A questionnaire on technology and a corresponding questionnaire on approach together describe a case study / strategy within a selected area.

Once the WOCAT questionnaires are filled in, the data can be entered in the on-line WOCAT databases for technologies and approaches. However, when this is done, the questionnaires are not yet accessible via internet. To achieve that, they need to be released by the WOCAT secretariat in Berne, Switserland. Before the questionnaires are released they are reviewed by two experts, and only if they have approved the questionnaires they are released. The evaluation that is performed is done to check that the database is filled completely, and that there are not contradictions in the data that has been entered. This review was, in WAHARA, done by project partners who have experience with the WOCAT questionnaires. Once the questionnaires are released they are accessible to all. One of the products that can be downloaded from the WOCAT website are so-called 4-page summaries of technologies and approaches, which list the most important information on these technologies and approaches. These 4-page summaries of the WAHARA questionnaires are included in Annex 1; in reality they are sometimes 5 pages if much information has been provided by the authors. The next section gives a brief summary of the technologies and approaches described in the different study sites of WAHARA, and also provides information on some other technologies relevant to the WAHARA study sites. Figure 1 illustrates which technologies have been described with WOCAT.

Ados (Burkina Faso)		Tabia (Tunisia)	

Banka (Burkina Faso)		Cistern (Tunisia)	
Bouli (Burkina Faso)		Recharge well (Tunisia)	
Check dam ponds (Ethiopia)		Animal draft-Ripping (Zambia)	
Soil faced deep trench bunds (Ethiopia)		Animal draft-Strip tillage (new) (Zambia)	
Large semi-circular stone bunds (Ethiopia)		Animal draft-Zero tillage (new) (Zambia)	

Jessour (Tunisia)		Hand hoe Planting basins (Zambia)	No picture available
Gabion check dam (Tunisia)			

Figure 1. Technologies selected for description with WOCAT

3 Description of the technologies

3.1 Water harvesting Technologies from Burkina Faso

The Zaï

The zaï is a traditional practice of the Yatenga area in Burkina Faso used during drought conditions on poor soils (bare soils). It consists by digging holes with 20 cm of circumference and a depth of 15 cm in which organic matter like compost manure is applied. The zaï collects the runoff water, improves the infiltration and can keep the moisture of the soil for one week to ten days after rain. The fertility of the soil is improved because of the use of compost manure. Chemical analysis shows a positive impact of zaï on the content of soil nutrients such as carbon, nitrogen, phosphorus and other chemical parameters. As a consequence, the plant growth was better in farm treated with zaï and the crop yields are increased. From 2006 to 2008, the effect of zaï on the sorghum's grain yield varied from increases of 137% to 240%. In the same time, the increase of leguminous yield was about 156%. So, the zaï leads to a better cereal crop security and give substantial incomes for the farmers.

The zaï has many social impacts too. It reduces the land pressure by the rehabilitation of bare soils so that the agricultural surface is increased. Young trees are growing in zaï pockets so the number of trees is bigger than in untreated farms. By digging pits to improve soil fertility, the zaï system helps to regenerate the growth of trees on barren farmland. This is very important because the wood problem is large in some areas. This is the main advantage of the farmers who invest in zaï work. The practices of zaï have three effects which are useful on their diffusion in the sahelian area. In a short time, the zaï improves the yield and leads to better crop security. The zaï gives substantial income by the sale of the surplus production. The long term effect is a better availability of wood fuel provided by the regenerated trees.

Rock bunds

Rock bunds have been developed in the north western part of Burkina Faso by the Agro forestry Project of Oxfam (PAF) in the early 1980s. The PAF was inspired by the traditional work of the farmers where the stones are used to protect against erosion. The Oxfam project improved the process by using materials to determine curves lines that are level and thus follow the contours. The project worked with the participation of the farmers so the results can be duplicated. The effectiveness of the rock bunds made the technique popular in all the country to fight against sheet or gully erosion. Rock bunds do not stop the run off but diminish the speed and increase the infiltration. The surplus of water is evacuated. The farmer training by Projects, NGO and public services was crucial in the diffusion of rock bunds in this part of Burkina Faso. Effects of rock bunds depend on soil type, on the position of the field, on the toposequence, and not least on rainfall.

Like the zaï, Rock bunds have an impact on the crops yields and the regeneration of woody vegetation and herbs. The key beneficiaries are farmers and pastoralists because the major part of the land is treated collectively and the global productivity of the land is increased. Women and young household members are also some beneficiaries but sometimes they meet a problem of land tenure.

Soil and water conservations techniques certainly have an impact at field level and they also provide improvements with respect to more secure livelihoods, effective reduction in rural poverty and reduced vulnerability to drought and famine. Policy that helps farmers to have access to inputs off farms should increase the amounts of production in the region and tend towards better food security despite climatic uncertainties and marginal soils with intrinsically low potential.

The bouli

The bouli is an traditional WHT for many uses in the dry season: Water to drink for humans and cattle, to build houses and to wash clothes. It consists a big hole : 30-40m of diameter with a depth of 6m or more. Nowadays, the bouli has been improved by Projects, NGO and research for irrigated crops in the dry season and wet season (rice). The bouli can retain water for 4-7 months if the depth is 10 m. The bouli plays a very important socio economic role in the conditions of sahel zone. Bouli are used to grow cash crops in the dry season like tomato, cabbage, potato etc.

The banka or Basin to stock water

The banka is an traditional water harvesting technology for human and animal drink in the rainy season. Nowadays, the banka has been improved for supplemental irrigation by Projects, NGO and research. The banka is a rectangular hole of 12 m long, 8m wide and 2m deep. The capacity of the banka is estimated to 150 000 l.The banka can retain water for 30-40 days.

The main objective of the banka is to collect of run off for supplemental irrigation of cereals during period of droughts within the rainy season. In Sahelian context, droughts frequently occur when the crops are in a critical stage, and supplemental irrigation can help bridge such dry spells and prevent damage to the crop.

The major constraint is the labor to dig the hole which is high (10 persons x 3 days). It also should be lined with a plastic sheet to avoid infiltration. It must be protected with a rock bund to avoid sedimentation. However, stones to build such bunds are not easily found nowadays. The slope of the area must be 2-3%.The result of cereal grain obtain by supplement irrigation is about 30% in year with normal rain. However, in case of a bad temporal distribution of rainfall, the effect is much more important (70-80%).

The compartment earth bunds

It is a rectangular hole of 30 cm depth in the soil with earth bunds (10 m x 2 m) on the 4 sides. It is shared in many compartments in which compost manure is applied and crops (sorghum and cowpea) are grown.

FILTRABLES DYKES : DIGUES FILTRANTES

These are composed of many big lines of stones realized in case of gully erosion in a basin level: downstream technology. There is a necessity of a collective organization because the labor is intensive. The filtrable dykes can also protect a road sometimes. Cash crops are grown in some cases.

Half moons

Half moons are semi circular holes made in the soil to collect run off and grow plants like cereals in the rainy season. Sometimes, they are used to grow useful trees. The half moons are like big zaï. They are used to rehabilitate very poor soils. The yield of these WHT are high in sahelian conditions (2000-2500 kg/ha) but the labor to dig the holes and lack of manure are the major constraints of half moons.

REHABILITATION OF DEGRADED LAND WITH TRENO PLOUGHER

It is a kind of ploughing made by tractor. The characteristics of the area treated are:

- Length = 4 à 5 m
- depth = 40 à 60 cm
- width = 50 cm
- Sub-soling = 15 à 20 cm
- Distance between furrows : 3 à 5 m

Surface of the micro-basin = 1,35 m²

The TRENO has many benefits like

- Rehabilitation of grazing areas, growing special grass and fourrage like by sheeps, goats and cattle.

- The crops are grow well in the field and the yield of the millet is very high compared to untreated plots (800-900 kg- 1,5 tons/ha).
- The major problems are the labor cost, the necessity to use tractors and fertilizers and organic matter

The grass field (tapis herbacé)

The grass field (tapis herbacé) is a technology made by a farmer organisation the Groupement Naam at Ouahigouya to rehabilitate degraded land for grazing. It consists on subsoiling the soil, following by a furrowing and sowing grass and the field is protected for 2-3 years from extensive grazing. The yield of the straw is about 5/6 tons. But after many years, the field can be cultivated. The grass field is established by using a collective organization because it necessitates high labor.

3.2 Water harvesting technologies from ETHIOPIA

The sections below present the 10 technologies that were deemed most relevant for the WAHARA study site in Ethiopia, by scientist and stakeholders, and that were input to the selection process during the stakeholder workshop (see deliverable 2.3). Figure 2 shows pictures of some of these technologies.

Figure 2. Some WHT relevant for study site in Ethiopia

Cistern

Soil improvement with mulch

Hillside conduits. Left: Catchment area, Right: Conveyance Channel

Subsurface dams: Left: under construction, Right: after the construction

Technology 1: Hillside Cisterns with bench terraces
Construction of bench terraces along with series of hillside cisterns (Figure 2) to harvest water for horticultural production using low pressure drip systems.

Technology 2: Stone faced vs. soil faced trench bunds
Both soil faced trench bunds (a) and stone faced trench bunds (b) are used in the study areas. It still needs to be studied which performs best for which soil types and land uses.
It is an excavation of trenches 1 m deep, 0.5 - 1 m wide and 2 - 3.5 m long with spacing between trenches of 0.3 - 0.5 m along the contour and using the excavated soil to construct a compacted bund downslope. The smaller dimensions are usually used in cultivated lands while the larger are implemented in grazing lands. Soil faced deep trench bund has a length of 60 - 100 m, with a base width of 0.75 - 1 m and top width of 0.3 m. The height of the bund is 1 - 1.2 m.
The technology decreases slope length, decreases runoff velocity, increases runoff harvesting and soil moisture, decreases soil erosion, increases groundwater recharge and increases productivity per unit area. The following work needs to be done to implement the technology: Alignment of a contour, excavation of trenches, construction and compaction of bund, planting grass, dredging of sediment from the trenches and use it for maintenance of embankment. Line level, tape meter, digging hoe, shovel and grass are needed for the establishment and maintenance.
The technology is implemented in moderate (5 - 8%) and hill (8 - 16%) slopes and in medium and heavy soil types of at least 1 m depth. It reduces runoff amount and velocity thereby decreasing soil loss and desertification/land degradation. It also improves soil moisture availability and groundwater recharge. It is mostly constructed using communal labor and there is an encouraging trend of spontaneous adoption. The technology is witnessed to be increasing crop and fodder production thereby improving the livelihood of the land users. It, however, is labour intensive and slightly reduces farm size.

Technology 3: Hillside Conduits with series of ponds
With these hillside conduits (Figure 2), man-made small conveyance channels are used to direct water to fields at the foot of a hill. These systems could be used along with community ponds.

Technology 4: Percolation/sediment storage ponds with hand-dug wells

These technologies can be applicable at hill bottom if the farmland is characterized by high infiltration as good results were observed in many areas of Tigray (e.g Abreha Weatsbeha). They can encourage infiltration and subsequent recharge of the groundwater and enable the construction of hand dug wells in the valley bottoms due to increased ground water level.

Technology 5: Check-Dams

It is a raised wall constructed using stone, concrete and gabion across a gully for dual purpose, namely, to pond/store the stream flow behind it for irrigation purpose while at the same time reducing the runoff velocity and enhancing gully rehabilitation.

A check dam pond is a raised wall constructed across a gully from stone, concrete and gabion to store water behind it for irrigation purpose using either gravity or lifting mechanism. The structure generally consists of construction of foundation, apron, retaining wall and the checkdam. The width of the checkdam ranges between 1 - 2 m while the height varies between 1 - 2 m depending up on the gully depth. The length of the checkdam depends on the gully width while the spacing between adjacent checkdams is determined based on the availability of water and a potential land that can be irrigated. It is also provided with a number of sluice gates which will be removed during the main rainy season to minimize siltation.

The dams decrease slope length and slope angle, decrease runoff velocity, decrease soil erosion, pond water for irrigation and increase productivity per unit area. Establishment of a check dam pond starts with collection and transportation of stone and sand. The construction is started by setting out the dimensions from the design on the selected site and excavating the foundation for the different parts, namely, key trench, apron and retaining wall. The check dam is then constructed using gabions filled with stones and tightly tied together with wire. Finally the superstructure is plastered using mortar to prevent the passage of water through the body. Gates of about 1 m wide are finally constructed at about 1 m interval and fitted with sluice gates. Maintenance usually involves fixing damaged gates and reinforcing gabions. The inputs include industrial materials (cement, gabion, angle iron and sheet metal), local materials (stone and sand) and construction equipments (digging hoe, shovel, hammer, bucket, crow bar, spirit level, tape meter).

The technology is implemented in gentle (2 - 5%) and moderate (5 - 8%) slopes and in medium and light soil types of at least 1 m depth. It increases water availability for irrigation and livestock consumption purposes. It also reduces runoff velocity thereby decreasing soil erosion and enhancing gully rehabilitation. It requires skilled labour and large construction cost. As a result, it is constructed through external support and spontaneous adoption is very little. However, the number of communities seeking for external support and willing to contribute their share is at the rise. The technology minimizes greatly the risk of crop failure and improves the livelihood of the land users.

Technology 6: Infiltration trenches coupled with biological measures

Construction of infiltration trenches following the root system of nitrogen fixing trees such as “Momona” and cutting/notching the root can ensure multiple benefits (reduced evaporation; increased feed, fuel wood and farm implement availability; and increased fertility).

Technology 7: Soil Improvement Methods

Implementation of different soil management techniques such as mulching (Figure 2), compost and effective micro-organisms can improve the fertility and productivity of the land.

Technology 8: Sub-surface Dams

Sub-surface dams (Figure 2) are dams that are built across a (dry) stream bed. Dam and reservoir behind the dam are then filled with sand. Although this reduces storage capacity compared to a dam that is not covered, it also reduces evaporation and protects the reservoir.

Technology 9: Large Semi-Circular Bunds

These are constructed from stone embankments built in the shape of a semi circle with the tips of the bund on the contour and are arranged in staggered orientation in rows so that overflow from one row will run into the next downslope.

There are excavations of foundation of 0.1 - 0.2 m following the semi circle, construction of the embankment using stones with a decreasing height at their tips to evacuate excess runoff, excavation of 1 - 3 planting pits along with a 1 m * 1 m * 1 m runoff harvesting ditch at the center. Large semi circular stone bunds (Large half moons)are constructed with a diameter of 6 m and corresponding perimeter/length of 9.42 m. The spacing between the tips of adjacent bunds within a row and between the base bund and tip of adjacent rows is 3 m. The height of the embankment varies from 0.5 - 0.75 m at the base bund to 0.4 - 0.5 m at the tip while the corresponding width varies from 0.4 - 0.5 m to 0.2 - 0.3 m. The planting pit has a diameter and depth of 0.3 m.

The bunds decrease slope length, decrease runoff velocity, increase runoff harvesting and soil moisture, decrease soil erosion, increase groundwater recharge and increase productivity per unit area.

The following activities are needed to make the bunds: Collection of stones, alignment of a contour and the semi circle, excavation of foundation, construction of the embankment and digging of planting pits and runoff harvesting ditch, maintaining of the embankment and dredging sediment from runoff harvesting ditch during the dry season. Line level, tape meter, digging hoe, shovel and hammer are needed for the establishment and maintenance. The technology is implemented in foot (5 - 8%) and hill (8 - 16%) slopes and in medium and light soil types of shallow to moderate depth (0.2 - 0.8 m). It reduces runoff amount and velocity thereby decreasing soil loss and desertification/land degradation. It also improves soil moisture availability and groundwater recharge. It is mostly constructed using communal labour and there is a moderate trend of spontaneous adoption. The technology is witnessed to be increasing fruit and fodder production thereby improving the livelihood of the land users. It, however, is demands high labour especially during establishment.

Technology 10: Deep tillage and other on farm moisture conservation techniques

Farmers in the area have stressed that one of the problems with moisture stress is the fact that only the top 15 cm of the soil mass is ploughed by the traditional “maresha”. With deep tillage, the soil can store more moisture and there is a strong need by the farmers for the introduction of technologies which can plough deeper than the traditional ploughing depth.

3.3 Water harvesting technologies from ZAMBIA

Minimum-Till Basin Method

The Southern province of Zambia is predominantly a cattle rearing region where animal draft power is the mainstay. Planting basins have not really caught on and the few farmers practicing this system are for demonstrations. The number of farmers is not precisely documented but are less than those using the Magoye Ripper (see next section).

The Minimum till basin method is a conservation farming practice involving the preparation of small holes where the crops are planted so as to reduce soil disturbance, maintain soil cover and harvest water.

The use of basins is an alternative tillage method meant to ensure sustainable use of the soil by avoiding the damaging effect of ploughing and preserving the crop residue cover. The basin method is a hand-hoe technology that involves digging planting holes instead of ploughing. The holes which are 30 x 30cm and 20cm deep should leave depressions after planting for water harvesting. The basins may be spaced at 90 x 70cm or 75 x 75cm with 3-4 plants per basin. The region between the basins is left untilled to protect the residue cover. The main objective of the basin method is to ensure that the soil is used sustainably but besides that, it aims at mitigating the effects of dry spells by harvesting water in the depressed basins and by enabling water conservation by maintaining a residue cover over the soil. The basins also enable efficient use of limited resources by placing manure and fertilizers in the same holes every year resulting in the accumulation of nutrients. Also, instead of ploughing the land in the rainy season, the basins are dug in the dry season so as to spread the labour demands over the year.

This also improves crop resilience to droughts by enabling early planting. There is no establishment phase when adopting the basin method other than the purchase of a specialized chaka hole. Farmers with very acidic soils may need a thorough application of lime followed by a last ploughing. Maintenance activities include moving the residues away from where the basins will be dug, digging the basins, sowing and weeding. Knowledge about alternative weed control practices and herbicide use is particularly cardinal as the farmer will have to establish new weeding practices and routines. Weeding should be preferable done by herbicides as the weed pressure in the absence of tillage can be high, especially at first. This implies that the major farm operations will include spraying. In addition to the normal conventional inputs, herbicides will also become a major input and cost.

Conservation Tillage with Magoye Ripper

250 rippers were distributed in Magoye and surveys show that only about half of these farmers continued to use the ripper. The field sizes range from 1/4ha to 1/2ha.

Conservation Tillage with the Magoye Ripper is an animal draft reduced tillage method that involves the use of the Magoye Ripper to loosen the soil instead of ploughing as a way of conserving the soil and soil water.

The Magoye ripper is an animal drawn implement used for conservation tillage. The Ripper consists of a frame that is attached to a common plough beam and on this frame is fixed a tine at an angle that penetrates the soil when pulled to break it up without inverting it. Only the region where the crop furrow will be is loosened by the tine and by so doing reducing the amount of tillage and disruption of soil structure while preserving the crop residue cover. The frame has some 'wings' attached to it that throw the soil out of the ripped furrow to leave it open for planting and collecting water. Ripping is done in one pass up to a depth of 15cm depending on the strength of the oxen, settings and the sharpness of the tine.

Reducing tillage first of all reduces tillage costs and tillage time allowing more time for the farmer to plant early and a larger area. Reducing tillage also reduces the loss of soil organic matter and the destructive effects to the soil structure ultimately improving soil fertility and soil water conservation. Ripping does not invert the soil hence does not bury crop residues which go further to enhance organic matter levels and protect the soil from excessive evaporation. The open furrow left by the Ripper collects water from the adjacent untilled soil much in the same way.

The furrows are used for water harvesting. This together with the increased rooting depth resulting from the breaking of compacted soil and enhanced infiltration and early planting improves water conservation and hence the resilience of crop to extended dry spells.

Ripping is best performed in dry soil although this may not be possible with some of the smaller and weak oxen when the soil is too dry. It is therefore recommended for farmers in regions that experience long dry seasons to rip at the end of harvest before the soils get too dry and the oxen lose their good condition the attained in the rainy season.

The ripper is mostly suited to small-scale farmers just adopting conservation agriculture (CA) since the tool can be easily adapted to the existing plough beam which most of the farmers already have. The small capital outlay for establishing the system makes it suited to resource poor and risk averse farmers.

Strip Tillage Conservation Farming

The strip tillage technology is only in its first year of promotion – 5 farmers used the technology in the 2011/12 season. The field sizes range from 1ha to 4ha

Strip Tillage Conservation Farming is an animal draft reduced tillage method that involves loosening a strip of soil where the crop will be planted with a strip tillage tool to reduce soil disturbance and improve soil and water conservation.

Animal draft strip tillage CA is similar to ripping except that the tillage tool is designed to work in moist soil so that it uses less draft force. A ripper uses a narrow point to penetrate the soil but the volume of loosened soil is large due to the breaking of the soil when dry. However when soil breaking is not possible when it is moist, the strip tillage tool employs sub-surface wings to increase the lateral extent of soil disruption and hence the volume of loosened soil. The sub-surface wings loosen the soil by lifting it slightly and letting it fall in place without inverting it. In this way, a strip of soil with a width of around 20cm is tilled up to 20cm deep and this is where the crop will be planted. The region between the strips is maintained as a no-till region for and water conservation.

The strip tillage tool is meant to be a transitional technology for farmers intending to adopt CA in degraded soils. These soils will need routine loosening while the biological activities allow the soil structure to recover sufficiently until tillage is no longer required. Strip tillage is able to achieve deeper soil loosening with much less draft force, wear of tines and soil disturbance than ripping. The untilled region between the strips enables the benefits of soil cover such improved infiltration, soil water storage and increased soil organic matter. Soil loosening by strip tillage does not produce large clods like ripping does but instead produces a fine seedbed that enables uniform emergence of the crop, and this together with the deep penetration results in early plant vigour. The strip tillage implement is also designed to allow the attachment of a planter unit to enable the tillage and planting in one operation or enable no-till planting.

The establishment of strip tillage based conservation agriculture mainly involves the purchase of the strip tillage implement and the replaceable tines. Liming followed by a final ploughing will be required to correct the soil PH which otherwise will be difficult to correct once conservation tillage has been established. Maintenance activities include strip-tilling the soil which may or may not include planting and fertilizing in the same operation. Weeding should preferably include the use of herbicides, implying that the major operations will include spraying. In addition to the normal conventional inputs, herbicides will also become a major input and cost.

The strip tillage technology is most suited to the bigger small-scale farmers with a capacity of up from 5ha to about 20ha. The strip tillage tool together with the planter will require a relatively substantial investment and only the bigger farmers will fully utilize its capacity. The strip tillage action will not be very effective in wet soils especially in the heavier soils, soil disruption is best achieved when the soil is slightly moist but not too dry as to require to high draft forces. Strip tillage can is useful in soil with poor structure that will require routine loosening to maintain yields while the soil is rehabilitated

Animal Draft Zero-Tillage

The Zero-Till technology is only in its first year of promotion – 2 farmers used the technology in the 2011/12 season

Animal Draft Zero-Till involves the use of an animal drawn mechanical planter to plant directly in untilled soil to minimise soil disturbance and leave a cover of crop residues to conserve the soil.

Zero-tillage takes advantage beneficial effects of biological processes to loosen the soil and improve fertility. The organic matter from these processes aggregate the soil while the movement of soil organisms like worms and termites loosen the soil. This is called biological tillage and replaces mechanical tillage. The untilled soil surface covered in residues will require a planter specailized to plant in these conditions. In a sense, adopting zero-till is actually adopting a zero-till planter. The development of the strip-planter has made zero-till a viable option for animal draft farmers which until now was not due to the unavailabiity or high cost of planters. The new planter is both cheap and easy to manufacture locally. The planter uses a narrow tine to open a planting furrow and seed/fertilizer is metered by vertically rotating plates. The planter is pulled by oxen and can plant rows of 75cm or 90cm rows with an intra row which is determined by the seed plate used (3, 4, 5,…… seeds/m). The planting technology needs to be complemented with sound residue cover and weeding management practices.

The planter enables planting and fertilizing in untilled soil so that the soil residue cover and soil structure are preserved and can be used sustainably. The protective soil cover reduces evaporation and enhances infiltration while the improved soil structure and organic matter content increases soil water storage making zero tillage an important drought mitigating strategy. The immediate benefits of adopting zero-till is the possibility to plant a bigger area quickly and in time as well as the reduced soil erosion. The first step in establishing zero-till is to assess the soil condition and levels of degradation. Where possible tests should be carried out but where not, the farmer needs to start on a small portion to verify if there will be yield reduction from not tilling the soil. Where soils are severely degraded, an establishment phase should be embarked on where reduced tillage is practiced until the soil structure has recovered sufficiently to support crop growth without tillage. Liming followed by a final ploughing will be required in the first year to correct the soil PH which otherwise will be difficult to correct once conservation tillage has been established. The organic matter levels need to be to be increased by increasing the amount of residues produced by the crop (i.e. the yields) and retaining these as soil cover. The next establishment activity is the purchase of the planter unit. Maintenance activities include planting and fertilizing in the same operation and weeding. Weeding will have to involve herbicide use to handle increased weed densities implying that spraying will became a major operation. In addition to the normal conventional inputs, herbicides will also become a major input and cost.

Zero-till has been applied in a wide range of bio-physical environments but mostly by the large scale farmers. The relatively higher costs of planters and access to herbicides and knowledge of their use has meant zero-till with planters has not been attractive to small farmers with less than 2ha. Economies of scale indicate that the farmers with a larger capacity are better able to utilize the capacity of the planter and realise the full benefits. Also the farmer has to have sufficient knowledge to assess the soil condition and decide if is too degraded for Zero-till or how long the transitional phase should be. Literacy is essential as the farmers will have to learn new approaches to weed control, pest control and crop rotations and adapt practices to suit his specific conditions.

3.4 Water harvesting technologies from Tunisia

Many water harvesting technologies have been already described during the DESIRE project (see e.g. Schwilch et al, 2012). These are tabia, Jessour, rocks bunds, gabion check dams, cisterns, recharge well etc. Later in the WAHARA project, there will be an actualization of some of these technologies using new knowledge obtained in the WAHARA project. At that stage, some new questionnaires might be added too, if WAHARA results indicate that other WHTs than those already described are worthwhile to include too. To provide an overview of all relevant WOCAT questionnaires that are currently available for the WAHARA study sites, the WOCAT descriptions from Tunisia are also included in Annex 1.

4 Conclusion

The study sites described and presented many technologies. Some of them will be implemented in this year according to the selection made by the stakeholders of each country (see deliverable 2.3). The results of this process will be presented during the coming years. The technologies and approaches that have been described are being made available in the on-line WOCAT databases, so that anyone can access them on-line.

References

Liniger, H-P., R.M. Studer, I.Providoli 2013. Promoting best practices in Sustainable Land Management. International Journal for Rural Development “Rural 21”, 03/2013, p 14,15

Schwilch, G. 2009 Database with evaluated and successful or promising strategies from all study sites. DESIRE report 48

Schwilch, G., Hessel, R. and Verzandvoort, S. (Eds). 2012. *Desire for Greener Land. Options for Sustainable Land Managementin Drylands.* Bern, Switzerland, and Wageningen, The Netherlands: University of Bern - CDE, Alterra - Wageningen UR, ISRIC - World Soil Information and CTA - Technical Centre for Agriculture and Rural Cooperation.

Annex 1. 4-page summaries of WAHARA approaches and technologies

The following pages contain the 4 page summaries of the WOCAT questionnaires that describe the relevant technologies and approaches in the 4 study sites of WAHARA: Burkina Faso, Ethiopia, Zambia and Tunisia. Although these summaries are intended to be 4 pages long, they sometimes are 5 pages. Table 3 shows which WHT are included in the annex.

Table 3 WOCAT technologies and approaches included in this annex

Technology code	**Technology name**	**Country**	**Status**[1]
T_BRK012	Bassin de captage des eaux de ruissellement (Banka)	Burkina Faso	Revised
T_BRK013	Bouli	Burkina Faso	Revised
T_BRK014	Ados	Burkina Faso	Revised
T_BRK015	Zaï forestier	Burkina Faso	Draft
T_BRK016	Tapis herbacé	Burkina Faso	Draft
T_ETH605	Soil faced deep trench bunds	Ethiopia	Draft
T_ETH606	Large semi circular stone bunds	Ethiopia	Draft
T_ETH607	Check dam ponds	Ethiopia	Draft
T_ZAM002	Strip tillage conservation farming	Zambia	Draft
T_ZAM003	Conservation tillage with Magoye Ripper	Zambia	Draft
T_ZAM004	Animal draft zero-tillage	Zambia	Draft
A_ZAM001	Participatory research and development	Zambia	Draft
T_TUN009	Jessour	Tunisia	Published
T_TUN010	Gabion check dam	Tunisia	Published
T_TUN012	Tabia	Tunisia	Published
T_TUN013	Cistern	Tunisia	Published
T_TUN014	Recharge well	Tunisia	Published
A_TUN009	Dryland watershed management approach	Tunisia	Published

[1] Draft indicates that questionnaires have been included in the on-line database, but have not been published yet; Revised means that the questionnaires have been revised based on comments of 2 reviewers, and that the WOCAT secretariat has been informed that these questionnaires can be published; Published means that questionnaires are released by WOCAT secretariat and are thus available on-line

Bassin de captage des eaux de ruissellement
Burkina Faso - Banka

Le Banka, ou Bassin de captage des eaux de ruissellement, est un ouvrage de stockage creusé dans le sol, de 12 m de long, 8 m de large et 2 m de profondeur. il permet de collecter les eaux de ruissellement pour faire des irrigations de complément en cas de poches de sécheresse.

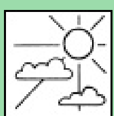
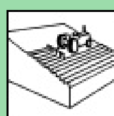
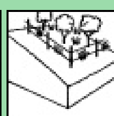
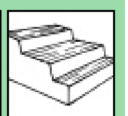
Le Banka est un ouvrage de forme rectangulaire de 12 m de long, 8 m de large et 2 m de profondeur, creusé dans le sol et destinés à collecter les eaux de ruissellement pour des irrigations de complément durant les poches de sécheresse.. Le fond du trou creusé est recouvert par un plastique afin de réduire les infiltrations.
L'objectif est la collecte des eaux de ruissellement pour des irrigations de complément. L'irrigation peut se faire avec des arrosoirs à la main, ou en utilisant une petite motopompe en système gravitaire. On peut également utiliser le système goutte à goutte. Un Banka permet d'exploiter raisonnablement 0,25 ha de culture comme le maïs, le riz ou le sorgho et même la tomate en hivernage.
Construction : On creuse un trou dans le sol à l'aide de la main d'œuvre humaine de 12 m de long sur 8 m de large et 2 m de profondeur. On utilise du plastic pour recouvrir le fond de l'ouvrage pour limiter l'infiltration. La terre de déblai constitue une digue en forme de rectangle autour du banka avec une ouverture du côté de captage des eaux. Il est généralement construit sur sol argileux ; ou limoneux ou latéritique. Pour limiter l'envasement du banka, on peut construire une diguette en pierre en amont de la digue pour éviter les sédiments (sable, feuilles d'arbres et autres déchets). Il faut également stabiliser la partie centrale ainsi que les extrémités du banka par des pierres pour éviter l'érosion. Entretien : il faut surveiller la digue et reboucher les brèches de la digue en les contournant. Main-d'oeuvre : Le creusage du Banka est un travail assez pénible. Alors il nécessite la contribution d'hommes valides et de matériels adéquats (un homme adulte, en un mois de travail achève le creusage de cet ouvrage)
Il est nécessaire que le terrain réponde au critère de pente faible (2 à 3 %). Le Banka doit être localisé dans un endroit ombragé afin de réduire l'évaporation de l'eau. Il faut protéger le fond avec un plactic pour minimiser l'infiltration. Du point de vue humain, il est nécessaire de faire le travail en groupement (action collective) afin de mobiliser la main d'œuvre nécessaire. Etant un ouvrage à l'échelle du champ, sa construction peut mobiliser une main d'œuvre familiale durant la saison sèche

droite: maïs de case irrigué à partir du bassin de captage (Photo: Sounkali SERME)

Lieu: Burkina/Yatenga
Région: Region du nord/Oula
Superficie de la Technologie: 10000 km^2
Pratique de conservation: agronomique, physique, gestion
Origine: Développé à travers l'expérimentation / la recherche, 10-50 ans
Type d'utilisation du sol: Terres cultivées: Cultures annuelles
Utilisation du sol: Terre en culture: Cultures annuelles (avant), Terre en culture: Cultures annuelles (après)
Climat: semi-aride
Référence de la base de données WOCAT: T_BRK012fr
Approche associée: Approche bassin de captage des eaux de ruissellement ()
Compilé par: SAWADOGO Hamado, INERA Institut de l'environnement et de recherches
Date: 14th Dec 2012
Personne de contact: Sounkali SERME, INERA Tougan, BP: 49 Tougan, sounkali@hotmail.com

Classification

Problèmes d'Utilisation des terres:
- Erosion des sols (apparition des rigoles et des ravines), une baisse notable de la fertilité des terres (Zippela) et une disparition de la végétation. Ruissellements intenses lors de fortes pluies Absence d'herbes (fourrages) pour les animaux. Baisse des rendements des cultures (point de vue de l'expert)
Baisse des rendements des cultures, insuffisance de fourrages Erosion des sols (apparition des rigoles et des ravines), manque de terres de bonnes qualité (point de vue de l'exploitant)

Utilisation du sol	Climat	Dégradation	Pratique de conservation
			  
Cultures annuelles Terre en culture: Cultures annuelles (avant) Terre en culture: Cultures annuelles (après) cultures pluviales mixtes : pluviales-irriguées plantations forestières (reboisements)	semi-aride		agronomique: Autres (Gestion de l'eau) physique: Réservoir de retenue / barrage : stockage de l'excès d'eau gestion: changement majeur dans la périodicité des activités

Stade de mise en oeuvre

- Prévention
- Atténuation/ Réduction
- Réhabilitation

Origine

- Initiatives des exploitants: 10-50 ans
- Expériences / Recherche: 10-50 ans
- Introduit extérieurement

Niveau de connaissances techniques

- Conseiller agricole
- Exploitant

Principales causes de la dégradation des terres:
Causes directes - Provoquées par l'homme: déforestation / disparition de la végétation naturelle (inclus les feux de forêts), surexploitation de la végétation pour l'usage domestique, surpâturage
Causes directes - Naturelles: changement de température
Causes indirectes: pression de la population

Principales fonctions techniques:
- contrôle du ruissellement en nappe: rétention / capture
- contrôle du ruissellement en ravines: rétention/capture
- amélioration de la couverture du sol
- augmentation de la disponibilité des nutriments (réserve, recyclage, ...)
- augmentation / maintien de la rétention d'eau dans le sol
- augmentation du niveau / recharge de la nappe phréatique
- récupération de l'eau / augmentation des réserves d'eau
- développement des espèces végétales et de la variété (qualité, ex: fourrage appétent)

Fonctions techniques secondaires:
- contrôle du ruissellement en nappe: ralentissement / retardement
- contrôle du ruissellement en ravines: ralentissement/retardement
- augmentation de la rugosité de surface
- amélioration de la structure du sol en surface (encroûtement, battance du sol)
- amélioration de la structure de la couche arable du sol (tassement, compaction)
- amélioration de la structure du sous-sol (couche dure)
- augmentation de la matière organique
- épandage des eaux
- diversification et arrangement spatiaux pour l'utilisation des terres

Environnement

Environnement naturel

Précipitations moyennes annuelles (mm)

- > 4000 mm
- 3000-4000 mm
- 2000-3000 mm
- 1500-2000 mm
- 1000-1500 mm
- 750-1000 mm
- 500-750 mm
- 250-500 mm
- < 250 mm

Altitude (m)

- > 4000
- 3000-4000
- 2500-3000
- 2000-2500
- 1500-2000
- 1000-1500
- 500-1000
- 100-500
- <100

Topographie

- plateaux / plaines
- crêtes
- flancs de montagne
- flancs de colline
- piémonts/glacis (bas de pente)
- fonds de vallée/bas-fond/cuvette

Pente (%)

- plat
- faible
- moyen
- onduleux
- vallonné
- raide
- très raide

Profondeur du sol (cm)

- 0-20
- 20-50
- 50-80
- 80-120
- >120

Saison(s) de culture: 150 days (juin à octobre)
Fertilité du sol: moyenne
Matière organique dans la couche arable: moyenne (1-3%)

Capacité de rétention d'eau du sol: élevé
Profondeur estimée de l'eau dans le sol: En surface
Disponibilité de l'eau de surface: excès (par ex . inondation)
Qualité de l'eau: eau pour l'agriculture seulement
Biodiversité: élevé

Sensible aux conditions climatiques extrêmes: Augmentation de la température, Augmentation des précipitations saisonnières, Diminution des précipitations saisonnières, Évènement de fortes précipitations (intensité et quantité), inondations, Sécheresses / périodes de sécheresse

Environnement humain

Terres cultivées par ménage (ha)

- <0.5
- 0.5-1
- 1-2
- 2-5
- 5-15
- 15-50
- 50-100
- 100-500
- 500-1,000
- 1,000-10,000
- >10,000

Exploitant: individu / ménage, exploitants de petite échelle, principalement des hommes
Densité de la population: 50-100 personnes/km2
Croissance annuelle de la population: 2% - 3%
Droits d'utilisation: individuel
Droits d'utilisation de l'eau: individuel
Niveau relatif de richesse des exploitants: moyens, que représente 50% des exploitants; pauvres, que représente 45% des exploitants;

Importance des revenus non agricoles: moins de 10% de tout le revenu: transferts reçus, l'artisanat, le commerce
Accès aux services et infrastructures: faible: santé, éducation, assistance technique, emploi (hors exploitation), commerce, énergie, routes et transports, eau potable et services sanitaires, services financiers
Economie générale: mixte (de subsistance et de rente)
Mécanisation: travail manuel
Cheptel pâturant sur les cultures: oui

Activités de mise en oeuvre, intrants et coûts

Activités de mise en place

-
- Construction du banka
- Main-d'oeuvre

Activités de maintenance /récurrentes

- Surveillance

Remarques:

Evaluation

Impacts de la Technologie

Bénéfices de production et socio-économiques

+++ augmentation de la disponibilité / qualité de l'eau
++ réduction des risques de perte de production
++ réduction des frais pour les intrants agricoles
++ augmentation des revenus agricoles
++ opérations agricoles facilitées
+ augmentation du rendement des cultures
+ augmentation de la production de fourrage
+ augmentation de la qualité du fourrage
+ augmentation de la disponibilité / qualité de l'eau d'irrigation
+ réduction des contraintes de main d'oeuvre

Inconvénients au niveau de la production et au niveau socio-économique

+++ augmentation des dépenses pour les intrants agricoles
+++ baisse des revenus agricoles
+++ réduction de la diversification de production
++ réduction de la production agricole

Bénéfices socio-culturels

++ renforcement des institutions communautaires
++ réduction des conflits
++ amélioration des connaissances en conservation / érosion
++ amélioration de la sécurité alimentaire et de l'autosuffisance
++ amélioration de la santé

Inconvénients socioculturels

Bénéfices écologiques

++ amélioration de la récupération / collecte des eaux de ruissellement
++ augmentation de l'humidité du sol
++ réduction de l'évaporation
++ réduction du ruissellement de surface
+ augmentation de la quantité d'eau
+ amélioration du drainage de l'eau en excès
+ baisse du risque vis-à-vis d'événements défavorables
+ amélioration de la couverture du sol
+ augmentation de la biomasse au-dessus du sol C
+ réduction de la perte en sol

Inconvénients écologiques

Bénéfices hors-site

+++ augmentation de la disponibilité de l'eau

Inconvénients hors-site

Contribution au bien-être humain / moyens d'existence

+++ Car l'accroissement de la production (maraîchère) engendre un accroissement de revenu permettant d'accéder à ces services sociaux de base. Cela contribue combler les déficits.

Bénéfices / coûts du point de vue de l'exploitant		
Bénéfices comparés aux coûts	**à court terme:**	**à long terme:**
Mise en place	non spécifié	non spécifié
Maintenance / récurrente	non spécifié	non spécifié

Car les exploitants investissent toujours lorsque le résultat est positif

Acceptation / adoption:

Il y a non tendance (en augmentation) vers une adoption spontanée de la technologie.

Conclusions

Points forts et → comment les maintenir / renforcer	Points faibles et → comment les surmonter
Augmentation de la disponibilité de l'eau → bonne organisation et bon entretien période	Utilisation plus importante de la main d'œuvre → par la mécanisation
Augmentation des rendement → bonne organisation et bon entretien période	Insuffisance de moyens financiers → Subvention crédits et meilleure organisation
augmentation des revenus → bonne organisation et bon entretien période	Coût de construction non accessible individuellement → Subvention et crédits
sécurisation de la production en hivernage → bonne organisation et bon entretien période	Accroissement de la main d'œuvre →
Diversification des produits alimentaires → bonne organisation et bon entretien période	Insuffisance de moyens financiers →
augmentation des rendements → subvention et crédits en transport et intrants agricoles	Coût très élevés → subvention et crédits
Couverture de besoins alimentaires → subventionet crédits en transport et intrants agricoles	
augmentation des résultats → subvention et crédits en transport et intrants agricoles	
couverture des besoins sociaux de base → subvention et crédits en transport et intrants agricoles	
diversité de produit → subvention et crédits en transport et intrants agricoles	

WOCAT


Bouli

Burkina Faso - Bouli

Les boulis : ce sont des ouvrages de forme ovale ou circulaire de 60 m de long et 4 à 6 m de profondeur, creusés dans le sol et destinés à collecter les eaux de ruissellement pour des usages divers (maraîchage, pépinières pour maraîchage et essences agroforestières en saison sèche) et pour la riziculture en hivernage

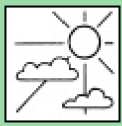
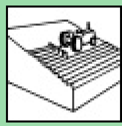
Ce sont des ouvrages de forme ovale ou circulaire de 60 m de long et 4 à 6 m de profondeur, creusés dans le sol et destinés à collecter les eaux de ruissellement pour des usages divers (maraîchage, pépinières pour maraîchage et essences agroforestières en saison sèche) et pour la riziculture en hivernage. Traditionnellement, les boulis étaient utilisés à des fins diverses d'abreuvage des animaux, de confection de briques en terre et de lessive
L'objectif est la collecte des eaux de ruissellement pour des usages en hivernage et saison sèche. La riziculture en hivernage et le maraîchage en saison sèche sont les principales activités du bouli. Le bouli peut être utilisé en irrigation complémentaire en période de crise
Construction : On creuse un trou dans le sol à l'aide de Bulldozer. La terre de déblai constitue une digue en forme de demi-lune en aval. Il est généralement construit sur un sol argileux. La profondeur est variable et pouvant atteindre 6 m. pour limiter l'envasement du bouli, on peut construire une diguette en pierre en amont de la digue (zone de captage des eaux). Il faut également stabiliser la partie centrale ainsi que les extrémités du bouli par des pierres pour éviter l'érosion. Cela nécessite au moins 10 jours d'utilisation du Bulldozer, 2 à 3 jours d'utilisation de camion pour le ramassage des pierres nécessaires à la digue filtrante. L'entretien : il faut surveiller la digue et reboucher les brèches de la digue en les contournant. Main-d'oeuvre : Les intrants sont d'abord fonction de la taille du bouli. Il faut au moins en moyenne 10 à 20 personnes par jour pour le ramassage des moellons, et entre 32 à 48 m3 de moellons. Cela nécessite une organisation collective des populations au préalable.
Il faut un sol argileux localisé dans un endroit ombragé afin de réduire l'évaporation de l'eau. Du point de vue humain, il est nécessaire de faire le travail en groupement (action collective) afin de mobiliser la main d'œuvre nécessaire. Etant un ouvrage à l'échelle terroir, sa construction peut mobiliser tout un village ou plusieurs villages.

gauche: Photo d'un bouli vue de face (Photo: hamado SAWADOGO)
droite: Photo d'un bouli communautaire (Photo: Hamado SAWADOGO)

Lieu: Burkina Faso/Yatenga
Région: région du Nord/Oula
Superficie de la Technologie: 10 km^2
Pratique de conservation: agronomique
Stade de mise en oeuvre: atténuation / réduction de la dégradation des terres, réhabilitation de terres dégradées
Origine: Développé à travers l'expérimentation / la recherche, récent (<10 ans)
Type d'utilisation du sol:
Terres cultivées: Cultures annuelles
Utilisation du sol:
Terre en culture: Cultures annuelles (avant), Terre en culture: Cultures annuelles (après)
Climat: semi-aride
Référence de la base de données WOCAT: T_BRK013fr
Approche associée:
Compilé par: SAWADOGO Hamado, INERA Institut de l'environnement et de recherches
Date: 15th Dec 2012
Personne de contact: Hamado SAWADOGO, CNRST/INERA, 70233546, hsawadogo@gmail.com

Classification

Problèmes d'Utilisation des terres:
- Erosion des sols (apparition des rigoles et des ravines), une baisse notable de la fertilité des terres (Zippela) et une disparition de la végétation. Ruissellements intenses lors de fortes pluies Absence d'herbes (fourrages) pour les animaux. Baisse des rendements des cultures (point de vue de l'expert) Baisse des rendements des cultures, insuffisance de fourrages Erosion des sols (apparition des rigoles et des ravines), manque de terres de bonnes qualité (point de vue de l'exploitant)

Utilisation du sol	Climat	Dégradation	Pratique de conservation
			
Cultures annuelles Terre en culture: Cultures annuelles (avant) Terre en culture: Cultures annuelles (après) post-inondation (culture de décrue) pâturage extensif mixtes : pluviales-irriguées	semi-aride	Erosion hydrique du sol: perte du sol de surface par l’eau	agronomique: Autres ()

Stade de mise en oeuvre

Prévention
Atténuation/ Réduction
Réhabilitation

Origine

Initiatives des exploitants: traditionnel (>50 ans)
Expériences / Recherche: récent (<10 ans)
Introduit extérieurement

Niveau de connaissances techniques

Conseiller agricole
Exploitant

Principales causes de la dégradation des terres:
Causes directes - Provoquées par l'homme: gestion des cultures (annuelles, pérennes, arbre/buissons), déforestation / disparition de la végétation naturelle (inclus les feux de forêts), sur–détournement / retrait excessif de l’eau (pour l’irrigation, l’industrie, etc.)
Causes directes - Naturelles: changement de température, fort / extrême niveau de précipitation (intensité et quantité), sécheresses

Principales fonctions techniques:
- contrôle du ruissellement en nappe: ralentissement / retardement
- augmentation / maintien de la rétention d'eau dans le sol
- récupération de l’eau / augmentation des réserves d’eau

Fonctions techniques secondaires:
- contrôle du ruissellement en ravines: rétention/capture
- augmentation de l'infiltration

Environnement

Environnement naturel

Précipitations moyennes annuelles (mm)

> 4000 mm
3000-4000 mm
2000-3000 mm
1500-2000 mm
1000-1500 mm
750-1000 mm
500-750 mm
250-500 mm
< 250 mm

Altitude (m)

> 4000
3000-4000
2500-3000
2000-2500
1500-2000
1000-1500
500-1000
100-500
<100

Topographie

plateaux / plaines
crêtes
flancs de montagne
flancs de colline
piémonts/glacis (bas de pente)
fonds de vallée/bas-fond/cuvette

Pente (%)

plat
faible
moyen
onduleux
vallonné
raide
très raide

Profondeur du sol (cm)

0-20
20-50
50-80
80-120
>120

Saison(s) de culture: 150 days (juin à octobre)

Capacité de rétention d’eau du sol: élevé
Profondeur estimée de l’eau dans le sol: En surface
Disponibilité de l’eau de surface: excès (par ex . inondation)
Qualité de l’eau: eau pour l’agriculture seulement

Sensible aux conditions climatiques extrêmes: Augmentation de la température, Augmentation des précipitations saisonnières, Diminution des précipitations saisonnières, Évènement de fortes précipitations (intensité et quantité), inondations, Sécheresses / périodes de sécheresse

Environnement humain

Terres cultivées par ménage (ha)

- <0.5
- 0.5-1
- 1-2
- 2-5
- 5-15
- 15-50
- 50-100
- 100-500
- 500-1,000
- 1,000-10,000
- >10,000

Exploitant: exploitants de petite échelle, principalement des hommes
Densité de la population: 50-100 personnes/km2
Croissance annuelle de la population: 2% - 3%
Droits d'utilisation: individuel (les terres agricoles ne se vendent pas alors que l'eau est librement accessible à tous)
Droits d'utilisation de l'eau: individuel (les terres agricoles ne se vendent pas alors que l'eau est librement accessible à tous)

Importance des revenus non agricoles: moins de 10% de tout le revenu: transferts reçus, l'artisanat, le commerce
Accès aux services et infrastructures: faible
Economie générale: mixte (de subsistance et de rente)
Mécanisation: travail manuel
Cheptel pâturant sur les cultures: oui

Activités de mise en oeuvre, intrants et coûts

Activités de mise en place

-

Activités de maintenance /récurrentes

- Construction du bouli
- Surveillance

Remarques:
Le coût des machines (Bulldozer) et les coûts de transport sont essentiellement les composantes les plus importantes des coûts de construction des Boulis. Il y a aussi une main-d'oeuvre importante à mobiliser.

Evaluation

Impacts de la Technologie

Bénéfices de production et socio-économiques

- ++ augmentation de la disponibilité en eau potable
- ++ augmentation de la disponibilité / qualité de l'eau d'irrigation
- ++ baisse de la demande d'eau d'irrigation
- ++ augmentation de la zone de production
- + augmentation du rendement des cultures
- + augmentation de la production de fourrage
- + augmentation de la qualité du fourrage
- + augmentation de la production animale
- + diversification des sources de revenus

Inconvénients au niveau de la production et au niveau socio-économique

- +++ augmentation de la demande en eau d'irrigation
- +++ augmentation des dépenses pour les intrants agricoles
- +++ augmentation des contraintes de main d'oeuvre
- ++ réduction de la production agricole

Bénéfices socio-culturels

- ++ renforcement des institutions communautaires
- ++ réduction des conflits
- ++ amélioration des connaissances en conservation / érosion
- ++ amélioration de la sécurité alimentaire et de l'autosuffisance
- ++
- ++

Inconvénients socioculturels

- +++ conflits socio-culturels

Bénéfices écologiques

- ++ amélioration de la récupération / collecte des eaux de ruissellement
- ++ augmentation de l'humidité du sol
- ++ réduction de l'évaporation
- ++ réduction du ruissellement de surface
- + augmentation de la quantité d'eau
- + amélioration du drainage de l'eau en excès
- + amélioration de la couverture du sol
- + réduction de la perte en sol

Inconvénients écologiques

Bénéfices hors-site

- +++ augmentation de la disponibilité de l'eau

Inconvénients hors-site

Contribution au bien-être humain / moyens d'existence

+++ Car l'accroissement de la production (maraîchère) engendre un accroissement de revenu permettant d'accéder à ces services sociaux de base. Cela contribue combler les déficits.

Bénéfices / coûts du point de vue de l'exploitant			
	Bénéfices comparés aux coûts	**à court terme:**	**à long terme:**
	Mise en place	très positifs	très positifs
	Maintenance / récurrente	très positifs	très positifs

Car les exploitants investissent toujours lorsque le résultat est positif

Acceptation / adoption:

Il y a non tendance (en augmentation) vers une adoption spontanée de la technologie.

Conclusions

Points forts et → comment les maintenir / renforcer	Points faibles et → comment les surmonter
Augmentation de la disponibilité de l'eau → bonne organisation et bon entretien période	Utilisation plus importante de la main d'œuvre → par la mécanisation
Augmentation des rendements → bonne organisation et bon entretien période	Insuffisance de moyens financiers → Subvention et meilleure organisation
augmentation des revenus → bonne organisation et bon entretien période	Coût de construction non accessible individuellement → Subvention et crédits
sécurisation de la production en hivernage → bonne organisation et bon entretien période	Accroissement de la main d'œuvre →
Diversification des produits alimentaires → bonne organisation et bon entretien période	Insuffisance de moyens financiers → subvention et crédits
augmentation des rendements → subvention et crédits en transport et intrants agricoles	
Couverture de besoins alimentaires → subvention et crédits en transport et intrants agricoles	
augmentation des résultats → subvention et crédits en transport et intrants agricoles	
couverture des besoins sociaux de base → subvention et crédits en transport et intrants agricoles	
diversité de produit → subvention et crédits en transport et intrants agricoles	

Ados

Burkina Faso - Diguette en terre (Français)

Les ados sont des diguettes en terres disposées en courbes de niveau dont la base est comprise entre 0,7 m et 1m ; et dont la hauteur vaut 0,5m.

Ce sont de grandes diguettes réalisées à la charrue bovine ou au tracteur. Elles possèdent des ailes en pierres pour permettre l'évacuation des eaux excédentaires. Cette technologie est caractérisée par ses dimensions (0,7m à 1m de base et 0,5m) et une combinaison de pierres et de terre simple
L'objectif poursuivi par la mise en œuvre des ados est de stopper les eaux de ruissellement et de permettre leur infiltration. Elle augmente ainsi la capacité de stockage de rétention en eau du sol
Construction : déterminer le sens de ruissellement grâce au niveau à eau. Il faut entre deux à trois lignes d'ados par hectare afin d'obtenir l'efficacité. Nécessité de 15 à 20 hommes/jour par hectare pour la construction des ados. L'entretien : consistant à surveiller et reboucher les brèches après une grosse pluie, il nécessite 5 hommes/jour pour l'entretien par an.
Il faut des terrains d'une pente n'excédant pas 1%, sinon, on ne peut pas l'appliquer. Nécessité de sol limono-sableux ou gravillonnaire. Du point de vue humain, il est nécessaire de faire de travailler en groupement (action collective). Il est également impératif de suivre une formation pour maîtriser la pratique des diguettes en terres.

droite: Vue d'un ados (Photo: Sounkali SERME)

Lieu: Burkina Faso/Yatenga
Région: Région du Nord/Oula
Superficie de la Technologie: 10000 km²
Pratique de conservation: agronomique, physique, gestion
Stade de mise en oeuvre: prévention de la dégradation des terres, atténuation / réduction de la dégradation des terres, réhabilitation de terres dégradées
Origine: Développé à travers l'expérimentation / la recherche, 10-50 ans
Type d'utilisation du sol: Terres cultivées: Cultures annuelles
Utilisation du sol: Terre en culture: Cultures annuelles (avant), Terre en culture: Cultures annuelles (après)
Climat: semi-aride
Référence de la base de données WOCAT: T_BRK014fr
Approche associée:
Compilé par: SAWADOGO Hamado, INERA Institut de l'environnement et de recherches
Date: 16th Dec 2012
Personne de contact: Hamado SAWADOGO, CNRST/INERA OUAGADOUGOU

Classification

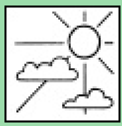
Problèmes d'Utilisation des terres:

- Erosion des sols (apparition des rigoles et des ravines), une baisse notable de la fertilité des terres (Zippela) et une disparition de la végétation. Ruissellements intenses lors de fortes pluies Absence d'herbes (fourrages) pour les animaux. Baisse des rendements des cultures (point de vue de l'expert)
Baisse des rendements des cultures, insuffisance de fourrages Erosion des sols (apparition des rigoles et des ravines), manque de terres de bonnes qualité (point de vue de l'exploitant)

Utilisation du sol

Cultures annuelles
Terre en culture: Cultures annuelles (avant)
Terre en culture: Cultures annuelles (après)
cultures pluviales
pâturage extensif
mixtes : pluviales-irriguées
coupe sélective de forêts (semi-) naturelles

Climat

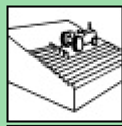
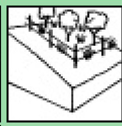
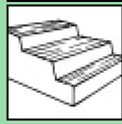


semi-aride

Dégradation

Erosion hydrique du sol: perte du sol de surface par l'eau

Pratique de conservation

agronomique: Autres (Amélioration du sol par infiltration de l'eau)
physique: Terrasses en banquette (pente du fond de la terrasse <6%)
gestion: dhangement du niveau de gestion / intensification

Stade de mise en oeuvre

Prévention
Atténuation/ Réduction
Réhabilitation

Origine

Initiatives des exploitants
Expériences / Recherche: 10-50 ans
Introduit extérieurement

Niveau de connaissances techniques

Conseiller agricole
Exploitant

Principales causes de la dégradation des terres:
Causes directes - Provoquées par l'homme: soil management, déforestation / disparition de la végétation naturelle (inclus les feux de forêts)
Causes directes - Naturelles: changement des précipitations saisonnières, inondations, sécheresses
Causes indirectes: pression de la population

Principales fonctions techniques:
- contrôle du ruissellement en nappe: rétention / capture
- amélioration de la structure du sol en surface (encroûtement, battance du sol)
- augmentation de la disponibilité des nutriments (réserve, recyclage, ...)

Fonctions techniques secondaires:

Environnement

Environnement naturel

Précipitations moyennes annuelles (mm)

> 4000 mm
3000-4000 mm
2000-3000 mm
1500-2000 mm
1000-1500 mm
750-1000 mm
500-750 mm
250-500 mm
< 250 mm

Altitude (m)

> 4000
3000-4000
2500-3000
2000-2500
1500-2000
1000-1500
500-1000
100-500
<100

Topographie

plateaux / plaines
crêtes
flancs de montagne
flancs de colline
piémonts/glacis (bas de pente)
fonds de vallée/bas-fond/cuvette

Pente (%)

plat
faible
moyen
onduleux
vallonné
raide
très raide

Profondeur du sol (cm)

0-20
20-50
50-80
80-120
>120

Saison(s) de culture: 150 days (juin à octobre)
Texture du sol: gros grain / léger (sablonneux)
Fertilité du sol: très pauvre
Matière organique dans la couche arable: faible (<1%)
Drainage du sol / infiltration: moyenne

Capacité de rétention d'eau du sol: élevé
Profondeur estimée de l'eau dans le sol: 5 – 50 m
Disponibilité de l'eau de surface: moyenne, pauvre / absente
Qualité de l'eau: eau pour l'agriculture seulement

Tolérante aux conditions climatiques extrêmes: Diminution des précipitations saisonnières, Diminution de la période de culture
Sensible aux conditions climatiques extrêmes: Augmentation de la température, Augmentation des précipitations saisonnières, Évènement de fortes précipitations (intensité et quantité), Sécheresses / périodes de sécheresse

Environnement humain

Terres cultivées par ménage (ha)

☐	<0.5
☐	0.5-1
☐	1-2
☐	2-5
☐	5-15
☐	15-50
☐	50-100
☐	100-500
☐	500-1,000
☐	1,000-10,000
☐	>10,000

Exploitant: exploitants typiques / dans la moyenne, principalement des hommes
Densité de la population: 50-100 personnes/km2
Croissance annuelle de la population: 2% - 3%
Droits d'utilisation: individuel (les terres agricoles ne se vendent pas alors que l'eau est librement accessible à tous)
Droits d'utilisation de l'eau: (les terres agricoles ne se vendent pas alors que l'eau est librement accessible à tous)
Niveau relatif de richesse des exploitants: moyens, que représente 50% des exploitants;

Importance des revenus non agricoles: moins de 10% de tout le revenu: transferts reçus, l'artisanat, le commerce
Accès aux services et infrastructures: faible: santé, éducation, assistance technique, emploi (hors exploitation), commerce, énergie, routes et transports, eau potable et services sanitaires, services financiers
Economie générale: mixte (de subsistance et de rente)
Mécanisation: travail manuel
Cheptel pâturant sur les cultures: oui

Activités de mise en oeuvre, intrants et coûts

Activités de mise en place

- NPK
- Urée
- Renforcement par andropogon

Intrants de mise en place et coûts par ha

Intrants	Coûts (US$)	% couvert par l'exploitant
Main d'oeuvre	60000.00	%
Equipement		
- outils	15000.00	%
TOTAL	**1600.00**	**100.00%**

Activités de maintenance /récurrentes

- Renforcement des diguettes avec des plants
- Fermer les brèches causées par le ruissellement
- Renforcement par andropogone
- 1. renforcement par andropogon

Intrants de maintenance /récurrents et coûts par ha par année

Intrants	Coûts (US$)	% couvert par l'exploitant
Main d'oeuvre	2000.00	100%
TOTAL		**%**

Remarques:
La main d'œuvre constitue le facteur le plus déterminant des coûts de construction et d'entretien. Elle est suivie du coût de l'équipement

Evaluation

Impacts de la Technologie

Bénéfices de production et socio-économiques

- +++ augmentation de la disponibilité / qualité de l'eau
- ++ réduction des risques de perte de production
- ++ réduction des frais pour les intrants agricoles
- ++ augmentation des revenus agricoles
- ++ opérations agricoles facilitées
- \+ augmentation du rendement des cultures
- \+ augmentation de la production de fourrage
- \+ augmentation de la qualité du fourrage
- \+ augmentation de la disponibilité / qualité de l’eau d’irrigation
- \+ réduction des contraintes de main d'oeuvre

Inconvénients au niveau de la production et au niveau socio-économique

- +++ augmentation de la demande en eau d’irrigation
- +++ augmentation des dépenses pour les intrants agricoles
- +++ augmentation des contraintes de main d’oeuvre
- ++ réduction de la production agricole

Bénéfices socio-culturels

- ++ renforcement des institutions communautaires
- ++ réduction des conflits
- ++ amélioration des connaissances en conservation / érosion
- ++ amélioration de la sécurité alimentaire et de l’autosuffisance
- ++ amélioration de la santé

Inconvénients socioculturels

- +++ conflits socio-culturels

Bénéfices écologiques

- ++ amélioration de la récupération / collecte des eaux de ruissellement
- ++ augmentation de l’humidité du sol
- ++ réduction de l’évaporation
- ++ réduction du ruissellement de surface
- \+ augmentation de la quantité d’eau
- \+ amélioration du drainage de l’eau en excès
- \+ baisse du risque vis-à-vis d’événements défavorables
- \+ amélioration de la couverture du sol
- \+ augmentation de la biomasse au-dessus du sol C
- \+ réduction de la perte en sol

Inconvénients écologiques

Bénéfices hors-site

- +++ augmentation de la disponibilité de l'eau

Inconvénients hors-site

Contribution au bien-être humain / moyens d'existence

\+ Car l’accroissement de la production engendre un accroissement de revenu permettant d’accéder à ces services sociaux de base.

Bénéfices / coûts du point de vue de l'exploitant

Bénéfices comparés aux coûts	à court terme:	à long terme:
Mise en place	très positifs	très positifs
Maintenance / récurrente	très positifs	très positifs

Car les exploitants investissent toujours lorsque le résultat est positif

Acceptation / adoption:

50% des familles d'exploitants (50 familles; 5% de la superficie) ont mis en oeuvre la technologie avec assistance matérielle externe Ce sont les familles qui bénéficient d’appuis du projet d’expérimentation de la technologie.
Il y a oui, peu tendance (en augmentation) vers une adoption spontanée de la technologie. Ce sont des tendances à l’expérimentation ou essais

Conclusions

Points forts et → comment les maintenir / renforcer	Points faibles et → comment les surmonter
Augmentation des rendements → Subvention, crédits et bon entretien	Utilisation plus importante de la main d'œuvre → par la mécanisation
augmentation du fourrage → Subvention, crédits et bon entretien	Insuffisance de moyens financiers → Subvention, crédits et meilleure organisation
	Accroissement de la main d'œuvre → accroissement de la mécanisation
	Insuffisance de moyens financiers →

Zaï forestier

Burkina Faso - Tissé zaï (mooré)

Les zaï forestier est une technique de réhabilitation des terres dans le but de régénérer la végétation. Il est l'œuvre d'un paysan innovateur Yacouba Sawadogo

La technique consiste à creuser des trous de 1 m de diamètre et de 50 à 70 cm de profondeur dans lesquels on met de la matière organique et on y plante des arbres en hivernage.
L'objectif est de régénérer la couverture végétale et de réhabiliter la terre en collectant des eaux de ruissellement pendant l'hivernage et la saison sèche. La technique vise aussi à lutter contre la désertification et de réintroduire des espèces disparues et utilitaires en disparition notamment dans le domaine de la pharmacopée.
Les trous sont creusés à l'aide de pic-à-axe et de barre à mine. La terre excavée entièrement et la fumure organique produite dans la fosse fumière est introduite en raison de 5 pelletées (variables selon l'espèce). Les graines sont semées dans le trou (pas des plants à partir d'une pépinière). Il est pratiqué sur des sols de type latéritique, gravillonnaire ou dénudé. il faut beaucoup surveiller le plant afin d'éviter qu'il soit mangé par les termites ainsi que des animaux. Les intrants sont constitués essentiellement des semences des espèces ligneuses à régénérer ainsi que de la main d'œuvre, la matière organique, le petit équipement (pelle, brouette, pic-à-ace, baril).
NB : l'exploitant de la technologie a un forage sur les lieux.
Il faut un sol latérite gravillonnaire ou dénudé. Le travail est individuel mais nécessite une main d'œuvre importante.

gauche: Zaï forestier d'un producteur (Photo: Hamado SAWADOGO)
droite: Zaï forestier d'un producteur (Photo: Hamado SAWADOGO)

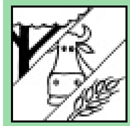
Lieu: Burkina Faso / Yatenga
Région: Nord / Ouahigouya
Superficie de la Technologie: 0,1 km^2
Pratique de conservation: biologique
Stade de mise en oeuvre: prévention de la dégradation des terres, atténuation / réduction de la dégradation des terres, réhabilitation de terres dégradées
Origine: Développé à l'initiative des exploitants agricoles, récent (<10 ans)
Type d'utilisation du sol:
Mixte: Agro-sylvo-pastoralisme
Utilisation du sol:
Mixte: Agro-pastoralisme (avant), Forêts / boisrêts / bois: Forêts / boisrêt nature (après)
Climat: semi-aride, tropical
Référence de la base de données WOCAT: T_BRK015en
Approche associée:
Compilé par: SAWADOGO Hamado, INERA Institut de l'environnement et de recherches
Date: 25th Aug 2013
Personne de contact: Janvier KINI, Université de Ouagadougou BP 7164 flavki@yahoo.fr

Classification

Problèmes d'Utilisation des terres:

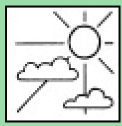
- Erosion des sols (apparition des rigoles et des ravines), une baisse notable de la fertilité des terres (Zippela) et une disparition de la végétation. Ruissellements intenses lors de fortes pluies Absence d'herbes (fourrages) pour les animaux. Baisse des rendements des cultures. (point de vue de l'expert)
Baisse des rendements des cultures, insuffisance de fourrages; Érosion des sols (apparition des rigoles et des ravines), manque de terres de bonne qualité. (point de vue de l'exploitant)

Utilisation du sol



Agro-sylvo-pastoralisme
Mixte: Agro-pastoralisme (avant)
Forêts / boisrêts / bois: Forêts / boisrêt nature (après)
mixtes : pluviales-irriguées
plantations forestières (reboisements)

Climat

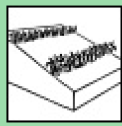


semi-aride

Dégradation

Dégradation biologique: réduction de la couverture végétale

Pratique de conservation



biologique: Herbes et plantes herbacées pérennes

Stade de mise en oeuvre

- ■ Prévention
- ■ Atténuation/ Réduction
- ■ Réhabilitation

Origine

- ■ Initiatives des exploitants: récent (<10 ans)
- □ Expériences / Recherche
- □ Introduit extérieurement

Niveau de connaissances techniques

- ■ Conseiller agricole
- ■ Exploitant

Principales causes de la dégradation des terres:
Causes directes - Provoquées par l'homme: soil management, gestion des cultures (annuelles, pérennes, arbre/buissons), déforestation / disparition de la végétation naturelle (inclus les feux de forêts)
Causes directes - Naturelles: changement des précipitations saisonnières, sécheresses
Causes indirectes: pression de la population

Principales fonctions techniques:
- contrôle du ruissellement en nappe: rétention / capture
- contrôle du ruissellement en ravines: rétention/capture
- amélioration de la couverture du sol
- stabilisation du sol (par ex. par des racines d'arbres contre les glissements de terrain)
- augmentation de la matière organique
- augmentation de la disponibilité des nutriments (réserve, recyclage, …)
- augmentation / maintien de la rétention d'eau dans le sol
- rétention / capture des sédiments, recueil des sédiments
- augmentation de la biomasse (quantité)
- développement des espèces végétales et de la variété (qualité, ex: fourrage appétent)

Fonctions techniques secondaires:
- contrôle du ruissellement en nappe: ralentissement / retardement
- contrôle du ruissellement en ravines: ralentissement/retardement
- augmentation de l'infiltration
- réduction de la vitesse du vent

Environnement

Environnement naturel

Précipitations moyennes annuelles (mm)

- □ > 4000 mm
- □ 3000-4000 mm
- □ 2000-3000 mm
- □ 1500-2000 mm
- □ 1000-1500 mm
- □ 750-1000 mm
- ■ 500-750 mm
- □ 250-500 mm
- □ < 250 mm

Altitude (m)

- □ > 4000
- □ 3000-4000
- □ 2500-3000
- □ 2000-2500
- □ 1500-2000
- □ 1000-1500
- □ 500-1000
- ■ 100-500
- □ <100

Topographie

- □ plateaux / plaines
- □ crêtes
- □ flancs de montagne
- □ flancs de colline
- ▒ piémonts/glacis (bas de pente)
- □ fonds de vallée/bas-fond/cuvette

Pente (%)

- □ plat
- ■ faible
- □ moyen
- □ onduleux
- □ vallonné
- □ raide
- □ très raide

Profondeur du sol (cm)

- ■ 0-20
- □ 20-50
- □ 50-80
- □ 80-120
- □ >120

Saison(s) de culture: 150 days (juin à octobre)
Texture du sol: gros grain / léger (sablonneux)
Fertilité du sol: très pauvre
Matière organique dans la couche arable: faible (<1%)
Drainage du sol / infiltration: bon

Capacité de rétention d'eau du sol: minimum
Profondeur estimée de l'eau dans le sol: 5 – 50 m
Disponibilité de l'eau de surface: pauvre / absente
Qualité de l'eau: eau pour l'agriculture seulement
Biodiversité: élevé

Tolérante aux conditions climatiques extrêmes: Augmentation de la température
Sensible aux conditions climatiques extrêmes: Augmentation des précipitations saisonnières, Diminution des précipitations saisonnières, Évènement de fortes précipitations (intensité et quantité), Sécheresses / périodes de sécheresse, Diminution de la période de culture

Environnement humain

Mixte par ménage (ha)

☐	<0.5
☐	0.5-1
☐	1-2
☐	2-5
☐	5-15
☐	15-50
☐	50-100
☐	100-500
☐	500-1,000
☐	1,000-10,000
☐	>10,000

Exploitant: exploitants de petite échelle, principalement des hommes
Densité de la population: 50-100 personnes/km2
Croissance annuelle de la population: 2% - 3%
Propriété foncière: état, commune / village
Droits d'utilisation: individuel (les terres agricoles ne se vendent pas alors que l'eau est librement accessible à tous)
Droits d'utilisation de l'eau: individuel (les terres agricoles ne se vendent pas alors que l'eau est librement accessible à tous)
Niveau relatif de richesse des exploitants: moyens, que représente 50% des exploitants;

Importance des revenus non agricoles: moins de 10% de tout le revenu: transferts reçus, l'artisanat, le commerce...
Accès aux services et infrastructures: faible: santé, éducation, assistance technique, emploi (hors exploitation), commerce, énergie, routes et transports, eau potable et services sanitaires
Economie générale:

Activités de mise en oeuvre, intrants et coûts

Activités de mise en place

-
- Trouaison
- Trouaison

Intrants de mise en place et coûts par ha

Intrants	Coûts (US$)	% couvert par l'exploitant
Main d'oeuvre	120.00	%
Equipement		
- outils	96.80	%
Intrants agricoles		
- engrais	100.00	%
TOTAL	**316.80**	**100.00%**

Activités de maintenance /récurrentes

- Surveillance des plants

Remarques:
Le coût de la main d'œuvre, de l'équipement nécessaire ainsi que le coût de la fumure constituent les principaux déterminants des coûts de mise en œuvre de cette technologie.

Evaluation

Impacts de la Technologie

Bénéfices de production et socio-économiques

+++ augmentation de la production de fourrage
+++ augmentation de la qualité du fourrage
+++ augmentation de la production de bois
++ augmentation de la production animale
++ diversification des sources de revenus
++ augmentation de la diversification des produits

Inconvénients au niveau de la production et au niveau socio-économique

+++ perte de terres
++ augmentation de la demande en eau d'irrigation
++ augmentation des dépenses pour les intrants agricoles
++ baisse des revenus agricoles
++ augmentation des contraintes de main d'oeuvre
++ réduction de la diversification de production
\+ réduction de la production agricole
\+ opérations agricoles entravées

Bénéfices socio-culturels

++ amélioration des connaissances en conservation / érosion
++ amélioration de la santé

Inconvénients socioculturels

++ conflits socio-culturels

Bénéfices écologiques

+++ réduction du ruissellement de surface
+++ amélioration de la couverture du sol
+++ augmentation de la biomasse au-dessus du sol C
+++ augmentation de la diversité végétale
++ amélioration de la récupération / collecte des eaux de ruissellement
++ augmentation de l'humidité du sol
++ réduction de la vitesse du vent
++ augmentation en nutriments recyclés / recharge du sol
++ augmentation de la matière organique du sol / au-dessous du sol C
++ réduction des émissions de carbone et des gaz à effet de serre
++ réduction de la compaction du sol
++ augmentation de la diversité animale
++ augmentation des espèces bénéfiques
++ augmentation / maintien de la diversité des habitats
\+ réduction de l'évaporation
\+ réduction de la perte en sol

Inconvénients écologiques

Bénéfices hors-site

\+ réduction des sédiments transportés

Inconvénients hors-site

Contribution au bien-être humain / moyens d'existence

\+ Car l'accroissement de la production d'arbres engendre un accroissement de revenu forestier permettant d'accéder à ces services sociaux de base. Cela contribue à combler les déficits

Bénéfices / coûts du point de vue de l'exploitant

Bénéfices comparés aux coûts	à court terme:	à long terme:
Mise en place	très positifs	très positifs
Maintenance / récurrente	très positifs	très positifs

Car les exploitants investissent toujours lorsque le résultat est positif

Acceptation / adoption:

Il y a oui, peu tendance (en augmentation) vers une adoption spontanée de la technologie. actuellement, environ 5 nouveaux exploitants sont entrain d'expérimenter la technologie

Conclusions

Points forts et → comment les maintenir / renforcer	Points faibles et → comment les surmonter
Augmentation des espèces végétales → bonne gestion et entretien (taillé, coupé, etc.)	Utilisation plus importante de la main d'œuvre → par la mécanisation
Augmentation des rendements en bois → bonne gestion et entretien (taillé, coupé, etc.)	Insuffisance de moyens financiers → Subvention et meilleure organisation
augmentation des revenus forestiers → bonne gestion et entretien (taillé, coupé, etc.)	Divagation des animaux → Construction des lieux de pâture
augmentation de la diversité végétale → subvention et crédits en moyen matériels	problèmes fonciers → sécurisation foncière
disponibilité accrue en bois → subvention et crédits en moyen matériels	Utilisation plus importante de la main d'œuvre → par la mécanisation
Possibilité d'accroître l'offre de soins traditionnels → subvention et crédits en moyen matériels	Insuffisance de moyens financiers → Subvention et meilleure organisation
Accroissement de source de bois de feu → subvention et crédits en moyen matériels	Divagation des animaux → Construction des lieux de pâture
	problèmes fonciers → sécurisation foncière

Tapis herbacé

Burkina Faso - Tapis herbacé

Le tapis herbacé est une technique de récupération des terres dégradées à des fins d'élevage. Il s'agit d'une technologie à l'échelle du terroir dont la réalisation nécessite une organisation en groupement.

C'est une technique qui consiste en un sous-solage suivi d'un scarifiage et un ensemencement d'espèces fourragères collectées. elle se pratique sur des sols impropres à l'agriculture (sols dénudés). la mise en défens se fait au moins durant deux campagnes. La pente du terrain ne doit pas être supérieure à 1 %, avec un sol de préférence limoneuse ou gravillonnaire.
Réhabilitation du terroir à des fins d'élevage. Après cinq années de fonctionnement, la parcelle peut être exploitée au profit de la production agricole.
Construction : La mise en place de la technologie exige un sous-solage. Il s'agit, par le biais d'un tracteur ou d'un bulldozer de casser la couche superficielle d'un sol colmaté afin d'améliorer sa capacité d'infiltration. Par la suite, un scarifiage est réalisé (par tracteur). Les semences d'espèces fourragères préalablement collectées (appétées par les animaux) y sont semées. En plus, il faut un mise en défend par une clôture en grillage. Entretien : Il s'agit de surveiller la clôture vis-à-vis des voleurs ainsi que de la divagation des animaux. Intrant : Les intrants sont d'abord les semences des espèces fourragères (herbacé ou ligneuse), la main d'œuvre, les machines nécessaires au cassage de la terre.
Il y a une forte exigence en main-d'oeuvre, pour la collecte des espèces adaptées et pour les travaux de protection et de gardiennage. Il faut également s'accorder sur le droit de propriété de la parcelle recevant la technologie.

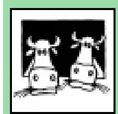
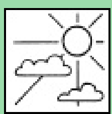
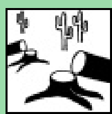
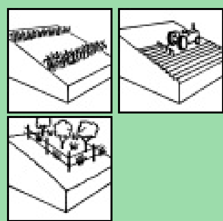
gauche: tapis herbacé (Photo: Hamado SAWADOGO)
droite: Tapis herbacé (Photo: Hamado SAWADOGO)

Lieu: Burkina Faso / Zondoma
Région: Nord / Yatenga
Superficie de la Technologie: 10 km^2
Pratique de conservation: agronomique, biologique, gestion
Stade de mise en oeuvre: prévention de la dégradation des terres
Origine: Développé à l'initiative des exploitants agricoles, traditionnel (>50 ans)
Type d'utilisation du sol: Pâturages: Pâturage intensif / production fourragère
Utilisation du sol: Pâturage: Pâturage intensif / production fourragère (avant), Pâturage: Pâturage intensif / production fourragère (après)
Climat: semi-aride, tropical
Référence de la base de données WOCAT: T_BRK016fr
Approche associée:
Compilé par: SAWADOGO Hamado, INERA Institut de l'environnement et de recherches
Date: 26th Aug 2013
Personne de contact: Hamado SAWADOGO, CNRST / INERA Ouagadougou hsawadogo@gmail.com

Classification

Problèmes d'Utilisation des terres:

- Erosion des sols (apparition des rigoles et des ravines), une baisse notable de la fertilité des terres (Zippela) et une disparition de la végétation. Ruissellements intenses lors de fortes pluies Absence d'herbes (fourrages) pour les animaux. Baisse des rendements des cultures (point de vue de l'expert)
Baisse des rendements des cultures, insuffisance de fourrages. Érosion des sols (apparition des rigoles et des ravines), manque de terres de bonnes qualité. (point de vue de l'exploitant)

Utilisation du sol	Climat	Dégradation	Pratique de conservation
			
Pâturage intensif / production fourragère Pâturage: Pâturage intensif / production fourragère (avant) Pâturage: Pâturage intensif / production fourragère (après) cultures pluviales pâturage extensif	semi-aride	Dégradation biologique: baisse de la quantité / biomasse	agronomique: Couverture du sol par la végétation biologique: Herbes et plantes herbacées pérennes gestion: changement du type d'utilisation des terres

Stade de mise en oeuvre

- ■ Prévention
- ▒ Atténuation/ Réduction
- ▒ Réhabilitation

Origine

- ■ Initiatives des exploitants: traditionnel (>50 ans)
- ▒ Expériences / Recherche: 10-50 ans
- □ Introduit extérieurement

Niveau de connaissances techniques

- ■ Conseiller agricole
- □ Exploitant

Principales causes de la dégradation des terres:
Causes directes - Provoquées par l'homme: soil management, déforestation / disparition de la végétation naturelle (inclus les feux de forêts), surpâturage
Causes directes - Naturelles: changement des précipitations saisonnières, sécheresses
Causes indirectes: pression de la population, régime foncier

Principales fonctions techniques:
- contrôle du ruissellement en nappe: ralentissement / retardement
- contrôle du ruissellement en ravines: ralentissement/retardement
- amélioration de la couverture du sol
- augmentation de la rugosité de surface
- stabilisation du sol (par ex. par des racines d'arbres contre les glissements de terrain)
- augmentation de la matière organique
- rétention / capture des sédiments, recueil des sédiments
- augmentation de la biomasse (quantité)
- développement des espèces végétales et de la variété (qualité, ex: fourrage appétent)

Fonctions techniques secondaires:
- contrôle du ruissellement en ravines: rétention/capture
- contrôle du ruissellement en ravines: rétention/capture
- amélioration de la structure du sol en surface (encroûtement, battance du sol)
- amélioration de la structure de la couche arable du sol (tassement, compaction)
- augmentation de la disponibilité des nutriments (réserve, recyclage, ...)
- augmentation de l'infiltration
- augmentation / maintien de la rétention d'eau dans le sol

Environnement

Environnement naturel

Précipitations moyennes annuelles (mm)

- □ > 4000 mm
- □ 3000-4000 mm
- □ 2000-3000 mm
- □ 1500-2000 mm
- □ 1000-1500 mm
- □ 750-1000 mm
- ■ 500-750 mm
- □ 250-500 mm
- □ < 250 mm

Altitude (m)

- □ > 4000
- □ 3000-4000
- □ 2500-3000
- □ 2000-2500
- □ 1500-2000
- □ 1000-1500
- □ 500-1000
- ■ 100-500
- □ <100

Topographie

- □ plateaux / plaines
- □ crêtes
- □ flancs de montagne
- □ flancs de colline
- ■ piémonts/glacis (bas de pente)
- □ fonds de vallée/bas-fond/cuvette

Pente (%)

- ■ plat
- □ faible
- □ moyen
- □ onduleux
- □ vallonné
- □ raide
- □ très raide

Profondeur du sol (cm)

- □ 0-20
- ■ 20-50
- □ 50-80
- □ 80-120
- □ >120

Saison(s) de culture: 150 days (juin à octobre)
Texture du sol: moyen (terreaux)
Fertilité du sol: très pauvre
Matière organique dans la couche arable: faible (<1%)
Drainage du sol / infiltration: mauvais (ex. battance du sol)

Capacité de rétention d'eau du sol: très pauvre
Profondeur estimée de l'eau dans le sol: < 5 m
Disponibilité de l'eau de surface: pauvre / absente
Qualité de l'eau: eau pour l'agriculture seulement
Biodiversité: moyenne

Tolérante aux conditions climatiques extrêmes: tempêtes de vent / de poussière
Sensible aux conditions climatiques extrêmes: Augmentation de la température, Augmentation des précipitations saisonnières, Diminution des précipitations saisonnières, Évènement de fortes précipitations (intensité et quantité), inondations, Sécheresses / périodes de sécheresse

Environnement humain

Pâturages par ménage (ha)

- □ <0.5
- □ 0.5-1
- □ 1-2
- □ 2-5
- □ 5-15
- ■ 15-50
- □ 50-100
- □ 100-500
- □ 500-1,000
- □ 1,000-10,000
- □ >10,000

Exploitant: groupe / communauté
Densité de la population: 50-100 personnes/km2
Croissance annuelle de la population: 2% - 3%
Propriété foncière: état, commune / village
Droits d'utilisation: individuel (les terres agricoles ne se vendent pas alors que l'eau est librement accessible à tous)
Droits d'utilisation de l'eau: (les terres agricoles ne se vendent pas alors que l'eau est librement accessible à tous)
Niveau relatif de richesse des exploitants: moyens, que représente 50% des exploitants;

Importance des revenus non agricoles: moins de 10% de tout le revenu: transferts reçus, l'artisanat, le commerce...
Accès aux services et infrastructures: faible: santé, éducation, assistance technique, emploi (hors exploitation), commerce, énergie, routes et transports, eau potable et services sanitaires, services financiers
Economie générale:
Densité du cheptel: 50-100 LU /km2

Activités de mise en oeuvre, intrants et coûts

Activités de mise en place

- Clôture au grillage
- Entretien
- Main-d'oeuvre de la collecte des graines par ha
- Main-d'oeuvre du sous-solge par ha
- Semences
- Semis en groupement par ha

Activités de maintenance /récurrentes

- Surveillance des haies vis-à-vis des animaux

Remarques:
Le coût des machines (Bulldozer et tracteur) sont essentiellement les composantes les plus importantes des coûts d'adoption de tapis herbacé. Le coût de la main d'œuvre est aussi un facteur important de la constitution des coûts d'adoption de la technologie

Evaluation

Impacts de la Technologie

Bénéfices de production et socio-économiques	Inconvénients au niveau de la production et au niveau socio-économique
+++ augmentation de la production de fourrage	
+++ augmentation de la qualité du fourrage	
++ augmentation du rendement des cultures	
++ augmentation de la production animale	
++ réduction des risques de perte de production	
++ augmentation de la zone de production	
++ augmentation de la diversification des produits	
+ augmentation des revenus agricoles	
+ diversification des sources de revenus	
+ opérations agricoles facilitées	

Bénéfices socio-culturels	Inconvénients socioculturels
++ renforcement des institutions communautaires	
++ amélioration de la sécurité alimentaire et de l'autosuffisance	
+ renforcement des institutions nationales	
+ réduction des conflits	
+ amélioration des connaissances en conservation / érosion	
+ amélioration de la santé	

Bénéfices écologiques	Inconvénients écologiques
+++ amélioration de la couverture du sol	
+++ augmentation de la biomasse au-dessus du sol C	
+++ augmentation de la diversité animale	
++ augmentation de l'humidité du sol	
++ réduction du ruissellement de surface	
++ augmentation en nutriments recyclés / recharge du sol	
++ augmentation de la matière organique du sol / au-dessous du sol C	
++ réduction de la perte en sol	
++ réduction de la compaction du sol	
+ augmentation de la quantité d'eau	
+ baisse du risque vis-à-vis d'événements défavorables	
+ réduction de la croûte du sol (battance)	
+ réduction de la salinité	
+ augmentation des espèces bénéfiques	
+ augmentation / maintien de la diversité des habitats	

Bénéfices hors-site	Inconvénients hors-site
++ augmentation de la disponibilité de l'eau	
++ réduction des sédiments transportés	
+ réduction des dommages sur les champs voisins	

Contribution au bien-être humain / moyens d'existence

++ Car elle contribue à l'accroissement des aliments de bétail, elle est favorable à une plus grande production animale. Ce qui est source de revenu supplémentaire pour les ménages

Bénéfices / coûts du point de vue de l'exploitant

Bénéfices comparés aux coûts	à court terme:	à long terme:
Mise en place	très positifs	très positifs
Maintenance / récurrente	très positifs	très positifs

Car les exploitants investissent toujours lorsque le résultat est positif

Acceptation / adoption:

Il y a non tendance (en augmentation) vers une adoption spontanée de la technologie.

Conclusions

Points forts et → comment les maintenir / renforcer	Points faibles et → comment les surmonter
Augmentation de la disponibilité en fourrage → bonne organisation et bon entretien périodique	Utilisation in intense de machines et main d'œuvre → Subvention ou crédits pour l'accès aux machines
augmentation des revenus pastoraux → bonne organisation et bon entretien périodique	Insuffisance de moyens financiers → Subvention ou crédits et meilleure organisation
sécurisation alimentaire → bonne organisation et bon entretien périodique	Coût de mise en œuvre non accessible individuellement → Subvention ou crédits et meilleure organisation
augmentation des rendements pastoraux → subvention des travauxou crédits et bonne gestion	Insuffisance de moyens financiers → Subvention ou crédits
Couverture de besoins alimentaires → subvention des travauxou crédits et bonne gestion	
augmentation des résultats → subvention des travauxou crédits et bonne gestion	
couverture des besoins sociaux de base → subvention des travauxou crédits et bonne gestion	

left: A compacted soil bund constructed following a contour using a soil excavated from deep trenches on the upslope side in grazing land. (Photo: Eyasu Yazew)
right: A compacted soil bund constructed following a contour using a soil excavated from deep trenches on the upslope side in cultivated land. (Photo: Eyasu Yazew)

Soil faced deep trench bunds

Ethiopia - Nay Hamed Amik Metrebwi Zala

Compacted soil bund constructed following a contour using a soil excavated from deep trenches on the up-slope side.

Excavation of trenches 1 m deep, 0.5 - 1 m wide and 2 - 3.5 m long with spacing between trenches of 0.3 - 0.5 m along the contour and using the excavated soil to construct a compacted bund downslope. The smaller dimensions are usually used in cultivated lands while the larger are implemented in grazing lands. Soil faced deep trench bund has a length of 60 - 100 m, with a base width of 0.75 - 1 m and top width of 0.3 m. The height of the bund is 1 - 1.2 m.
Decrease slope length, decrease runoff velocity, increase runoff harvesting and soil moisture, decrease soil erosion, increase groundwater recharge and increase productivity per unit area.
Alignment of a contour, excavation of trenches, construction and compaction of bund, planting grass, dredging of sediment from the trenches and use it for maintenance of embankment. Line level, tape meter, digging hoe, shovel and grass are needed for the establishment and maintenance.
The technology is implemented in moderate (5 - 8%) and hill (8 - 16%) slopes and in medium and heavy soil types of at least 1 m depth. It reduces runoff amount and velocity thereby decreasing soil loss and desertification/land degradation. It also improves soil moisture availability and groundwater recharge. It is mostly constructed using communal labour and there is an encouraging trend of spontaneous adoption. The technology is witnessed to be increasing crop and fodder production thereby improving the livelihood of the land users. It, however, is labour intensive and slightly reduces farm size.

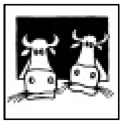
Location: Tigray
Region: Kilte Awlaelo
Technology area: 10 - 100 km2
Conservation measure: structural
Stage of intervention: mitigation / reduction of land degradation
Origin: Developed externally / introduced through project,
Land use type:
Cropland: Annual cropping
Grazing land: Intensive grazing/ fodder production
Climate: semi-arid, subtropics
WOCAT database reference: T_ETH605en
Related approach: Food for work (ETH44), Mass mobilization (ETH46)
Compiled by: Eyasu Yazew, Mekelle University
Date: 10th Nov 2012
Contact person: Eyasu Yazew, Mekelle University, P.O.Box 231, Mekelle, Ethiopia Tel: +251 910 170415 Fax: +251 344 409304 Email: eyasuet@yahoo.com

Classification

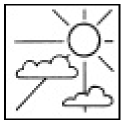
Land use problems:

- Soil erosion, overgrazing, decline of soil fertility and productivity. (expert's point of view)
- Soil erosion, reduced soil depth, fertility and productivity. (land user's point of view)

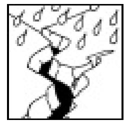
Land use	Climate	Degradation	Conservation measure

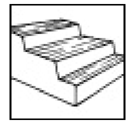
Annual cropping
Intensive grazing/ fodder production
rainfed
intensive grazing land
rainfed



semi-arid



Soil erosion by water: loss of topsoil / surface erosion



structural: Bunds / banks

Stage of intervention

Prevention
Mitigation / Reduction
Rehabilitation

Origin

Land users initiative
Experiments / Research
Externally introduced

Level of technical knowledge

Agricultural advisor
Land user

Main causes of land degradation:
Direct causes - Human induced: soil management, overgrazing
Direct causes - Natural: Heavy / extreme rainfall (intensity/amounts)
Indirect causes: population pressure

Main technical functions:
- control of dispersed runoff: retain / trap
- reduction of slope length

Secondary technical functions:
- increase of infiltration
- increase / maintain water stored in soil
- sediment retention / trapping, sediment harvesting

Environment

Natural Environment

Average annual rainfall (mm)

> 4000 mm
3000-4000 mm
2000-3000 mm
1500-2000 mm
1000-1500 mm
750-1000 mm
500-750 mm
250-500 mm
< 250 mm

Altitude (m a.s.l.)

> 4000
3000-4000
2500-3000
2000-2500
1500-2000
1000-1500
500-1000
100-500
<100

Landform

plateau / plains
ridges
mountain slopes
hill slopes
footslopes
valley floors

Slope (%)

flat
gentle
moderate
rolling
hilly
steep
very steep

Soil depth (cm)

0-20
20-50
50-80
80-120
>120

Growing season(s): 150 days (June - November)
Soil texture: medium (loam)
Soil fertility: low
Topsoil organic matter: low (<1%)
Soil drainage/infiltration: medium

Soil water storage capacity: medium
Ground water table: 5 - 50 m
Availability of surface water: poor / none
Water quality:
Biodiversity: low

Human Environment

Cropland per household (ha)

<0.5
0.5-1
1-2
2-5
5-15
15-50
50-100

Land user: groups / community, Small scale land users, common / average land users, men and women
Population density: 100-200 persons/km2
Annual population growth: 2% - 3%
Land ownership: state
Land use rights: individual ()
Water use rights: ()
Relative level of wealth: average, which represents 60% of the land users; 55% of the total area is owned by average land

Importance of off-farm income: less than 10% of all income: Every land user has implemented one or another type of conservation measures. As a result, there is no major variation in off-farm income.
Access to service and infrastructure: low: employment (eg off-farm), energy; moderate: health, market, roads & transport, drinking water and sanitation, financial services, Mobile communication; high: education, technical assistance

	100-500	users
	500-1,000	
	1,000-10,000	
	>10,000	

Market orientation: subsistence (self-supply)

Implementation activities, inputs and costs

Establishment activities

- Purchase of elephant grass
- Grass plantation
- Contour alignment, marking trench dimensions, trench excavation and construction and compaction of bund

Establishment inputs and costs per ha

Inputs	Costs (US$)	% met by land user
Labour	2118.50	60%
Equipment		
- tools	44.40	0%
Agricultural		
- seedlings	35.50	0%
TOTAL	**2198.40**	**59.00%**

Maintenance/recurrent activities

- Dredging of deposited sediment from trenches and compacting it on the bund

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US$)	% met by land user
Labour	833.30	100%
TOTAL	**833.30**	**100.00%**

Remarks:
Labour, slope, landuse, soil depth.
The cost was calculated for an average bund length and spacing of 80 m and 12.5 m respectively, which would result in a construction of 10 bunds per ha. In addition, an average trench length and spacing between trenches along the contour of 2.75 m and 0.4 m was considered respectively resulting in 25 trenches per bund and 250 trenches per ha. The excavation of one deep trench and construction of the corresponding bund requires 3 person days during establishment while maintaing it needs 1.5 person days. A single row grass is planted on the bunds at 0.5 m interval and a person is assumed to plant about 100 seedlings per day. The cost calculation rates apply to 2012. Accordingly, the price of single elephant grass is 0.4 Birr and the daily labour wage is 40 Birr for light and 50 Birr for medium.

Assessment

Impacts of the Technology

Production and socio-economic benefits

- ++ increased crop yield
- ++ increased fodder production
- ++ increased fodder quality
- ++ increased animal production
- ++ increased farm income

Production and socio-economic disadvantages

- ++ increased labour constraints

Socio-cultural benefits

- +++ improved conservation / erosion knowledge
- ++ community institution strengthening
- ++ improved situation of disadvantaged groups
- ++ improved food security / self sufficiency
- ++ improved health

Socio-cultural disadvantages

Ecological benefits

- +++ reduced surface runoff
- +++ reduced soil loss
- ++ improved harvesting / collection of water
- ++ increased soil moisture

Ecological disadvantages

++ improved soil cover
+ recharge of groundwater table / aquifer

Off-site benefits	Off-site disadvantages
++ reduced downstream flooding	
++ reduced downstream siltation	
+ reduced damage on neighbours fields	

Contribution to human well-being / livelihoods

++

Benefits /costs according to land user

Benefits compared with costs	short-term:	long-term:
Establishment	positive	positive
Maintenance / recurrent	positive	very positive

Acceptance / adoption:

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Reduced runoff amount and velocity and soil erosion → Continuous maintenance of the structures and controlled grazing of the grass	Labour intensive → Mass mobilization and improving the design.
Increase in rainwater harvesting, soil moisture and productivity →	Reduced farm land → Increasing the spacing and reduce dimension of bunds without compromising their effectiveness.
Increase in infiltration and groundwater recharge →	Reduced farm land → Increase the productivity of the bunds.
Increase in fodder production →	Increased labour requirement → Mass mobilization and/or increased incentives to households.
Decrease slope length →	
Reduce soil erosion and increase soil fertility → Continuous maintenance and excavation of sediment	
Increase soil moisture and yield → Planting grass, sunflower and other fodder plants on the bund to increase conservation as well as economic benefits.	
Reduce surface runoff, increase water storage in trenches and recharging downstream springs →	

WOCAT


left: These are constructed from stone embankments built in the shape of a semi circle with the tips of the bund on the contour and are arranged in staggered orientation in rows so that overflow from one row will run into the next downslope. (Photo: Eyasu Yazew)
right: hese are constructed from stone embankments built in the shape of a semi circle with the tips of the bund on the contour and are arranged in staggered orientation in rows so that overflow from one row will run into the next downslope. (Photo: Eyasu Yazew)

Large semi circular stone bunds

Ethiopia - Abiy nay emni firki werhi

These are constructed from stone embankments built in the shape of a semi circle with the tips of the bund on the contour and are arranged in staggered orientation in rows so that overflow from one row will run into the next downslope.

Excavation of foundation of 0.1 - 0.2 m following the semi circle, construction of the embankment using stones with a decreasing height at their tips to evacuate excess runoff, excavation of 1 - 3 planting pits along with a 1 m * 1 m * 1 m runoff harvesting ditch at the center. Large semi circular stone bunds (Large half moons) are constructed with a diameter of 6 m and corresponding perimeter/length of 9.42 m. The spacing between the tips of adjacent bunds within a row and between the base bund and tip of adjacent rows is 3 m. The height of the embankment varies from 0.5 - 0.75 m at the base bund to 0.4 - 0.5 m at the tip while the corresponding width varies from 0.4 - 0.5 m to 0.2 - 0.3 m. The planting pit has a diameter and depth of 0.3 m.
Decrease slope length, decrease runoff velocity, increase runoff harvesting and soil moisture, decrease soil erosion, increase groundwater recharge and increase productivity per unit area.
Collection of stones, alignment of a contour and the semi circle, excavation of foundation, construction of the embankment and digging of planting pits and runoff harvesting ditch, maintaining of the embankment and dredging sediment from runoff harvesting ditch during the dry season. Line level, tape meter, digging hoe, shovel and hammer are needed for the establishment and maintenance.
The technology is implemented in foot (5 - 8%) and hill (8 - 16%) slopes and in medium and light soil types of shallow to moderate depth (0.2 - 0.8 m). It reduces runoff amount and velocity thereby decreasing soil loss and desertification/land degradation. It also improves soil moisture availability and groundwater recharge. It is mostly constructed using communal labour and there is a moderate trend of spontaneous adoption. The technology is witnessed to be increasing fruit and fodder production thereby improving the livelihood of the land users. It, however, is demands high labour especially during establishment.

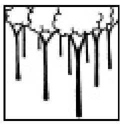
Location: Tigray
Region: Kilte Awlaelo
Technology area: 10 - 100 km2
Conservation measure: structural
Stage of intervention: mitigation / reduction of land degradation
Origin: Developed externally / introduced through project, recent (<10 years ago)
Land use type:
Cropland: Tree and shrub cropping
Forests / woodlands: Plantations, afforestations
Climate: semi-arid, subtropics
WOCAT database reference: T_ETH606en
Related approach: Food for work (ETH44), Mass mobilization (ETH46), Self help (ETH32)
Compiled by: Eyasu Yazew, Mekelle University
Date: 11th Nov 2012
Contact person: Eyasu Yazew, Mekelle University, P.O.Box 231, Mekelle, Ethiopia Tel: +251 910 170415 Fax: +251 344 409304 Email: eyasuet@yahoo.com

Classification

Land use problems:

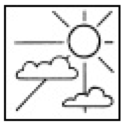
- Deforestation, soil erosion, overgrazing, decline of soil fertility and productivity. (expert's point of view)
- Decrease soil moisture, drought, soil erosion, decrease fodder production and shortage of fuel wood. (land user's point of view)

Land use

Tree and shrub cropping
Plantations, afforestations
rainfed
plantation forestry

Climate

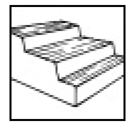


semi-arid

Degradation

Soil erosion by water: loss of topsoil / surface erosion

Conservation measure



structural: Bunds / banks

Stage of intervention

- Prevention
- Mitigation / Reduction
- Rehabilitation

Origin

- Land users initiative
- Experiments / Research
- Externally introduced: recent (<10 years ago)

Level of technical knowledge

- Agricultural advisor
- Land user

Main causes of land degradation:
Direct causes - Human induced: deforestation / removal of natural vegetation (incl. forest fires)
Direct causes - Natural: Heavy / extreme rainfall (intensity/amounts), other natural causes, Steep topography
Indirect causes: population pressure

Main technical functions:

- control of dispersed runoff: retain / trap
- reduction of slope length

Secondary technical functions:

- increase of infiltration
- increase / maintain water stored in soil
- sediment retention / trapping, sediment harvesting

Environment

Natural Environment

Average annual rainfall (mm)

- > 4000 mm
- 3000-4000 mm
- 2000-3000 mm
- 1500-2000 mm
- 1000-1500 mm
- 750-1000 mm
- 500-750 mm
- 250-500 mm
- < 250 mm

Altitude (m a.s.l.)

- > 4000
- 3000-4000
- 2500-3000
- 2000-2500
- 1500-2000
- 1000-1500
- 500-1000
- 100-500
- <100

Landform

- plateau / plains
- ridges
- mountain slopes
- hill slopes
- footslopes
- valley floors

Slope (%)

- flat
- gentle
- moderate
- rolling
- hilly
- steep
- very steep

Soil depth (cm)

- 0-20
- 20-50
- 50-80
- 80-120
- >120

Growing season(s): 150 days (June - November)
Soil texture: medium (loam)
Soil fertility: low
Topsoil organic matter: low (<1%)
Soil drainage/infiltration: poor (eg sealing /crusting)

Soil water storage capacity: medium
Ground water table: 5 - 50 m
Availability of surface water:
Water quality:
Biodiversity: low

Human Environment

Cropland per household (ha)

■	<0.5
□	0.5-1
□	1-2
□	2-5
□	5-15
□	15-50
□	50-100
□	100-500
□	500-1,000
□	1,000-10,000
□	>10,000

Land user: groups / community, Small scale land users, common / average land users, men and women
Population density: 100-200 persons/km2
Annual population growth: 2% - 3%
Land ownership: state
Land use rights: individual ()
Water use rights: ()
Relative level of wealth: average, which represents 60% of the land users; 55% of the total area is owned by average land users

Importance of off-farm income: less than 10% of all income: Every land user has implemented one or another type of conservation measures. As a result, there is no major variation in off-farm income.
Access to service and infrastructure: low: employment (eg off-farm), energy; moderate: health, market, roads & transport, drinking water and sanitation, financial services, Mobile communication; high: education, technical assistance
Market orientation: subsistence (self-supply)

Implementation activities, inputs and costs

Establishment activities

- Collection of stones, contour and semi circle alignment, excavation of foundation, construction of bunds and excavation of planting pits and water storage ditch.

Establishment inputs and costs per ha

Inputs	Costs (US$)	% met by land user
Labour	3666.60	60%
Equipment		
- tools	75.00	0%
TOTAL	**3741.60**	**60.00%**

Maintenance/recurrent activities

- Replacement of displaced stones and dredging of planting pits and storage ditch

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US$)	% met by land user
Labour	117.30	100%
TOTAL	**117.30**	**100.00%**

Remarks:
Labour, slope, stone availability and size.
The cost was calculated for a semi circular bund of 6 m diameter, spacing between the tips of adjacent bunds within a row of 3 m and spacing between a base bund of one row and the tip of the next row of 3 m. This arrangement results in a construction of 2.5 bunds over 94.5 square meter area and a total of 264 bunds per ha. The construction of one large semi circular stone bund and excavation of the planting pits and runoff harvesting ditch requires 5 person days during establishment while maintaining it needs 0.2 person days.The cost calculation rates apply to 2012. Accordingly, the daily labour wage is 40 Birr for light and 50 Birr for medium.

Assessment

Impacts of the Technology

Production and socio-economic benefits

- ++ increased crop yield
- ++ increased fodder production
- ++ increased animal production
- ++ increased farm income
- ++ diversification of income sources

Production and socio-economic disadvantages

- \+ increased labour constraints

Socio-cultural benefits

- +++ improved conservation / erosion knowledge
- ++ community institution strengthening
- ++ improved situation of disadvantaged groups
- ++ improved food security / self sufficiency
- ++ improved health

Socio-cultural disadvantages

Ecological benefits		Ecological disadvantages
+++	improved soil cover	
+++	reduced soil loss	
++	improved harvesting / collection of water	
++	increased soil moisture	
++	reduced surface runoff	
++	increased plant diversity	
+	recharge of groundwater table / aquifer	

Off-site benefits		Off-site disadvantages
++	reduced downstream flooding	
++	reduced downstream siltation	
+	increased water availability	
+	increased stream flow in dry season	

Contribution to human well-being / livelihoods

++

Benefits /costs according to land user

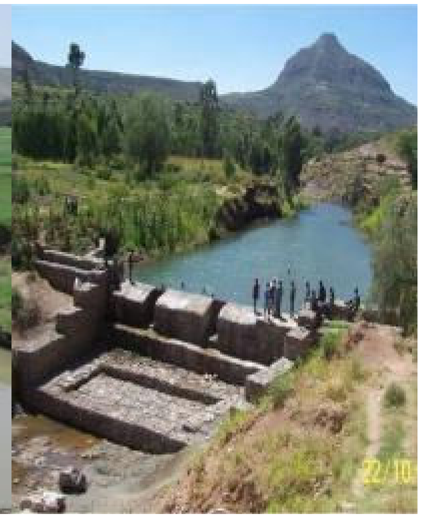
Benefits compared with costs	short-term:	long-term:
Establishment	positive	very positive
Maintenance / recurrent	very positive	very positive

Acceptance / adoption:

70% of land user families (1880 families; 60% of area) have implemented the technology with external material support.
30% of land user families (940 families; 40% of area) have implemented the technology voluntary.
There is moderate trend towards (growing) spontaneous adoption of the technology.

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Reduced runoff amount and velocity and soil erosion → Maintenance of bunds and runoff harvesting ditch.	Poor design approach (the same diameter and spacing for different slope ranges) → Improve the design approach.
Increase in rainwater harvesting, soil moisture and groundwater recharge →	Increased labour demand → Mass mobilization and improving the design.
Increase in fruit and fodder production →	Reduced farm land → Increasing the spacing and reducing the dimension of bunds without compromising their effectiveness.
Decrease slope length →	Damage to structures constructed at foot slopes if the hillside is not well conserved → Conserve the upper catchment first.
Reduced maintenance requirement →	Increase labour requirement → Mass mobilization and/or increased incentives to households. Reducing the size4 of the structure.
Increased vegetation coverage and fruit and fodder production → Continuous maintenance of the structure.	
Reduce soil erosion and increase soil moisture →	
Increase spring discharges downstream →	



left: It is a raised wall constructed using stone, concrete and gabion across a gully for dual purpose, namely, to pond/store the stream flow behind it for irrigation purpose while at the same time reducing the runoff velocity and enhancing gully rehabilitati (Photo: Eyasu Yazew)
right: It is a raised wall constructed using stone, concrete and gabion across a gully for dual purpose, namely, to pond/store the stream flow behind it for irrigation purpose while at the same time reducing the runoff velocity and enhancing gully rehabilitati (Photo: Eyasu Yazew)

Check dam ponds
Ethiopia - May me'ekori ketri

It is a raised wall constructed using stone, concrete and gabion across a gully for dual purpose, namely, to pond/store the stream flow behind it for irrigation purpose while at the same time reducing the runoff velocity and enhancing gully rehabilitation.

A check dam pond is a raised wall constructed across a gully from stone, concrete and gabion to store water behind it for irrigation purpose using either gravity or lifting mechanism. The structure generally consists of construction of foundation, apron, retaining wall and the checkdam. The width of the checkdam ranges between 1 - 2 m while the height varies between 1 - 2 m depending up on the gully depth. The length of the checkdam depends on the gully width while the spacing between adjacent checkdams is determined based on the availability of water and a potential land that can be irrigated. It is also provided with a number of sluice gates which will be removed during the main rainy season to minimize siltation.
Decrease slope length and slope angle, decrease runoff velocity, decrease soil erosion, pond water for irrigation and increase productivity per unit area.
Establishment of a check dam pond starts with collection and transportation of stone and sand. The construction is started by setting out the dimensions from the design on the selected site and excavating the foundation for the different parts, namely, key trench, apron and retaining wall. The check dam is then constructed using gabions filled with stones and tightly tied together with wire. Finally the superstructure is plastered using mortar to prevent the passage of water through the body. Gates of about 1 m wide are finally constructed at about 1 m interval and fitted with sluice gates. Maintenance usually involves fixing damaged gates and reinforcing gabions. The inputs include industrial materials (cement, gabion, angle iron and sheet metal), local materials (stone and sand) and construction equipments (digging hoe, shovel, hammer, bucket, crow bar, spirit level, tape meter).

Location: Tigray
Region: Kilite Awlaelo
Technology area: 1 - 10 km2
Conservation measure: structural
Stage of intervention: mitigation / reduction of land degradation
Origin: Developed externally / introduced through project, recent (<10 years ago)
Land use type:
Cropland: Annual cropping
Climate: semi-arid, subtropics
WOCAT database reference: T_ETH607en
Related approach: Food for work (ETH44), Mass mobilization (ETH46)
Compiled by: Eyasu Yazew, Mekelle University
Date: 11th Nov 2012
Contact person: Eyasu Yazew, Mekelle University, P.O.Box 231, Mekelle, Ethiopia Tel: +251 910 170415 Fax: +251 344 409304 Email: eyasuet@yahoo.com

The technology is implemented in gentle (2 - 5%) and moderate (5 - 8%) slopes and in medium and light soil types of at least 1 m depth. It increases water availability for irrigation and livestock consumption purposes. It also reduces runoff velocity thereby decreasing soil erosion and enhancing gully rehabilitation. It requires skilled labour and large construction cost. As a result, it is constructed through external support and spontaneous adoption is very little. However, the number of communities seeking for external support and willing to contribute their share is at the rise. The technology minimizes greatly the risk of crop failure and improves the livelihood of the land users.

Classification

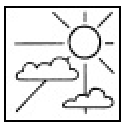
Land use problems:

- Deforestation and overgrazing, high erosion risk, gully formation and land loss, decline in productivity. (expert's point of view)
- Population pressure, deforestation, flood, soil erosion, reduced productivity. (land user's point of view)

Land use

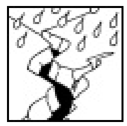
Annual cropping

Climate



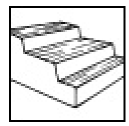
semi-arid

Degradation



Soil erosion by water: gully erosion / gullying

Conservation measure



structural: Walls / barriers / palisades

Stage of intervention

Prevention
Mitigation / Reduction
Rehabilitation

Origin

Land users initiative
Experiments / Research
Externally introduced: recent (<10 years ago)

Level of technical knowledge

Agricultural advisor
Land user
Engineer/designer

Main causes of land degradation:
Direct causes - Human induced: deforestation / removal of natural vegetation (incl. forest fires)
Direct causes - Natural: Heavy / extreme rainfall (intensity/amounts), other natural causes, Steep topography
Indirect causes: population pressure

Main technical functions:
- control of dispersed runoff: impede / retard
- reduction of slope length

Secondary technical functions:
- reduction of slope angle
- sediment retention / trapping, sediment harvesting

Environment

Natural Environment

Average annual rainfall (mm)

> 4000 mm
3000-4000 mm
2000-3000 mm
1500-2000 mm
1000-1500 mm
750-1000 mm
500-750 mm
250-500 mm
< 250 mm

Altitude (m a.s.l.)

> 4000
3000-4000
2500-3000
2000-2500
1500-2000
1000-1500
500-1000
100-500
<100

Landform

plateau / plains
ridges
mountain slopes
hill slopes
footslopes
valley floors

Slope (%)

flat
gentle
moderate
rolling
hilly
steep
very steep

Soil depth (cm)

0-20
20-50

Growing season(s): 150 days (June - November)
Soil texture: medium (loam)
Soil fertility: low
Topsoil organic matter: low (<1%)

Soil water storage capacity: medium
Ground water table: 5 - 50 m
Availability of surface water: good
Water quality: for agricultural use only
Biodiversity: low

50-80
80-120
>120

Soil drainage/infiltration: medium

Sensitive to climatic extremes: floods

Human Environment

Cropland per household (ha)

<0.5
0.5-1
1-2
2-5
5-15
15-50
50-100
100-500
500-1,000
1,000-10,000
>10,000

Land user: groups / community, Small scale land users, common / average land users, men and women
Population density: 100-200 persons/km2
Annual population growth: 2% - 3%
Land ownership: state
Land use rights: individual ()
Water use rights: communal (organised) ()
Relative level of wealth: average, which represents 60% of the land users; 55% of the total area is owned by average land users

Importance of off-farm income: less than 10% of all income: Every land user has implemented one or another type of conservation measures. As a result, there is no major variation in off-farm income.
Access to service and infrastructure: low: employment (eg off-farm), energy; moderate: health, market, roads & transport, drinking water and sanitation, financial services, Mobile communication; high: education, technical assistance
Market orientation: subsistence (self-supply)
Mechanization: manual labour, animal traction
Livestock grazing on cropland: no

Implementation activities, inputs and costs

Establishment activities

- Site clearance and excavation of foundation
- Stone collection and transportation
- Sand collection and transportation
- Gabion masonry work
- Plastering

Establishment inputs and costs per unit

Inputs	Costs (US$)	% met by land user
Labour	4678.20	25%
Construction material		
- Cement	953.30	0%
- Gabion	6268.00	0%
- Sheet metal		0%
- Angle iron	55.50	0%
TOTAL	**11999.40**	**10.00%**

Maintenance/recurrent activities

Remarks:
Labour, availability of construction material, depth and width of gully.
Since the check dam ponds generally vary in depth, width and most importantly in length depending up on the gully profile, calculation of cost per meter length will not be a reliable presentation. As a result, one typical check dam pond was selected and the total volume of the structure and the corresponding total cost of construction calculated. Then, the cost per cubic meter of the check dam was determined by dividing the total construction cost to the total volume of the structure. The major features and inputs of the selected representative check dam pond were as follows: 1. Site clearance and excavation of foundation: the total volume of excavation was 141.4 cubic meter and one person (Medium) excavates 0.5 cubic meter per day which results in a total of 283 person days; 2. Stone collection and transportation: the total volume used was 201 cubic meter and one person (Medium) collects 0.5 cubic meter per day which results in a total of 402 person days; 3. Sand collection and transportation: the total volume used was 13.32 cubic meter and one person (Medium) collects 0.5 cubic meter per day which results in a total of 26 person days; 4. Gabion masonry work: the total volume constructed was 201 cubic meter and one person (Medium) constructs 0.25 cubic meter per day which results in a total of 804 person days. In addition, industrial materials, namely, cement, gabion, sheet metal and angle iron are used as inputs; 5. Plastering: the total area plastered was 188 square meter and one person (Heavy) plasters 4 square meter per day which results in a total of 47 person days; 6. The constructed check dam has a total volume of 361.2 cubic meter. The price of the industrial materials and the labour wage used in the cost calculation apply to 2012. The daily labour wage for plastering is 180 Birr while it is 50 Birr for all other works. Finally, the total cost of construction of the check dam was 215994 Birr which is equivalent to 598 Birr per cubic meter of structure (33.2 US$ per cubic meter).

Assessment

Impacts of the Technology

Production and socio-economic benefits		Production and socio-economic disadvantages	
+++	increased crop yield	+	increased expenses on agricultural inputs
++	reduced risk of production failure	+	increased labour constraints
++	increased irrigation water availability quality		
++	increased farm income		
+	increased water availability / quality		

Socio-cultural benefits		Socio-cultural disadvantages
+++	community institution strengthening	
+++	improved conservation / erosion knowledge	
+++	improved food security / self sufficiency	
++	improved situation of disadvantaged groups	
++	improved health	

Ecological benefits		Ecological disadvantages
+++	improved harvesting / collection of water	
++	increased water quantity	
++	reduced hazard towards adverse events	
++	reduced soil loss	
+	recharge of groundwater table / aquifer	
+	increased plant diversity	

Off-site benefits		Off-site disadvantages
++	reduced downstream flooding	
++	reduced damage on public / private infrastructure	
+	increased water availability	
+	reduced downstream siltation	

Contribution to human well-being / livelihoods

++

Benefits /costs according to land user

Benefits compared with costs	short-term:	long-term:
Establishment	very positive	very positive
Maintenance / recurrent	very positive	very positive

Acceptance / adoption:

100% of land user families (500 families; 100% of area) have implemented the technology with external material support.
There is little trend towards (growing) spontaneous adoption of the technology.

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Increased water availability for irrigation as well as livestock consumption → Integrated watershed management	High cost of construction → Selecting a site that has good availability of construction material and that can irrigate as large area as possible.
Reduce slope length and angle →	Require skilled labour → Training of land users
Reduce erosion risk and enhance gully rehabilitation →	Labour intensive → Mass mobilization
Reduce risk of crop failure →	
Increased water availability for irrigation and livestock consumption → Watershed management	
Reduced soil erosion → Construction of retaining walls	
Increased employment opportunity →	

Strip Tillage Conservation Farming
Zambia

left: The strip tillage tool with the sub-surface wings attached (Photo: Arthur Chomba)
right: A field after strip tillage (Photo: Arthur Chomba)

Strip Tillage Conservation Farming is an animal draft reduced tillage method that involves loosening a strip of soil with a strip tillage tool so as to reduce soil disturbance and improve soil and water conservation.

The strip Tillage tool is an adaptation of a Ripper but is meant to be used in moist soil. In the strip tillage tool, sub-surface wings are attached to the ripper tine to increase the width of soil disruption which the ripper will be unable to achieve in moist soil. The sub-surface wings loosen the soil by lifting it slightly and letting it fall in place without inverting it. In this way, a strip of soil with a width of around 20cm is tilled up to 20cm deep and this is where the crop will be planted. The region between the strips is maintained as a no-till region for and water conservation.
The strip tillage tool is meant to be a transitional technology for farmers intending to adopt CA in degraded soils. These soils will need routine loosening while the biological activities allow the soil structure to recover sufficiently until tillage is no longer required. Strip tillage is able to achieve deeper soil loosening with much less draft force, wear of tines and soil disturbance than ripping. The untilled region between the strips enables the benefits of soil cover such improved infiltration, soil water storage and increased soil organic matter. Soil loosening by strip tillage does not produce large clods like ripping does but instead produces a fine seedbed that enables uniform emergence of the crop, and this together with the deep penetration results in early plant vigour. The strip tillage implement is also designed to allow the attachment of a planter unit to enable the tillage and planting in one operation.
The establishment of strip tillage based conservation agriculture mainly involves the purchase of the strip tillage implement and the replaceable tines. Liming followed by a final ploughing will be required to correct the soil PH which otherwise will be difficult to correct once conservation tillage has been established. Maintenance activities include strip-tilling the soil which may or may not include planting and fertilizing in the same operation. Weeding should preferably include the use of herbicides, implying that the major operations will include spraying. In addition to the normal conventional inputs, herbicides will also become a major input and cost.
The strip tillage technology is most suited to the bigger small-scale farmers with a capacity of 5ha to about 20ha. The strip tillage tool together with the planter will require a relatively substantial investment and only the bigger farmers will fully utilize its capacity. The strip tillage action will not be very effective in wet soils especially in the heavier soils, soil disruption is best achieved when the soil is slightly moist but not too dry as to require to high draft forces. Strip tillage can is useful in soil with poor structure that will require routine loosening to maintain yields while the soil is rehabilitated.

Location: Southern Province
Region: Mazabuka/Magoye
Technology area: 0.1 - 1 km2
Stage of intervention: mitigation / reduction of land degradation, rehabilitation / reclamation of denuded land
Origin: Developed through experiments / research, recent (<10 years ago)
Land use type:
Cropland: Annual cropping
Climate: semi-arid, subtropics
WOCAT database reference: T_ZAM002en
Related approach: Participatory Research and Development (A_ZAM001en)
Compiled by: Arthur Chomba, Golden Valley agricultural research trust
Date: 14th Jan 2013

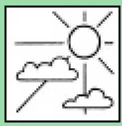
Classification

Land use problems:
- Loss of soil structure and loss of soil fertility (expert's point of view)
Droughts and dry spells (land user's point of view)

Land use

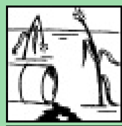
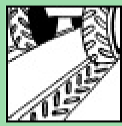
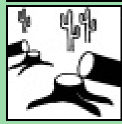
Annual cropping
rainfed
rainfed

Climate



semi-arid

Degradation

Chemical soil deterioration: fertility decline and reduced organic matter content, Physical soil deterioration: compaction, sealing and crusting, Biological degradation: loss of soil life

Conservation measure

Stage of intervention

- Prevention
- Mitigation / Reduction
- Rehabilitation

Origin

- Land users initiative
- Experiments / Research: recent (<10 years ago)
- Externally introduced

Level of technical knowledge

- Agricultural advisor
- Land user

Main causes of land degradation:
Direct causes - Human induced: soil management, crop management (annual, perennial, tree/shrub), overgrazing
Indirect causes: poverty / wealth

Main technical functions:
- control of raindrop splash
- improvement of ground cover
- improvement of topsoil structure (compaction)
- improvement of subsoil structure (hardpan)
- increase in organic matter
- increase of infiltration
- increase / maintain water stored in soil

Secondary technical functions:
- improvement of surface structure (crusting, sealing)
- increase in nutrient availability (supply, recycling,…)
- water harvesting / increase water supply

Environment

Natural Environment

Average annual rainfall (mm)

- > 4000 mm
- 3000-4000 mm
- 2000-3000 mm
- 1500-2000 mm
- 1000-1500 mm
- 750-1000 mm
- 500-750 mm
- 250-500 mm
- < 250 mm

Altitude (m a.s.l.)

- > 4000
- 3000-4000
- 2500-3000
- 2000-2500
- 1500-2000
- 1000-1500
- 500-1000
- 100-500
- <100

Landform

- plateau / plains
- ridges
- mountain slopes
- hill slopes
- footslopes
- valley floors

Slope (%)

- flat
- gentle
- moderate
- rolling
- hilly
- steep
- very steep

Soil depth (cm)

- 0-20
- 20-50
- 50-80
- 80-120
- >120

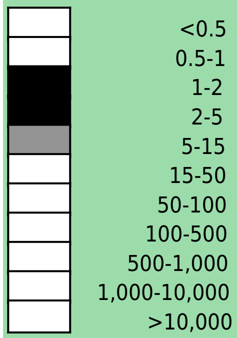
Growing season(s): 135 days (mid november to end of march)
Soil texture: medium (loam)
Soil fertility: low
Topsoil organic matter: low (<1%)
Soil drainage/infiltration: good

Soil water storage capacity: medium
Ground water table: > 50 m
Water quality: poor drinking water
Biodiversity: medium

Tolerant of climatic extremes: seasonal rainfall increase, seasonal rainfall decrease, heavy rainfall events (intensities and amount), droughts / dry spells
Sensitive to climatic extremes: floods

Human Environment

Cropland per household (ha)



Land user: Individual / household, Small scale land users, common / average land users, mainly men
Population density: 10-50 persons/km2
Annual population growth: 3% - 4%
Land ownership: communal / village, individual, not titled
Land use rights: open access (unorganised) (Land is apportioned by traditional rulers where rights of use belong to the individual and his family indefinitely. The remaining land not apportioned is open for communal grazing)
Water use rights: open access (unorganised) (Land is apportioned by traditional rulers where rights of use belong to the individual and his family indefinitely. The remaining land not apportioned is open for communal grazing)
Relative level of wealth: very poor, which represents 68% of the land users; 40% of the total area is owned by very poor land users

Importance of off-farm income: 10-50% of all income: sale of rainfed crops makes up about half of their income, the remainder coming from sale of livestock, petty trading, hiring out labour and remittances
Access to service and infrastructure: low: employment (eg off-farm), energy, financial services; moderate: health, education, technical assistance, market, roads & transport, drinking water and sanitation
Market orientation: mixed (subsistence and commercial)
Mechanization: animal traction
Livestock grazing on cropland: yes

Implementation activities, inputs and costs

Establishment activities

- Strip Tillage implement
- Knapsack Sprayer

Maintenance/recurrent activities

- Slashing and spreading crop residues
- Liming soil
- strip tillage, planting and fertilizing
- Chemical weeding
- Harvesting

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US$)	% met by land user
Labour	139.00	100%
Equipment		
- animal traction	40.00	100%
Agricultural		
- seeds	50.00	100%
- fertilizer	320.00	100%
- lime	42.00	100%
- herbicides	30.00	100%
TOTAL	**621.00**	**100.00%**

Remarks:
The weeding method employed is the main determinate factor depending on whether the farmer uses hand hoe or herbicides for weeding. Weed densities are higher in unploughed fields increasing the labour requirements/costs by a factor of about 5 if hand weeding is used instead of herbicides. Another major cost is that of fertilizer which makes up about half the cost hence the total cost will vary significantly depending on fertilizer cost.
Calculation are for a 1ha of maize under strip tillage based conservation tillage and costs are for the Zambia situation in Magoye as of August 2012.

Assessment

Impacts of the Technology

Production and socio-economic benefits

+++ increased farm income
+++ increased production area
+++ decreased labour constraints
++ increased crop yield
++ reduced risk of production failure
++ diversification of income sources

Production and socio-economic disadvantages

+++ increased labour constraints
++ reduced fodder production
++ increased risk of crop failure
+ increased expenses on agricultural inputs

Socio-cultural benefits

++ increased recreational opportunities
++ community institution strengthening
++ improved conservation / erosion knowledge
++ improved food security / self sufficiency
++ improved health

Socio-cultural disadvantages

+ socio cultural conflicts

Ecological benefits

+++ reduced surface runoff
+++ improved soil cover
+++ reduced soil loss
+++ reduced soil crusting / sealing
+++ reduced soil compaction
++ improved harvesting / collection of water
++ increased soil moisture
++ reduced evaporation
++ reduced hazard towards adverse events
++ increased biomass above ground C
++ increased nutrient cycling recharge
++ increased soil organic matter / below ground C
+ improved excess water drainage

Ecological disadvantages

Off-site benefits

+++ reduced downstream flooding
+++ increased stream flow in dry season
+++ reduced downstream siltation
++ increased water availability

Off-site disadvantages

Contribution to human well-being / livelihoods

+ The technology was only introduced recently and not yet widely adopted to make an impact. However the few farmers that have adopted have been able to multiply their production capacities and incomes.

Benefits /costs according to land user

Benefits compared with costs	short-term:	long-term:
Establishment	very positive	positive
Maintenance / recurrent	very positive	positive

: Timely and quicker planting enables larger areas to be planted and with less labour in the short term. Improved soil structure and soil fertility leads to higher yields and better resilience to droughts in the long term

Acceptance / adoption:

There is strong trend towards (growing) spontaneous adoption of the technology. Even before promotion, inquiries to purchase the strip planter have been overwhelming. This is most likely due to the ability to till, plant and fertilize in one operation.

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Enables early planting →	The purchase price is on the higher side making it affordable only to the larger small scale farmers → It is already by far the cheapest planter available but mass production can lead to significant reduction in purchase price
Quicker planting enabling the planting of larger areas → Use herbicides because without them, the capacity to weed will limit the production capacity	Benefits more evident on a scale larger than many farmers capacity especially when used in combination with herbicides → Support farmers to increase capacity
Fewer operations and lower costs →	the difficulty to control weeds in the absence of herbicides → make herbicides more available at a lower cost
Preserves soil cover and reduces soil disturbance →	The purchase price of the strip tillage planter → subsidizing the strip tillage implement
Enables early planting → acquire more than one strip tillage implement	Excessive weeds and lack of information on herbicide use → More training on herbicide use
Quicker enabling the planting of larger areas →	
Lighter to pull enabling deeper penetration of the tillage tool increasing the rooting depth →	

WOCAT

Conservation Tillage with Magoye Ripper
Zambia

Conservation Tillage with the Magoye Ripper is an animal draft reduced tillage method that involves the use of the Magoye Ripper to loosen the soil by shattering with a tine instead of ploughing.

The Magoye ripper is an animal drawn implement used for conservation tillage. The Ripper consists of a frame that is attached to a common plough beam and on this frame is fixed a tine at an angle that penetrates and breaks up the soil when pulled. Only the region where the crop furrow will be is loosened by the the tine and by so doing reducing the amount of tillage and disruption of soil structure while preserving the crop residue cover. The frame has some 'wings' attached to it that throw the soil out of the ripped furrow to leave it open for planting and collecting of water. Ripping is done in one pass up to a depth of 15cm depending on the strength of the oxen, settings and the sharpness of the tine.
Reducing tillage first of all reduces tillage costs and tillage time allowing more time for the farmer to plant early and a bigger area. Reducing tillage also reduces the loss of soil organic matter and the destructive effects to the soil structure ultimately improving soil fertility and soil water conservation. Ripping does not invert the soil hence does not bury crop residues which go further to enhance organic matter levels and protect the soil from excessive evaporation. The open furrow left by the Ripper collects water from the adjacent untilled soil much in the same way. basins are used for water harvesting. This together with the increased rooting depth resulting from the breaking of compacted soil and enhanced infiltration and early planting improves water conservation and hence the resilience of crop to extended dry spells.
The establishment of ripping based conservation tillage mainly involves the purchase of the ripper frame and the replaceable tines. Liming followed by a final ploughing will be required to correct the soil PH which otherwise will be difficult to correct once conservation tillage has been established. The main establishment activity involves adopting a new mindset and increasing the knowledge base to apply the technology correctly. Knowledge about alternative weed control practices and herbicide use is particularly cardinal as the farmer will have to establish new weeding practices and routines in the absence of ploughing. Maintenance activities are more or less the same as conventional tillage except for replacing the tillage tines which wear every now and then. The same applies for the inputs except for the increase in use of herbicides. Ripping is best performed in dry soil although this may not be possible with some of the smaller and weak oxen when the soil is too dry. It is therefore recommended for farmers in regions that expirience long dry seasons to rip at the end of harvest before the soils get too dry and the oxen lose there good condition the attained in the rainy season. The ripper is mostly suited to small-scale farmers just adopting CA since the tool can be easily adapted to the existing plough beam which most of the farmers already have. The small capital outlay for establishing the system makes it suited to resource poor and risk averse farmers.

left: The Magoye Ripper (Photo: Arthur Chomba)
right: A field after ripping with the Magoye Ripper (Photo: Arthur Chomba)

Location: Zambia/Southern Province
Region: Mazabuka/Magoye
Technology area: 0.1 - 1 km2
Stage of intervention: mitigation / reduction of land degradation
Origin: Developed through experiments / research, 10-50 years ago
Land use type:
Cropland: Annual cropping
Climate: semi-arid, subtropics
WOCAT database reference: T_ZAM003en
Related approach: Participatory research and Development (A_ZAM002en)
Compiled by: Arthur Chomba, Golden Valley agricultural research trust
Date: 15th Jan 2013

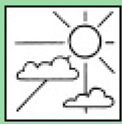
Classification

Land use problems:
- Loss of soil structure and loss of soil fertility (expert's point of view)
Droughts and dry dpells (land user's point of view)

Land use

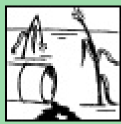
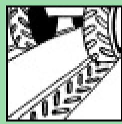
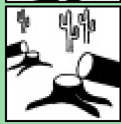
Annual cropping
rainfed
rainfed

Climate



semi-arid

Degradation

Chemical soil deterioration: fertility decline and reduced organic matter content, Physical soil deterioration: compaction, Biological degradation: loss of soil life

Conservation measure

Stage of intervention

Prevention
Mitigation / Reduction
Rehabilitation

Origin

Land users initiative
Experiments / Research: 10-50 years ago
Externally introduced: 10-50 years ago

Level of technical knowledge

Agricultural advisor
Land user

Main causes of land degradation:
Direct causes - Human induced: soil management, crop management (annual, perennial, tree/shrub), overgrazing
Indirect causes: poverty / wealth

Main technical functions:
- improvement of ground cover
- improvement of topsoil structure (compaction)
- improvement of subsoil structure (hardpan)
- increase of infiltration
- water harvesting / increase water supply

Secondary technical functions:
- control of raindrop splash
- improvement of surface structure (crusting, sealing)
- increase in organic matter
- increase in nutrient availability (supply, recycling,…)
- increase / maintain water stored in soil

Environment

Natural Environment

Average annual rainfall (mm)

> 4000 mm
3000-4000 mm
2000-3000 mm
1500-2000 mm
1000-1500 mm
750-1000 mm
500-750 mm
250-500 mm
< 250 mm

Altitude (m a.s.l.)

> 4000
3000-4000
2500-3000
2000-2500
1500-2000
1000-1500
500-1000
100-500
<100

Landform

plateau / plains
ridges
mountain slopes
hill slopes
footslopes
valley floors

Slope (%)

flat
gentle
moderate
rolling
hilly
steep
very steep

Soil depth (cm)

0-20
20-50
50-80
80-120
>120

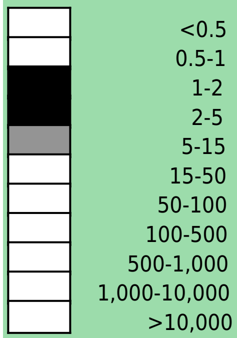
Growing season(s): 135 days (Mid november to end of march)
Soil texture: medium (loam)
Soil fertility: low
Topsoil organic matter: low (<1%)
Soil drainage/infiltration: good

Soil water storage capacity: medium
Ground water table: > 50 m
Availability of surface water: medium

Tolerant of climatic extremes: seasonal rainfall decrease, droughts / dry spells, decreasing length of growing period
Sensitive to climatic extremes: seasonal rainfall increase, heavy rainfall events (intensities and amount), floods
If sensitive, what modifications were made / are possible: Magoye ripper based conservation tillage should be applied in well drained fields to avoid water-logging in the ripped furrows during seasons of excess rainfall or events of heavy downpours.

Human Environment

Cropland per household (ha)



Land user: Individual / household, Small scale land users, common / average land users, mainly men
Population density: 10-50 persons/km2
Annual population growth: 3% - 4%
Land ownership: individual, not titled
Land use rights: individual (Land is apportioned by traditional rulers where rights of use belong to the individual and his family indefinatly but the remaining land not apportioned is open for communal grazing)
Water use rights: open access (unorganised) (Land is apportioned by traditional rulers where rights of use belong to the individual and his family indefinatly but the remaining land not apportioned is open for communal grazing)
Relative level of wealth: very poor, which represents 68% of the land users; 40% of the total area is owned by very poor land users

Importance of off-farm income: 10-50% of all income: sale of rainfed crops makes up about half of their income, the remainder coming from sale of livestock, petty trading, hiring out labour and remittances
Access to service and infrastructure: low: employment (eg off-farm), energy, financial services; moderate: health, education, technical assistance, market, roads & transport, drinking water and sanitation
Market orientation: mixed (subsistence and commercial)
Mechanization: animal traction
Livestock grazing on cropland: yes

Implementation activities, inputs and costs

Establishment activities

- Magoye ripper
- Knapsack sprayer

Establishment inputs and costs per ha

Inputs	Costs (US$)	% met by land user
Equipment		
- machine use	130.00	100%
TOTAL	**130.00**	**100.00%**

Maintenance/recurrent activities

- chemical weeding
- harvesting
- Liming
- Planting and fertilizing
- Ripping
- slashing and spreading residues

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US$)	% met by land user
Labour	94.00	100%
Equipment		
- animal traction	50.00	100%
Agricultural		
- seeds	50.00	100%
- fertilizer	320.00	100%
- herbicides	30.00	100%
- lime	42.00	100%
TOTAL	**586.00**	**100.00%**

Remarks:
The weeding method employed is the main determinate factor depending on whether the farmer uses hand hoe or herbicides for weeding. Abandoning ploughing leads to higher weed densities leading to increased labour requirements/costs if hand weeding is used. However, with herbicides the weeding labour demand and costs cost are much lower by a factor of about 5. Another major cost is that of fertilizer which makes up about half the cost hence the total cost will vary significantly depending on fertilizer cost.
Calculation are for a 1ha of maize under magoye ripper based conservation tillage and costs are for the Zambia situation in Magoye as of August 2012.

Assessment

Impacts of the Technology

Production and socio-economic benefits		Production and socio-economic disadvantages	
++	reduced risk of production failure	++	reduced fodder production
++	decreased labour constraints	++	increased risk of crop failure
+	increased crop yield	++	increased labour constraints
+	increased farm income	+	increased expenses on agricultural inputs
+	increased production area		

Socio-cultural benefits		Socio-cultural disadvantages	
+++	improved conservation / erosion knowledge	+	socio cultural conflicts
++	improved food security / self sufficiency		
+	increased recreational opportunities		

Ecological benefits		Ecological disadvantages	
+++	reduced soil compaction	+++	increased soil erosion locally
++	improved harvesting / collection of water	+	waterlogging
++	increased soil moisture		
++	reduced evaporation		
++	reduced surface runoff		
++	reduced hazard towards adverse events		
++	improved soil cover		
++	reduced soil loss		
++	reduced soil crusting / sealing		
+	improved excess water drainage		
+	increased biomass above ground C		
+	increased nutrient cycling recharge		
+	increased soil organic matter / below ground C		

Off-site benefits	Off-site disadvantages

Contribution to human well-being / livelihoods

+ Technology not yet been applied on a large enough area to make significant impact at community level.

Benefits /costs according to land user

Benefits compared with costs	short-term:	long-term:
Establishment	positive	very positive
Maintenance / recurrent	positive	positive

Timely planting enables larger areas to be planted and better yields. In the long term, improved soil fertility and soil structure results in sustained improved yields. However, if herbicides are not used, the costs and labour requirements of weeding can result in negative benefits.

Acceptance / adoption:

There is little trend towards (growing) spontaneous adoption of the technology. availability of replacement tines and the increased weed challenge have been a major hindrances to widespread adoption

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome

WOCAT


Animal Draft Zero-Tillage
Zambia - Direct Planting

Animal Draft Zero-Till involves the use of an animal drawn mechanical planter to plant directly in untilled soil to minimise soil disturbance and leave a cover of crop residues to conserve the soil.

Zero-tillage takes advantage beneficial effects of biological processes to loosen the soil and improve fertility. The organic matter from these processes aggregate the soil while the movement of soil organisms like worms and termites loosen the soil. This is called biological tillage and replaces mechanical tillage. The untilled soil surface covered in residues will require a planter specailized to plant in these conditions. In a sense, adopting zero-till is actually adopting a zero-till planter. The development of the strip-planter has made zero-till a viable option for animal draft farmers which until now was not due to the unavailabiity or high cost of planters. The new planter both cheap and easy to manufacture locally. The planter uses a narrow tine to open a planting furrow and seed/fertilizer is metered by vertically rotating plates. The planter is pulled by oxen and can plant rows of 75cm or 90cm rows with an intra row which is determined by the seed plate used (3, 4, 5,…… seeds/m). The planting technology needs to be complemented with sound residue cover and weeding management practices.
The planter enables planting and fertilizing in untilled soil so that the soil residue cover and soil structure are preserved and can be used sustainably. The protective soil cover reduces evaporation and enhances infiltration while the improved soil structure and organic matter content increases soil water storage making zero tillage an important drought mitigating strategy. The immediate benefits of adopting zero-till is the possibility to plant a bigger area quickly and in time as well as the reduced soil erosion.
The first step in establishing zero-till is to assess the soil condition and levels of degradation. Where possible tests should be carried out but where not, the farmer needs to start on a small portion to verify if there will be yield reduction from not tilling the soil. Where soils are severely degraded, an establishment phase should be embarked on where reduced tillage is practiced until the soil structure has recovered sufficiently to support crop growth without tillage. Liming followed by a final ploughing will be required in the first year to correct the soil PH which otherwise will be difficult to correct once conservation tillage has been established. The organic matter levels need to be to be increased by increasing the amount of residues produced by the crop (i.e. the yields) and retaining these as soil cover. The next establishment activity is the purchase of the planter unit. Maintenance activities include planting and fertilizing in the same operation and weeding. Weeding will have to involve herbicide use to handle increased weed densities implying that spraying will became a major operation. In addition to the normal conventional inputs, herbicides will also become a major input and cost.
Zero-till has been applied in a wide range of bio-physical environments but mostly by the large scale farmers. The unavailability and high cost of specialized zero-till planter for small-scale farming has resulted in low adoption rates. The development of the Magoye Planter creates new opportunities for this practice. The farmer has to have sufficient knowledge to assess the soil condition and decide if is too degraded for Zero-till or how long the transitional phase should be. Literacy is essential as the farmers will have to learn new approaches to weed control, pest control and crop rotations and adapt practices to suit his specific conditions.

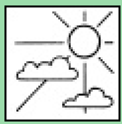
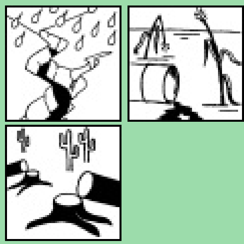
left: The Magoye CA planter used for Zero-tillage (Photo: Arthur Chomba)
right: A farmer in his field planted with the Magoye CA planter (Photo: Arthur Chomba)

Location: Zambia/Southern Province
Region: Mazabuka/Magoye
Technology area: 0.56 km^2
Stage of intervention: prevention of land degradation, mitigation / reduction of land degradation
Origin: Developed through experiments / research, recent (<10 years ago)
Land use type:
Cropland: Annual cropping
Climate: semi-arid, subtropics
WOCAT database reference: T_ZAM004en
Related approach: Participatory Research and development (A_ZAM001en)
Compiled by: Arthur Chomba, Golden Valley agricultural research trust
Date: 15th Jan 2013

Classification

Land use problems:

- Loss of soil structure and low of soil fertility (expert's point of view)
Droughts and dry spell (land user's point of view)

Land use	Climate	Degradation	Conservation measure
 Annual cropping rainfed extensive grazing land rainfed	 semi-arid	 Soil erosion by water: loss of topsoil / surface erosion, Chemical soil deterioration: fertility decline and reduced organic matter content, Biological degradation: loss of soil life	

Stage of intervention

- Prevention
- Mitigation / Reduction
- Rehabilitation

Origin

- Land users initiative
- Experiments / Research: recent (<10 years ago)
- Externally introduced

Level of technical knowledge

- Agricultural advisor
- Land user

Main causes of land degradation:
Direct causes - Human induced: soil management, crop management (annual, perennial, tree/shrub), overgrazing
Indirect causes: poverty / wealth, inputs and infrastructure

Main technical functions:
- improvement of surface structure (crusting, sealing)
- improvement of topsoil structure (compaction)
- increase of infiltration
- increase / maintain water stored in soil

Secondary technical functions:
- control of raindrop splash
- improvement of ground cover
- improvement of subsoil structure (hardpan)
- increase in organic matter
- increase in nutrient availability (supply, recycling,...)
- water harvesting / increase water supply

Environment

Natural Environment

Average annual rainfall (mm)

- > 4000 mm
- 3000-4000 mm
- 2000-3000 mm
- 1500-2000 mm
- 1000-1500 mm
- 750-1000 mm
- 500-750 mm
- 250-500 mm
- < 250 mm

Altitude (m a.s.l.)

- > 4000
- 3000-4000
- 2500-3000
- 2000-2500
- 1500-2000
- 1000-1500
- 500-1000
- 100-500
- <100

Landform

- plateau / plains
- ridges
- mountain slopes
- hill slopes
- footslopes
- valley floors

Slope (%)

- flat
- gentle
- moderate
- rolling
- hilly
- steep
- very steep

Soil depth (cm)

- 0-20
- 20-50
- 50-80
- 80-120
- >120

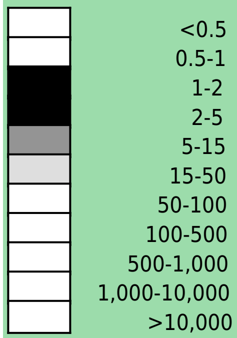
Growing season(s): 135 days (mid nov to end of march)
Soil texture: medium (loam)
Soil fertility: low
Topsoil organic matter: low (<1%)
Soil drainage/infiltration: good

Soil water storage capacity: medium
Ground water table: > 50 m
Availability of surface water: medium
Water quality: poor drinking water

Tolerant of climatic extremes: seasonal rainfall increase, seasonal rainfall decrease, heavy rainfall events (intensities and amount), droughts / dry spells, decreasing length of growing period
Sensitive to climatic extremes: floods

Human Environment

Cropland per household (ha)



Land user: Individual / household, Small scale land users, common / average land users, mainly men
Population density: 10-50 persons/km2
Annual population growth: 3% - 4%
Land ownership: individual, not titled
Land use rights: individual (Land is apportioned by traditional rulers where rights of use belong to the individual and his family indefinatly but the remaining land not apportioned is open for communal grazing)
Water use rights: open access (unorganised) (Land is apportioned by traditional rulers where rights of use belong to the individual and his family indefinatly but the remaining land not apportioned is open for communal grazing)
Relative level of wealth: very poor, which represents 68% of the land users; 40% of the total area is owned by very poor land users

Importance of off-farm income: 10-50% of all income: sale of rainfed crops makes up about half of their income, the remainder coming from sale of livestock, petty trading, hiring out labour and remittances
Access to service and infrastructure: low: employment (eg off-farm), energy, financial services; moderate: health, education, technical assistance, market, roads & transport, drinking water and sanitation
Market orientation: mixed (subsistence and commercial)
Mechanization: animal traction
Livestock grazing on cropland: yes

Implementation activities, inputs and costs

Establishment activities

- Knapsack sprayer
- Magoye Planter

Maintenance/recurrent activities

- 1.Slashing, spreading residues
- 2. Liming Nov - Dec every 3years
- 3.Planting and fertilizing
- 5.Chemical weeding
- Harvesting

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US$)	% met by land user
Labour	69.00	100%
Equipment		
- animal traction	40.00	100%
Agricultural		
- seeds	50.00	100%
- fertilizer	320.00	100%
- lime	42.00	100%
- herbicides	30.00	100%
TOTAL	**551.00**	**100.00%**

Remarks:
The weeding method employed is the main determinate factor depending on whether the farmer uses hand hoe or herbicides for weeding. Weed densities are higher in unploughed fields increasing the labour requirements/costs by a factor of about 5 if hand weeding is used instead of herbicides. Another major cost is that of fertilizer which makes up about half the cost hence the total cost will vary significantly depending on fertilizer cost.
Calculation are for a 1ha of maize under strip tillage based conservation tillage and costs are for the Zambia situation in Magoye as of August 2012.

Assessment

Impacts of the Technology

Production and socio-economic benefits		Production and socio-economic disadvantages	
+++	increased farm income	++	reduced fodder production
+++	increased production area	++	increased risk of crop failure
++	increased crop yield	++	increased labour constraints
++	reduced risk of production failure	+	increased expenses on agricultural inputs
++	diversification of income sources		
++	decreased labour constraints		

Socio-cultural benefits		Socio-cultural disadvantages	
+++	improved conservation / erosion knowledge	+	socio cultural conflicts
++	increased recreational opportunities		

Ecological benefits		Ecological disadvantages	
+++	reduced evaporation		
+++	reduced surface runoff		
+++	reduced soil loss		
+++	reduced soil crusting / sealing		
++	improved harvesting / collection of water		
++	increased soil moisture		
++	improved excess water drainage		
++	improved soil cover		
++	increased biomass above ground C		
++	increased nutrient cycling recharge		
++	increased soil organic matter / below ground C		

Off-site benefits | **Off-site disadvantages**

Contribution to human well-being / livelihoods

Benefits /costs according to land user

Benefits compared with costs	short-term:	long-term:
Establishment	positive	very positive
Maintenance / recurrent	positive	very positive

Timely and quicker planting enables larger areas to be planted and with less labour in the short term. Improved soil structure and soil fertility leads to higher yields and better resilience to droughts in the long term

Acceptance / adoption:

There is strong trend towards (growing) spontaneous adoption of the technology. There have numerous enquiries to purchase the Magoye planter even before it can be promoted

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Enables early planting →	The purchase price for the planter is on the higher side making it affordable only to the larger small scale farmers → the price is likely to go down when the planter is mass produced
Quicker planting enabling the planting of larger areas → Use herbicides because without them, the capacity to weed will limit the production capacity	the difficulty to control weeds in the absence of herbicides → use herbicides
Fewer operations and lower costs →	The purchase price of the Magoye planter quite high →
Preserves soil cover and reduces soil disturbance →	Excessive weeds and lack of information on herbicide use → More training on herbicide use
Enables early planting →	
Quicker enabling the planting of larger areas →	
reduced workload →	

participatory research and development

Zambia - on-farm research

This is a collaborative process between the researchers and the farmers for developing and adapting new technologies that focuses on incorporating the perspectives and input from the farmers into the development process

left: Discussing the performance of the Magoye Planter with a test farmer in a field planted with the same. (Photo: Arthur Chomba)

right: Farmers attending a field day (Photo: Arthur Chomba)

Location: Zambia, Mazabuka/Magoye
Approach area: 2200.00 km^2
Type of Approach: project/programme based
Focus: mainly on conservation with other activities
WOCAT database reference: A_ZAM001en
Related technology(ies): Animal Draft Zero-Tillage, Conservation Tillage with Magoye Ripper, Strip Tillage Conservation Farming
Compiled by: Arthur Chomba, Golden Valley agricultural research trust
Date: 2013-01-16

Aim/objectives: To stimulate active farmer participation in the technology development process so that local conditions and perspectives are integrated in the process.(2)Build the capacity of farmers to identify problems and contribute to selecting/improving technology options. (3) Raise farmers' yields in sustainable manner and ultimately contribute to increased net farm income

Methods: A series of on-farm experiments are set up to test a range of technology options. These trials are implemented by the farmers so that vital feedback on which technology works and why it does so is collected. Suggestions for improvements are also collected, reviewed and incorporated into new designs or all together new technologies developed. The process is repeated until spontaneous adoption is evident before the technologies are promoted widely

Stages of implementation: (1) Preparation of trial protocols for technologies to be tested (2) Identifying farmers and mobilization into farmer groups (3) Capacity building and increasing the knowledge base of farmers to effectively participate and contribute to development process. (4) Setting up of on-farm trials (5) Monitoring trials and collecting data/feedback from farmers (6) incorporation of feedback into technology development process and conducting on-station trials (7) technologies adapted or developed and introduced and the process is repeated.

Role of stakeholders: The approach was designed by national specialists where 'best-bet' technologies were pre-selected for testing. The role of GART was that of research and training of trainers. The supervision of the farmers was carried out by government extension workers who were supervised by the researchers and GART field technicians. The farmers implemented the approach and the decision on which technology to adopt was made by them. The land users also participated in evaluating the technologies and made suggestions on possible improvements. The decision on how best to consolidate these suggestions and incorporate in the technologies was made by the specialists in consultation with the land users.

Problem, objectives and constraints

Problems

Unsustainable farming practices leading to environmental degradation and low agricultural productivity

Aims/Objectives

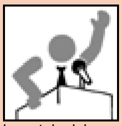
1)To stimulate active farmer participation in the technology development process so that local conditions and perspectives are integrated in the process.(2)Build the capacity of farmers to identify problems and contribute to selecting/improving technology options. (3) Raise farmers' yields in sustainable manner through technology innovation and ultimately contribute to increased net farm income

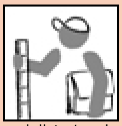
Constraints addressed

	Constraint	Treatment
social / cultural / religious	The participation of women not as much as that of men	Women headed households were identified and targeting for inclusion in the project
financial	The short cycle of projects and funding that made long-term planning difficult	Collaborate with government structures and extension service to ensure sustainability of projects
institutional	Weak collaboration between organizations promoting conservation agriculture leading to mixed messages being delivered to farmers	Formation of the Conservation Farming Association (CAA) to synchronise messages and avoid duplication of efforts
legal / land use and / water rights	Lack of secure land tenure leading to hesitancy to invest in long-term conservation efforts	Emphasise the short-term benefits of conservation
technical	The failure of rural workshops to produce and supply the necessary equipment for the implementation of the approach	Collaboration was initiated with mainstream equipment suppliers
other	Low returns from the sale of the staple crop, maize, and hence low returns to farming genral	Encourage crop livestock integration and promote crop diversification

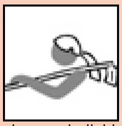
Participation and decision making

Stakeholders / target groups


politicians / decision makers


SLM specialists / agricultural advisors


land users, groups


land users, individual

Approach costs met by:

Total	**0%**

Annual budget for SLM component: US$

Decisions on choice of the Technology(ies) mainly by land users supported by SLM specialists

Decisions on method of implementing the Technology(ies): mainly by land users supported by SLM specialists

Approach designed by: national specialists, international specialists

Implementing bodies: other (GART, the main implementing body is a quasi-government body), government (Government extension implemented the approach after training from GART)

Land user involvement

Phase	Involvement	Activities
Initiation/motivation	Interactive	Approach inititated by specialists based on interactions with land-users from previous programmes
Planning	Passive	Planning was done by specialists although farmers were informed and consulted at every stage
Implementation	Interactive	Land users implemented the approach with the help of specialists
Monitoring/evaluation	Passive	Monitoring/evaluation was done by the specialists together with the land users as well as external evaluators
Research	Interactive	

Differences between participation of men and women: Yes, great
Most of the households are male headed
of the 250 farmers registered in Magoye, only 22 were female headed

Involvement of disadvantaged groups: Yes, moderate
The project targeted HIV/AIDS infected and affected households by working with community based organizations (CBOs) involved in care giving

Technical support

Training / awareness raising:
Training provided for land user, field staff/agricultural advisor
Training was site visits / farmer to farmer, demonstration areas, public meetings
Training focused on soil conservation and soil fertility improvement, how to use the conservation agricultural technologies, crop-livestock integration

Advisory service:
Name: Training of Trainers
Key elements:
1. trainig of goverment exgension workers and NGOs invloved in promotion of conservation agriculture
2. on-farm demonstrations
3. field days

The extension system is inadequate to ensure continuation of activities. There too few extension workers and there aren’t sufficient training manuals

Research:
Yes, great research. Mostly on station and on-farm research.
Research by GART focused on equipment development and adaptation of soil improvement technologies to make CA a viable option for animal draft farmers

External material support / subsidies

Contribution per area (state/private sector): Yes. Mostly contributions from EU supplemented by finances from commercial activities i.e. commercial crop production and contract research

Labour: Voluntary. GART only provided technical support while the farmer provided all the inputs

Inputs:
- Equipment (machinery, tools, etc) - tools. Partly financed

Credit: Credit was not available

Support to local institutions: Yes, moderate support with training, equipment
: Capacity building of local cooperatives and farmer associations, training of trainers and practical demonstrations

Monitoring and evaluation

Monitored aspects	Methods and indicators
no. of land users involved	Regular observations by project/programme based recent local initiative / innovative
economic / production	observations - Yields, labour inputs, costs, income, adoption
socio-cultural	Ad hoc observations by project/programme based recent local initiative / innovative - Gender, mindset, status
technical	measurements - equipment breakdowns
technical	observations - Yield, production area, labour, timeliness
bio-physical	measurements by project/programme based recent local initiative / innovative - soil miosture, soil fertility
bio-physical	Regular observations by project/programme based recent local initiative / innovative - Soil properties, moisture conservation

Changes as result of monitoring and evaluation:
There were several changes in the approach. There was more emphasis on on-farm trials as the project went on with more training on weeding techniques and livestock crop-intergration The magoye ripper was modified to penetrate deeper and an altogether new technology called the Magoye planter was develop to overcome some of the constraint of the Ripper.

Impacts of the Approach

Improved sustainable land management: Yes, little; The farmers that adopted the Magoye ripper were ploughing less thereby reducing erosion and loss of organic matter. However, some of the technologies have not been adopted on a wide enough scale to to create an impact at community level. Even the farmers that did not adopt the technologies are now more aware of the need for soil conservation.

Adoption by other land users / projects: Yes, some; On-farm research has been adopted by the conservation farming unit (CFU) who are the biggest player in promotion of conservation agriculture in Zambia. There are not many other research organizations in Zambia

Improved livelihoods / human well-being: Yes, moderate; Increased income and improved food security, less labour constraints and more time for other economic activities

Improved situation of disadvantaged groups: Yes, moderate; ? HIV/AIDS affected families and female headed households were specifically targeted

Poverty alleviation: Yes, moderate; Increased income and improved food security, less labour constraints and more time for other economic activities

Training, advisory service and research:

- Training effectiveness

  Land users* - good
  SLM specialists - good
  Agricultural advisor / trainers - fair
  Politicians / decision makers - good

  The training on how to implement the approach was good but not sufficient for the farmers and trainers to troubleshoot when unexpected circumstances or problems arise in the field.

- Advisory service effectiveness

  Land users* - good
  Politicians / decision makers - good
  Technicians / conservation specialists - good

- Research contributing to the approach`s effectiveness: Greatly
  research has been able to respond to some of the technical constraints by developing new technologie, adapting existing one and incorporating new weeding practices.

Land/water use rights:

Hinder - moderately in the implementation of the approach. Lack of secure land tenure discourages land user from seeking long-term conservation efforts
The approach did reduce the land/water use rights problem (low). Apart from lobbying policy makers, issues of land tenure were beyond the scope of the approach

Long-term impact of subsidies:

Concluding statements

Main motivation of land users to implement SLM:

Reduced workload

Increased profit(ability), improve cost-benefit-ratio

Environmental consciousness, moral, health

Production

Sustainability of activities:

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Farmers well informed of current developments and technology advancements	Too little emphasis on knowledge transfer and too much on practical demonstrations and 'how-to' training. → Focus more on understanding principles and technology selection
2)Farmers organizations strengthened	
1)There is strong farmer involvement in technology adaptation → Increase the farmers knowledge base to ensure effective participation	

Jessour

Tunisia - Jesser, Katra, Tabias (Arabic)

Jessour is an ancient runoff water harvesting technique widely practiced in the arid highlands

Jessour technology is generally practised in mountain dry regions (less than 200 mm annually) with medium to high slopes. This technology was behind the installation of very old olive orchards based on rainfed agriculture in rugged landscapes which allowed the local population not only to ensure self-sufficiency but also to provide neighbouring areas many agricultural produces (olive oil, dried figs, palm dates, etc.). Jessour is the plural of jessr, which is a hydraulic unit made of three components: the impluvium, the terrace and the dyke. The impluvium or the catchment is the area which collects and conveys runoff water. It is bordered by a natural water divide line (a line that demarcates the boundary of a natural area or catchment, so that all the rain that falls on this area is concentrated and drained towards the same outlet). Each unit has its own impluvium, but can also receive excess water from upstream units. The terrace or cropping zone is the area in which farming is practised. It is formed progressively by the deposition of sediment. An artificial soil will then be created, which can be up to 5 m deep close to the dyke. Generally, fruit trees (e.g. olive, fig, almond, and date palm), legumes (e.g. pea, chickpeas, lentil, and faba bean) and barley and wheat are cultivated on these terraces.

Although the jessour technique was developed for the production of various agricultural crops, it now also plays three additional roles: (1) aquifer recharge, via runoff water infiltration into the terraces, (2) flood control and therefore the protection of infrastructure and towns built downstream, and (3) wind erosion control, by preventing sediment from reaching the downstream plains, where windspeeds can be particularly high.

In the Jessour, a dyke (tabia, sed, katra) acts as a barrier used to hold back sediment and runoff water. Such dykes are made of earth, and are equipped with a central and/or lateral spillway (masref and/or manfes) and one or two abutments (ktef), assuring the evacuation of excess water. They are trapezoidal and measure 15-50 m in length, 1-4 m in width and 2-5 m in height. In old units, the dyke is stabilised with a covering of dry stones to overcome the erosive effects of water wave action on the front and back of the dyke. The spillway is made of stones arranged in the form of stairs, in order to dissipate the kinetic energy of the overflow. This technology is currently encountered in the mountain ranges of Matmata of South Eastern Tunisia where the local agricultural activities are based mainly on rainfed agriculture and livestock breeding. However, high rates of migration to cities may threaten the long-term maintenance of those structures.

left: Jessour is the plural of a Jessr which is the hydraulic unit comprising a dyke, spillway, terrace (cropping area: fruit trees and annuals), and impluvium (runoff catchment area) (Photo: van Delden H.)
right: Jessour is an ancient runoff water harvesting technique widely practised in the arid highlands of southern Tunisia. After each rainfall event, significant volumes of runoff water accumulate on the terrace and infiltrate into the soil to sustain trees and (Photo: Ouessar M.)

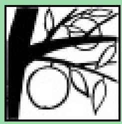
Location: Medenine
Region: Beni Khedache
Technology area: 100 km2 - 1,000 km2
Conservation measure: structural
Stage of intervention: mitigation / reduction of land degradation
Origin: Developed through land user`s initiative, traditional (>50 years ago)
Land use type:
Cropland: Annual cropping
Cropland: Tree and shrub cropping
Land use:
Grazing land: Extensive grazing land (before), Cropland: Tree and shrub cropping (after)
Climate: arid, subtropics
WOCAT database reference: T_TUN009en
Related approach: Participative sustainable water harvesting and soil conservation in the Jeffara region (TUN001)
Compiled by: Mongi Ben Zaied, Institut des Régions Arides (IRA)
Date: 22nd Sep 2008
Contact person: Mongi Sghaier, IRA - 4119 Medenine - Tunisia

Classification

Land use problems:

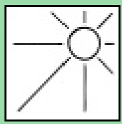
- Loss of surface water (runoff), problems of flooding, water erosion, soil degradation, drought (expert's point of view)

Land use

Annual cropping
Tree and shrub cropping
Grazing land: Extensive grazing land (before)
Cropland: Tree and shrub cropping (after)
rainfed

Climate

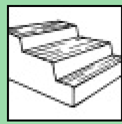


arid

Degradation

Soil erosion by water: loss of topsoil / surface erosion

Conservation measure



structural: Bunds / banks

Stage of intervention

Prevention
Mitigation / Reduction
Rehabilitation

Origin

Land users initiative: traditional (>50 years ago)
Experiments / Research
Externally introduced

Level of technical knowledge

Agricultural advisor
Land user

Main causes of land degradation:
Direct causes - Human induced: crop management (annual, perennial, tree/shrub)
Direct causes - Natural: change of seasonal rainfall, Heavy / extreme rainfall (intensity/amounts)
Indirect causes: poverty / wealth

Main technical functions:
- increase of infiltration
- sediment retention / trapping, sediment harvesting
- harvesting of runoff water / water trapping

Secondary technical functions:
- control of concentrated runoff: retain / trap
- increase / maintain water stored in soil
- increase of groundwater level / recharge of groundwater

Environment

Natural Environment

Average annual rainfall (mm)

> 4000 mm
3000-4000 mm
2000-3000 mm
1500-2000 mm
1000-1500 mm
750-1000 mm
500-750 mm
250-500 mm
< 250 mm

Altitude (m a.s.l.)

> 4000
3000-4000
2500-3000
2000-2500
1500-2000
1000-1500
500-1000
100-500
<100

Landform

plateau / plains
ridges
mountain slopes
hill slopes
footslopes
valley floors

Slope (%)

flat
gentle
moderate
rolling
hilly
steep
very steep

Soil depth (cm)

0-20
20-50
50-80
80-120
>120

Growing season(s): 180 days (Oct - Mar)
Soil texture: medium (loam)
Soil fertility: very low
Topsoil organic matter: low (<1%)
Soil drainage/infiltration: medium

Soil water storage capacity: medium
Ground water table: 5 - 50 m
Availability of surface water: medium
Water quality: poor drinking water
Biodiversity: medium

Tolerant of climatic extremes: temperature increase, seasonal rainfall increase, seasonal rainfall decrease, heavy rainfall events (intensities and amount), wind storms / dust storms, droughts / dry spells, decreasing length of growing period
Sensitive to climatic extremes: floods

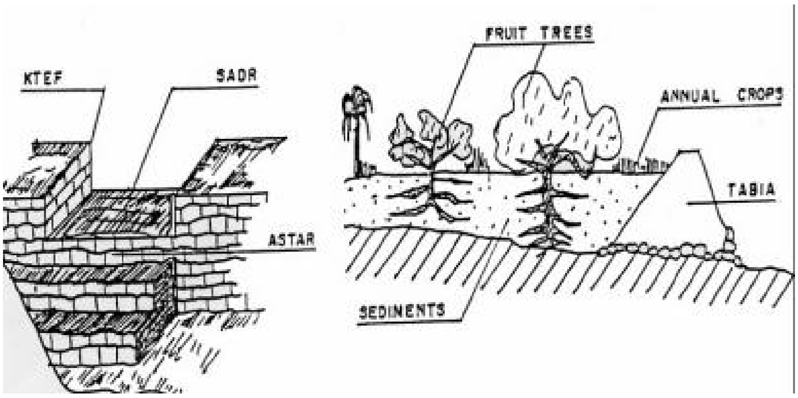
Human Environment

Cropland per household (ha)

☐	<0.5
☐	0.5-1
■	1-2
☐	2-5
☐	5-15
☐	15-50
☐	50-100
☐	100-500
☐	500-1,000
☐	1,000-10,000
☐	>10,000

Land user: Individual / household, Small scale land users, common / average land users, mainly men
Population density: 10-50 persons/km2
Annual population growth: < 0.5%
Land ownership: individual, not titled
Land use rights: individual (The communal rule applies in this region: the farmer owns the terrace (the cropping area) and its impluvium from which the runoff is harvested.)
Water use rights: individual (The communal rule applies in this region: the farmer owns the terrace (the cropping area) and its impluvium from which the runoff is harvested.)
Relative level of wealth: average, which represents 80% of the land users; 75% of the total area is owned by average land users

Importance of off-farm income: > 50% of all income: The technique is very ancient and, therefore, ALL the farmers apply this technology. The only difference is the number of the owned units. Off-farm incomes come from migration, construction works, commerce, tourism sector, administration or informal activities.
Access to service and infrastructure: low: financial services; moderate: health, technical assistance, employment (eg off-farm), market, energy, roads & transport, drinking water and sanitation; high: education
Market orientation: subsistence (self-supply)



Technical drawing

Left: Cross-section of dyke (locally called tabia) and terrace (cropping area). The Jessour ensure the collection of both runoff water and sediments allowing creating very deep 'artificial' soils (terrace) which form a very good reservoir for water and nutrients to be used by fruit trees and annual crops. Right: The spillway allows the overflow to the other Jessour downstream. It also represents the symbol of water sharing equity between different farmers in the same watershed.
(Drawing adapted from El Amami (1984))
(Ouessar M.)

Implementation activities, inputs and costs

Establishment activities

- Dyke construction
- Plantations
- Spillway construction

Establishment inputs and costs per ha

Inputs	Costs (US$)	% met by land user
Labour	1200.00	100%
Construction material		
- Total cost	1000.00	100%
Agricultural		
- Total cost	800.00	100%
TOTAL	**3000.00**	**100.00%**

Maintenance/recurrent activities

- Crop and trees maintenance
- Dyke and spillway maintenance
- Repairs
- Tillage (against soil sealing)

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US$)	% met by land user
Labour	400.00	100%
Construction material		
- Total cost	300.00	100%
Agricultural		
- Total cost	200.00	100%
TOTAL	**900.00**	**100.00%**

Remarks:
Found in inaccessible and even remote areas, labour is the most determining factors affecting the costs of this system.
The technology establishment and maintenance costs met by the land users are 100% if executed on a private basis, but it can range from 10 to 50% when the site is subject to a publicly-funded programme.

Assessment

Impacts of the Technology

Production and socio-economic benefits		Production and socio-economic disadvantages	
+++	increased crop yield	++	Reduced grazing lands
++	reduced risk of production failure	++	Reduced available runoff for downstream users
++	increased farm income		
+	diversification of income sources		

Socio-cultural benefits		Socio-cultural disadvantages	
++	improved conservation / erosion knowledge	+	socio cultural conflicts
++	improved situation of disadvantaged groups		
++	improved food security / self sufficiency		

Ecological benefits		Ecological disadvantages	
+++	improved harvesting / collection of water		
++	reduced surface runoff		
++	reduced hazard towards adverse events		
++	reduced soil loss		
+	recharge of groundwater table / aquifer		

Off-site benefits		Off-site disadvantages	
++	increased water availability	++	reduced river flows
++	reduced downstream flooding	++	reduced sediment yields
++	reduced downstream siltation		
+	reduced damage on public / private infrastructure		

Contribution to human well-being / livelihoods

++

Benefits /costs according to land user

Benefits compared with costs	short-term:	long-term:
Establishment	very negative	very positive
Maintenance / recurrent	neutral / balanced	positive

Acceptance / adoption:

10% of land user families have implemented the technology with external material support.
90% of land user families have implemented the technology voluntary. This technique is very ancient and it is therefore already fully adopted/used in the region.
There is moderate trend towards (growing) spontaneous adoption of the technology.

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
This technique allowed a expansion of cropping lands in the mountain area → encourage maintenance of existing structure	Risks related to the climatic changes → It needs to be combined with supplemental irrigation
Allows crop production in very dry environments (with less than 200 mm of rainfall) → encourage maintenance of existing structure	Risk of local know how disappearence → Trainig of new generations
Collects and accumulates water, soil and nutrients behind the tabia and makes it available to crops → encourage maintenance of existing structure	Land ownership fragmentation → Agrarian reform
Reduced damage by flooding → encourage maintenance of existing structure	Productivity of the land is very low → Development of alternative income generation activities.
Well adapted technology for the ecological environment → ensure maintenance works	Land ownership fragmentation → New land access
Well known technique by the local population → training of new generations	


Gabion check dam

Tunisia - Ouvrage en gabion (Fr)

The technology of check dam is a technique consisting of binding different gabion cages filled with small stones together to form a complete flexible gabion unit.

In order to slow down the water flow in the wadi courses and improve its infiltration into deeper soil layers and geologic formations, small check dams are installed on the wadi beds. They are usually positioned in series, with a spacing of 100-500m. These dams are made of gabion. The gabion technique has been first introduced in the civil engineering domain. They are largely used since then and found many applications. A gabion is a cage which has a cubic shape filled with stony material of suitable diameter enclosed in metal grating keeping the stones together and stops them from moving under the pressure of water. The gabion is normally the name of the cage only but it is also used frequently for the whole structure itself. The technique of gabion check dam consists in binding different cages together to form a complete gabion unit. The average height varies from 1 to 4 m and its length is a function of the width of the wadi bed (Royet, 1992).

left: Gabion check dams are used to slow down (more infiltration) the runoff flow and in some cases to divert partly to neighbouring fields. (Photo: Ouessar M.)
right: Gabion check dam in the Jeffara plain. During the last flood, it was bypassed due to erosion (on the left side) and then lost its effectiveness (Photo: Cyprien Hauser)

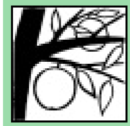
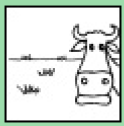
Location: Medenine
Region: Beni Kedhache - Bhayra
Technology area: 10 - 100 km2
Conservation measure: structural
Stage of intervention: rehabilitation / reclamation of denuded land
Origin: Developed externally / introduced through project, 10-50 years ago
Land use type:
Cropland: Tree and shrub cropping
Grazing land: Extensive grazing land
Land use:
Grazing land: Extensive grazing land (before), Cropland: Tree and shrub cropping (after)
Climate: arid, subtropics
WOCAT database reference: T_TUN010en
Related approach: Participative sustainable water harvesting and soil conservation in the Jeffara region (TUN001)
Compiled by: Mongi Ben Zaied, Institut des Régions Arides (IRA)
Date: 30th Dec 2008
Contact person: Mohamed Ouessar, IRA - 4119 Medenine - Tunisia

Classification

Land use problems:

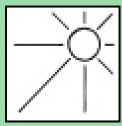
- -Degradation of soil and land cover -Loss of water and soil ressources -Flooding (expert's point of view)
Loss of water resources by flow out from the watershed (land user's point of view)

Land use

Tree and shrub cropping
Extensive grazing land
Grazing land: Extensive grazing land (before)
Cropland: Tree and shrub cropping (after)

Climate

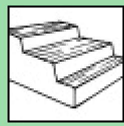


arid

Degradation

Soil erosion by water: gully erosion / gullying

Conservation measure



structural: Dams / pans: store excessive water

Stage of intervention

Prevention
Mitigation / Reduction
Rehabilitation

Origin

Land users initiative: traditional (>50 years ago)
Experiments / Research: recent (<10 years ago)
Externally introduced: 10-50 years ago

Level of technical knowledge

Agricultural advisor
Land user

Main causes of land degradation:
Direct causes - Human induced: deforestation / removal of natural vegetation (incl. forest fires)

Main technical functions:
- increase of groundwater level / recharge of groundwater

Secondary technical functions:
- water spreading

Environment

Natural Environment

Average annual rainfall (mm)

> 4000 mm
3000-4000 mm
2000-3000 mm
1500-2000 mm
1000-1500 mm
750-1000 mm
500-750 mm
250-500 mm
< 250 mm

Altitude (m a.s.l.)

> 4000
3000-4000
2500-3000
2000-2500
1500-2000
1000-1500
500-1000
100-500
<100

Landform

plateau / plains
ridges
mountain slopes
hill slopes
footslopes
valley floors

Slope (%)

flat
gentle
moderate
rolling
hilly
steep
very steep

Soil depth (cm)

0-20
20-50
50-80
80-120
>120

Growing season(s): 180 days (Oct - Mar)

Ground water table: 5 - 50 m
Availability of surface water: excess (eg flood), medium, poor / none
Water quality: poor drinking water
Biodiversity: medium

Tolerant of climatic extremes: heavy rainfall events (intensities and amount), floods

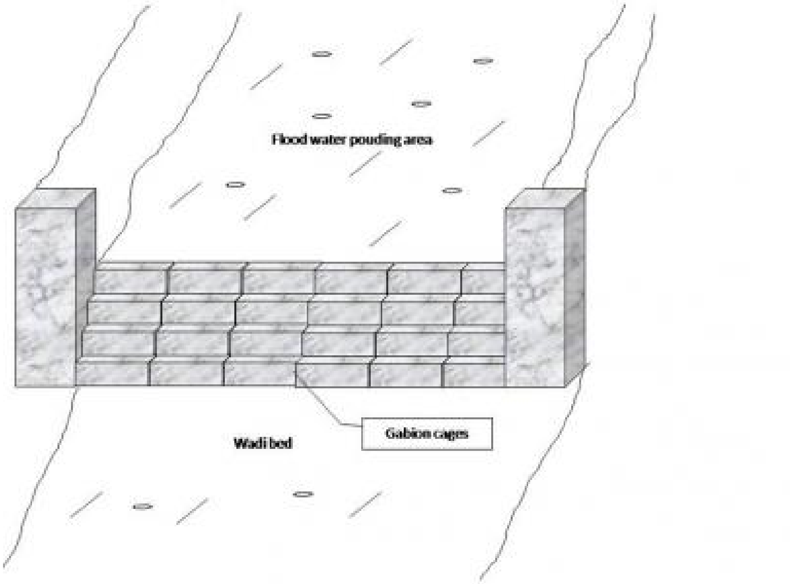
Human Environment

Cropland per household (ha)

<0.5
0.5-1
1-2
2-5
5-15
15-50
50-100
100-500
500-1,000
1,000-10,000
>10,000

Land user: groups / community, Small scale land users, common / average land users, mainly men
Population density: 10-50 persons/km2
Annual population growth: < 0.5%
Land ownership: state
Land use rights: communal (organised) (Generally, this technology is applied in the wadi beds which is considered as state owned but the local community can have access.)
Water use rights: communal (organised) (Generally, this technology is applied in the wadi beds which is considered as state owned but the local community can have access.)
Relative level of wealth: average, which represents 60% of the land users; 30% of the total area is owned by average land users

Importance of off-farm income: > 50% of all income: Off-farm incomes come from migration, construction works, commerce, tourism sector, administration or informal activities.
Access to service and infrastructure: low: financial services; moderate: health, technical assistance, employment (eg off-farm), market, energy, roads & transport; high: education, drinking water and sanitation
Market orientation:



Technical drawing

Gabion check dam is made of galvanised blocks filled with stones. (Ouessar M.)

Implementation activities, inputs and costs

Establishment activities

- Digging of the basement
- Gabion installation
- Topographic survey and selection of the site

Establishment inputs and costs per unit

Inputs	Costs (US$)	% met by land user
Labour	5000.00	0%
Construction material		
- construction material	5000.00	0%
- Gabion cages	10000.00	0%
TOTAL		**0.00%**

Maintenance/recurrent activities

- Reconstruction
- Repair of breaks

Maintenance/recurrent inputs and costs per unit per year

Inputs	Costs (US$)	% met by land user
Labour	500.00	0%
Construction material		
- construction material	500.00	0%
- Gabion cages	1000.00	0%
TOTAL	**0.00**	**0.00%**

Remarks:
construction materials

Assessment

Impacts of the Technology

Production and socio-economic benefits	Production and socio-economic disadvantages
+ increased crop yield + increased fodder production	

Socio-cultural benefits	Socio-cultural disadvantages

Ecological benefits	Ecological disadvantages
+++ increased water quantity +++ recharge of groundwater table / aquifer ++ increased water quality ++ reduced surface runoff ++ reduced hazard towards adverse events + reduced soil loss	

Off-site benefits	Off-site disadvantages
+++ increased water availability +++ reduced downstream flooding + reduced downstream siltation	++ Decrease water availability for coastal depressions (sebkhas) + Decrease water availability for downstream users

Contribution to human well-being / livelihoods

+ Recharge of groundwater (water less salty and more available) and protection against the floods.

Benefits /costs according to land user

Benefits compared with costs	short-term:	long-term:
Establishment	slightly negative	positive
Maintenance / recurrent	positive	positive

Gabion chech dams are financed by the State

Acceptance / adoption:

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Robust and flexible structures → Regular and good maintenance	Accumulation of sediments → Desilting
Efficient structures → Regular and good maintenance	They can not be fully exploited by the farmers → Change regulations.
	Very expensive and cost not affordable by normal farmers → Continue subsidising by the government.

WOCAT

Tabia
Tunisia

The tabia earthen dyke is a water harvesting technique used in the foothill and piedmont areas.

The tabia technology is similar to the jessour system but is used in the gently-sloping foothill and piedmont areas. It is considered to be a relatively new technique, developed by mountain dwellers who migrated to the plains. Tabias, like jessour, comprise an earthen dyke (50-150 m in length, 1-2 m in height), a spillway (central and/or lateral) and an associated water harvesting area. The ratio between the area where water is applied (cropped area) and the total area from which water is collected varies from 1:6 to 1:20. The differences between the tabia and the jessour systems are that the former contains two additional lateral bunds (up to 30 m long) and sometimes a small flood diversion dyke (mgoud). Small tabia are constructed manually using shovels, pickles and carts. Larger constructions are done mechanically using tractors and bulldozers.
Tree products and annual crops are commonly grown using tabia. Besides their water harvesting qualities, tabias also have a positive effect on soil erosion and groundwater recharge.
The tabia runoff-water harvesting technique is widely practised in central Tunisia. Tabias are usually installed on the piedmont, where the slope does not exceed 3% and where the soil is relatively deep. Ancient remnants of tabias have been found in the region of Gafsa (south west Tunisia). The system has been adopted by people living in the neighbouring foothills and plains of the central and southeastern regions (Jeffara) of the country, following the transformation of their pasture to cultivated fields.

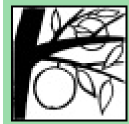
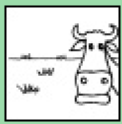
left: Tabia on the piedmont area. Tree products (olive, almond, fig, palm) and annuals (barley) can be harvested. (Photo: M. Chniter)
right: Tabia earthen dam in the plain. Olive trees are generally grown along the dam, where the harvested water infiltrates better (Photo: Ouessar M.)

Location: Medenine
Region: Medenine nord
Technology area: 10 - 100 km2
Conservation measure: structural
Stage of intervention: prevention of land degradation
Origin: Developed externally / introduced through project, 10-50 years ago
Land use type:
Cropland: Tree and shrub cropping
Grazing land: Extensive grazing land
Climate: arid, subtropics
WOCAT database reference: T_TUN012en
Related approach: Participative sustainable water harvesting and soil conservation in the Jeffara region (A_TUN001), Dryland watershed management approach (A_TUN009)
Compiled by: Mohamed Ouessar, Institut des Régions Arides (IRA)
Date: 05th Jul 2011
Contact person: Mongi Chniter, CRDA, 4100 Medenine, Tunisia

Classification

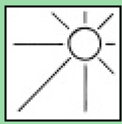
Land use problems:
- - soil erosion by water - runoff loss into the sea - overgrazing (expert's point of view)
- soil erosion by water - runoff and soil loss (land user's point of view)

Land use

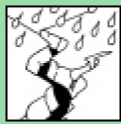
Tree and shrub cropping
Extensive grazing land
rainfed

Climate



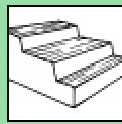
arid

Degradation



Soil erosion by water: loss of topsoil / surface erosion

Conservation measure



structural: Bunds / banks

Stage of intervention

- Prevention
- Mitigation / Reduction
- Rehabilitation

Origin

- Land users initiative: traditional (>50 years ago)
- Experiments / Research
- Externally introduced: 10-50 years ago

Level of technical knowledge

- Agricultural advisor
- Land user

Main causes of land degradation:
Direct causes - Natural: Heavy / extreme rainfall (intensity/amounts)
Indirect causes: land tenure

Main technical functions:
- control of concentrated runoff: retain / trap

Secondary technical functions:
- increase of infiltration
- water spreading

Environment

Natural Environment

Average annual rainfall (mm)

- > 4000 mm
- 3000-4000 mm
- 2000-3000 mm
- 1500-2000 mm
- 1000-1500 mm
- 750-1000 mm
- 500-750 mm
- 250-500 mm
- < 250 mm

Altitude (m a.s.l.)

- > 4000
- 3000-4000
- 2500-3000
- 2000-2500
- 1500-2000
- 1000-1500
- 500-1000
- 100-500
- <100

Landform

- plateau / plains
- ridges
- mountain slopes
- hill slopes
- footslopes
- valley floors

Slope (%)

- flat
- gentle
- moderate
- rolling
- hilly
- steep
- very steep

Soil depth (cm)

- 0-20
- 20-50
- 50-80
- 80-120
- >120

Growing season(s): 180 days (Oct - Apr)
Soil texture: medium (loam)
Soil fertility: very low
Topsoil organic matter: low (<1%)
Soil drainage/infiltration: medium

Soil water storage capacity: medium
Ground water table: 5 - 50 m
Availability of surface water: medium
Water quality: poor drinking water
Biodiversity: medium

Tolerant of climatic extremes: heavy rainfall events (intensities and amount)
Sensitive to climatic extremes: droughts / dry spells

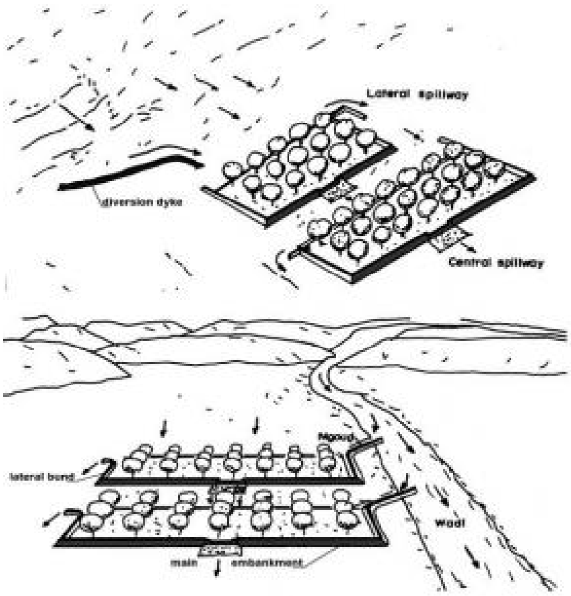
Human Environment

Cropland per household (ha)

- <0.5
- 0.5-1
- 1-2
- 2-5
- 5-15
- 15-50
- 50-100
- 100-500
- 500-1,000
- 1,000-10,000
- >10,000

Land user: Individual / household, Small scale land users, common / average land users, mainly men
Population density: 10-50 persons/km2
Annual population growth: 0.5% - 1%
Land ownership: individual, titled
Land use rights: individual
Water use rights: individual
Relative level of wealth: average, which represents 70% of the land users; 75% of the total area is owned by average land users

Importance of off-farm income: > 50% of all income:
Access to service and infrastructure: low: financial services; moderate: health, technical assistance, employment (eg off-farm), market, energy, roads & transport, drinking water and sanitation; high: education
Market orientation: mixed (subsistence and commercial)



Technical drawing

Tabia with natural water collection area (upper) and tabia on an expanded system with additional flood water diversions (lower). (Adapted from Alaya et al. 1993) Found in flatter areas, tabia can accommodate more trees on the terrace especially when it can receive additional water from floods. (Adapted from Alaya et al. 1993)

Implementation activities, inputs and costs

Establishment activities

- Diversion channel
- Plantation
- Spillway construction
- Terracing

Establishment inputs and costs per ha

Inputs	Costs (US$)	% met by land user
Labour	500.00	100%
Construction material		
- Other	170.00	100%
TOTAL	**670.00**	**100.00%**

Maintenance/recurrent activities

- Dyke and spillway maintenance
- Reconstruction

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US$)	% met by land user
Labour	150.00	100%
Construction material		
- Other	50.00	100%
TOTAL	**200.00**	**100.00%**

Remarks:
Labour is the most determining factor affecting the costs.
The technology establishment and maintenance costs met by the land users are 100% if executed on a private basis, but it can range from 10 to 50% when the site is part of a publicly-funded programme.

Assessment

Impacts of the Technology

Production and socio-economic benefits

- ++ increased crop yield
- ++ reduced risk of production failure
- ++ increased farm income
- ++ increased production area

Production and socio-economic disadvantages

- ++ loss of grazing land

Socio-cultural benefits

- ++ improved conservation / erosion knowledge
- + improved food security / self sufficiency

Socio-cultural disadvantages

Ecological benefits

- +++ improved harvesting / collection of water
- ++ reduced surface runoff
- ++ recharge of groundwater table / aquifer
- ++ reduced hazard towards adverse events
- ++ reduced soil loss

Ecological disadvantages

- + increased evaporation

Off-site benefits

- ++ increased water availability
- + reduced downstream flooding
- + reduced downstream siltation
- + reduced damage on public / private infrastructure

Off-site disadvantages

- + reduced river flows
- + reduced sediment yields

Contribution to human well-being / livelihoods

+

Benefits /costs according to land user

Benefits compared with costs	short-term:	long-term:
Establishment	negative	very positive
Maintenance / recurrent	positive	very positive

Acceptance / adoption:

35% of land user families have implemented the technology with external material support.
65% of land user families have implemented the technology voluntary.
There is strong trend towards (growing) spontaneous adoption of the technology.

Concluding statements

Strengths and → how to sustain/improve

This technique allows a rapid expansion of cropping lands in the piedmont and flat areas → encourage maintenance of existing structure

Allows crop production in very dry environments (with less than 200 mm of rainfall) → encourage maintenance of existing structure

Collects and accumulates water, soil and nutrients behind the tabia and makes it available to crops → encourage maintenance of existing structure

Reduced damage by flooding → encourage maintenance of existing structure

Improved production and expansion of cropping land →

Weaknesses and → how to overcome

Risks related to the climatic changes → it needs to be combined with supplementary irrigation

Drought spells → Supplemental irrigation

Land ownership fragmentation → new land access / agrarian reform

Productivity of the land is very low → development of alternative income generation activities

Risk of local know-how disappearance → training of new generations

Expansion is done at the expense of natural grazing land →

Cistern

Tunisia - Majen / Majel / fasquia (Ar)

left: Different components of a cistern (majen/majel): the impluvium (collection area), the decantation basin, the main reservoir, and the outlet. (Photo: Ouessar M.)

Cisterns are reservoirs used for storing rainfall and runoff water for multiple purposes: drinking, animal watering and supplemental irrigation.

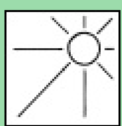
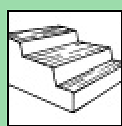
Cisterns were traditionally used to provide drinking water. In the cistern system, runoff water is collected and stored in stone-faced underground cisterns, of various sizes, called majel (private reservoirs) and fesquia (communal reservoirs). Basically, a cistern is a hole dug in the ground and lined with a gypsum or concrete coating, in order to avoid vertical and lateral infiltration. Each unit consists of three main parts: the impluvium, the sediment settlement basin, and the storage reservoir. The impluvium is a sloping piece of land delimited by a diversion channel (hammala).
It is estimated that a tank with a capacity of 35 m3 can meet the annual water needs of a family and its livestock (Ennabli, 1993).
In flat areas, where it is possible also to exploit floods via a diversion dyke, one also finds artificially paved runoff areas. A small basin before the entrance of the cistern allows the sedimentation of runoff loads. This improves the stored water quality and reduces maintenance costs. Big cisterns have, in addition to the storage compartment, a pumping reservoir from which water is drawn (Ouessar, 2007).
Small private and communal cisterns (5 to 200 m3) and big cisterns (up to 70,000 m3), mainly built during the Roman and Arab-Muslim eras, can be found throughout the water-deficient zone south of the 400-mm isohyet .

Location: Medenine
Region: Medenine nord
Technology area: 10 - 100 km2
Conservation measure: structural
Stage of intervention: mitigation / reduction of land degradation
Origin: Developed through land user`s initiative, traditional (>50 years ago)
Land use type:
Mixed: Other
Climate: arid, subtropics
WOCAT database reference: T_TUN013en
Related approach: Participative sustainable water harvesting and soil conservation in the Jeffara region (TUN001)
Compiled by: Mohamed Ouessar, Institut des Régions Arides (IRA)
Date: 31st Jan 2009
Contact person: Mongi Chniter, CRDA, 4100 Medenine, Tunisia

Classification

Land use problems:

- Runoff loss (expert's point of view)
Water loss (land user's point of view)

Land use	Climate	Degradation	Conservation measure
			
Other	arid	Water degradation: aridification	structural: Others ()

Stage of intervention

- Prevention
- Mitigation / Reduction
- Rehabilitation

Origin

- Land users initiative: traditional (>50 years ago)
- Experiments / Research: recent (<10 years ago)
- Externally introduced: 10-50 years ago

Level of technical knowledge

- Agricultural advisor
- Land user

Main causes of land degradation:
Direct causes - Natural: droughts

Main technical functions:
- water harvesting / increase water supply

Secondary technical functions:

Environment

Natural Environment

Average annual rainfall (mm)

- > 4000 mm
- 3000-4000 mm
- 2000-3000 mm
- 1500-2000 mm
- 1000-1500 mm
- 750-1000 mm
- 500-750 mm
- 250-500 mm
- < 250 mm

Altitude (m a.s.l.)

- > 4000
- 3000-4000
- 2500-3000
- 2000-2500
- 1500-2000
- 1000-1500
- 500-1000
- 100-500
- <100

Landform

- plateau / plains
- ridges
- mountain slopes
- hill slopes
- footslopes
- valley floors

Slope (%)

- flat
- gentle
- moderate
- rolling
- hilly
- steep
- very steep

Soil depth (cm)

- 0-20
- 20-50
- 50-80
- 80-120
- >120

Growing season(s): 180 days (Oct - Apr)

Water quality: good drinking water

Tolerant of climatic extremes: temperature increase, seasonal rainfall increase, heavy rainfall events (intensities and amount), wind storms / dust storms, floods, decreasing length of growing period
Sensitive to climatic extremes: seasonal rainfall decrease, droughts / dry spells

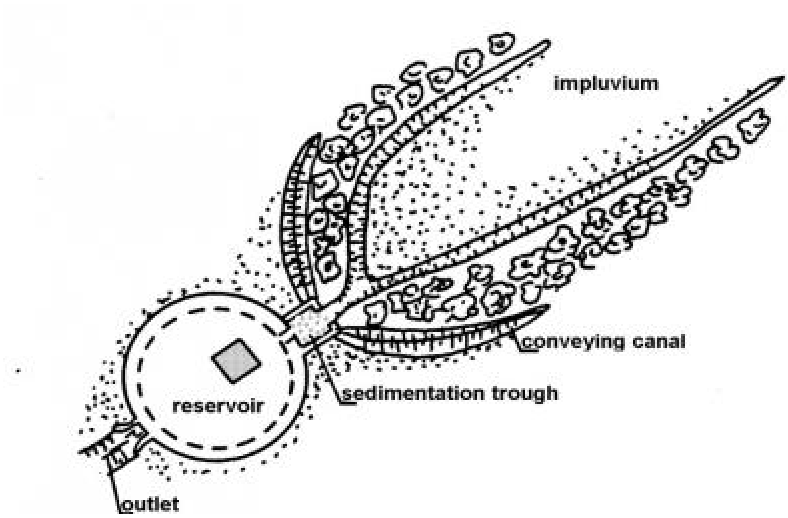
Human Environment

Mixed per household (ha)

- <0.5
- 0.5-1
- 1-2
- 2-5
- 5-15
- 15-50
- 50-100
- 100-500
- 500-1,000
- 1,000-10,000
- >10,000

Land user: Individual / household, Small scale land users, common / average land users, mainly men
Population density: 10-50 persons/km2
Annual population growth: 0.5% - 1%
Land ownership: individual, titled
Land use rights: individual
Water use rights: individual
Relative level of wealth: average, which represents 70% of the land users; 75% of the total area is owned by average land users

Importance of off-farm income: > 50% of all income:
Access to service and infrastructure: low: financial services; moderate: health, technical assistance, employment (eg off-farm), market, energy, roads & transport, drinking water and sanitation; high: education
Market orientation:



Technical drawing

Components of the cistern system. (Ouessar M.)

Implementation activities, inputs and costs

Establishment activities

- Coating
- Pit digging

Establishment inputs and costs per ha

Inputs	Costs (US$)	% met by land user
Labour	250.00	%
Construction material		
- Other	150.00	%
TOTAL	**400.00**	**%**

Maintenance/recurrent activities

- Desilting
- Repairs

Maintenance/recurrent inputs and costs per unit per year

Inputs	Costs (US$)	% met by land user
Labour	80.00	%
Construction material		
- Other	50.00	%
TOTAL	**0.00**	**%**

Remarks:

Assessment

Impacts of the Technology

Production and socio-economic benefits

++ increased drinking water availability
+ increased animal production

Production and socio-economic disadvantages

Socio-cultural benefits

Socio-cultural disadvantages

Ecological benefits

+++ improved harvesting / collection of water
++ increased water quantity
++ reduced hazard towards adverse events

Ecological disadvantages

++ decreased soil cover
++ increased wind velocity
++ increased soil erosion locally

Off-site benefits

Off-site disadvantages

Contribution to human well-being / livelihoods

+

Benefits /costs according to land user			
	Benefits compared with costs	**short-term:**	**long-term:**
	Establishment	positive	positive
	Maintenance / recurrent	positive	positive

Acceptance / adoption:

30% of land user families have implemented the technology with external material support.
70% of land user families have implemented the technology voluntary.
There is moderate trend towards (growing) spontaneous adoption of the technology.

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Increased availability of water especially in remote areas →	Creation of degradation hot spots around animal watering points. → Multiplication of watering points.
Availability of water for multiple purposes →	

Recharge well

Tunisia - Puits de recharge (French)

A recharge well comprises a drilled hole, up to 30-40 m deep that reaches the water table, and a surrounding filter used to allow the direct injection of floodwater into the aquifer.

The main worldwide used methods to enhance groundwater replenishment are through recharge basins or recharge wells. Though groundwater recharge aiming at storage of water in the periods of abundance for recovery in times of drought has a long history dating back millennia, the recharge wells began to be used only in the twentieth century, especially during the Second World War following concerns on attacks of the water supply facilities. Its use was extended later to sea intrusion control, treated waste water, water harvesting in the dry areas, and strategic water storage.
Recharge wells are used in combination with gabion check dams to enhance the infiltration of floodwater into the aquifer. In areas where the permeability of the underlying bedrock in front of a gabion is judged too low, recharge wells could be installed in wadi (ephemeral river) beds. Water is retained by the gabion check dam and it flows through the recharge well allowing accelerated percolation into the aquifer. A recharge well consists of a long inner tube surrounded by an outer tube, the circumference of which ranges between 1 and 2 m. The area between the tubes is filled with river bed gravel which acts as a sediment filter. Water enters the well through rectangular-shaped openings (almost 20 cm long and a few mm in width) located in the outer tube, and it flows in the inner hole having passed through the gravel and the rectangular shaped openings of the dill hole. The above-ground height is around 2 to 3 m whereas the depth is linked to the depth of the water table (normally up to 40 m). The drill hole connects directly with the aquifer, where it is connected either directly with the water table or indirectly via cracks. Pond volume is dependent on the size of the gabion check dam but generally ranges between 500 and 3000 m3. The filtered water can directly flow into the aquifer at a rate exceeding what would occur naturally through the soil and the underlying strata. The design should be conducted primarily by a hydrogeologist and a soil and water conservation specialist in order to determine the potential sites and the required drilling equipment. Drilling needs to be carried out by a specialized company. Depending on the geological setting, the overall cost is around 5000 to 10000 US$. The recharge wells are used to recharge the deep groundwater aquifers, which are mainly exploited by government agencies. However, private irrigated farms are benefiting indirectly by increased groundwater availability.
This technique has been first tried for the replenishment of the Zeuss-Koutine aquifer (south east Tunisia).

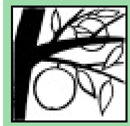
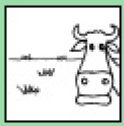
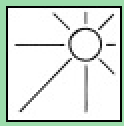
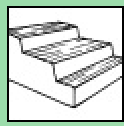
left: This is an example of a recharge well behind a gabion check dam after rain. (Photo: Ouessar M)
right: A recharge well needs to be always combined with a gabion check dam which prevents floodwater movement downstream and creates a temporary pond (Photo: Temmerman S.)

Location: Medenine
Region: Medenine nord
Technology area: 10 - 100 km2
Conservation measure: structural
Stage of intervention: prevention of land degradation
Origin: Developed externally / introduced through project, 10-50 years ago
Land use type:
Cropland: Tree and shrub cropping
Grazing land: Extensive grazing land
Climate: arid, subtropics
WOCAT database reference: T_TUN014en
Related approach: Dryland watershed management approoc (A_TUN009), Participative sustainable water harvesting and soil conservation in the Jeffara region (A_TUN001)
Compiled by: Mohamed Ouessar, Institut des Régions Arides (IRA)
Date: 10th Jun 2011
Contact person: Houcine Yahyaoui, CRDA, 4100 Medenine, Tunisia

Classification

Land use problems:

- Runoff water loss, riverbank erosion, flooding risk, aridity (expert's point of view)
water loss (land user's point of view)

Land use	Climate	Degradation	Conservation measure
 			
Tree and shrub cropping Extensive grazing land	arid	Water degradation: aridification	structural: Others ()

Stage of intervention

- Prevention
- Mitigation / Reduction
- Rehabilitation

Origin

- Land users initiative
- Experiments / Research: recent (<10 years ago)
- Externally introduced: 10-50 years ago

Level of technical knowledge

- Agricultural advisor
- Land user

Main causes of land degradation:
Direct causes - Human induced: over abstraction / excessive withdrawal of water (for irrigation, industry, etc.)

Main technical functions:
- increase of groundwater level / recharge of groundwater

Secondary technical functions:
- water harvesting / increase water supply

Environment

Natural Environment

Average annual rainfall (mm)

- > 4000 mm
- 3000-4000 mm
- 2000-3000 mm
- 1500-2000 mm
- 1000-1500 mm
- 750-1000 mm
- 500-750 mm
- 250-500 mm
- < 250 mm

Altitude (m a.s.l.)

- > 4000
- 3000-4000
- 2500-3000
- 2000-2500
- 1500-2000
- 1000-1500
- 500-1000
- 100-500
- <100

Landform

- plateau / plains
- ridges
- mountain slopes
- hill slopes
- footslopes
- valley floors

Slope (%)

- flat
- gentle
- moderate
- rolling
- hilly
- steep
- very steep

Soil depth (cm)

- 0-20
- 20-50
- 50-80
- 80-120
- >120

Growing season(s): 180 days (Oct - Apr)
Soil texture: medium (loam)
Soil fertility: very low
Topsoil organic matter: low (<1%)
Soil drainage/infiltration: medium

Soil water storage capacity: medium
Ground water table: 5 - 50 m
Availability of surface water: poor / none
Water quality: poor drinking water
Biodiversity: medium

Tolerant of climatic extremes: temperature increase, seasonal rainfall increase, seasonal rainfall decrease, heavy rainfall events (intensities and amount), wind storms / dust storms, droughts / dry spells, decreasing length of growing period
Sensitive to climatic extremes: extreme floods

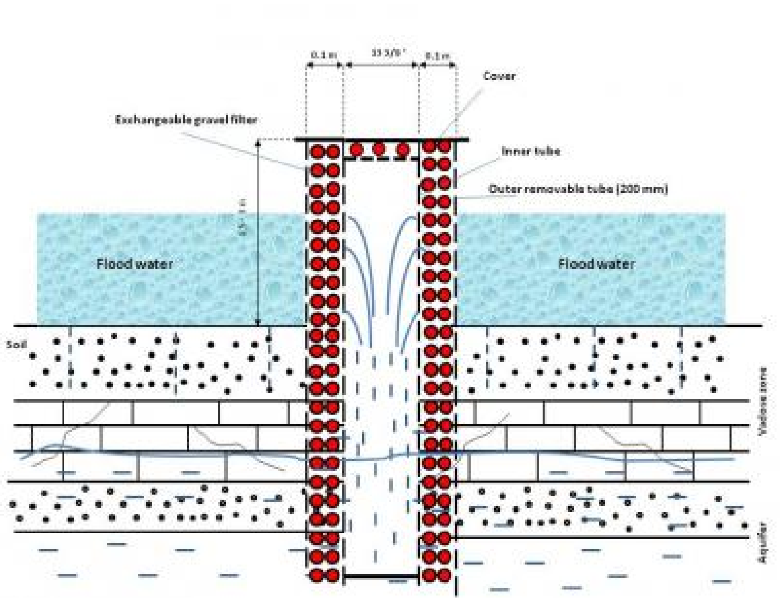
Human Environment

Cropland per household (ha)

- <0.5
- 0.5-1
- 1-2
- 2-5
- 5-15
- 15-50
- 50-100
- 100-500
- 500-1,000
- 1,000-10,000
- >10,000

Land user: employee (company, government)
Population density: 10-50 persons/km2
Annual population growth: 0.5% - 1%
Land ownership: state
Land use rights: communal (organised) (The recharge wells are used to recharge the deep groundwater aquifers which are mainly exploited by the government agencies. However, private irrigated farms could benefit indirectly, by increased groundwater availability.)
Water use rights: communal (organised) (The recharge wells are used to recharge the deep groundwater aquifers which are mainly exploited by the government agencies. However, private irrigated farms could benefit indirectly, by increased groundwater availability.)
Relative level of wealth: average, which represents 70% of the land users; 75% of the total area is owned by average land users

Importance of off-farm income: > 50% of all income:
Access to service and infrastructure: low: financial services; moderate: health, technical assistance, employment (eg off-farm), market, energy, roads & transport, drinking water and sanitation; high: education
Market orientation: mixed (subsistence and commercial)



Technical drawing

Schematic representation of the main components of a recharge well. The flood water retained behind the gabion check dam flows through the outer tube and the gravel filter into the water table. Clogging of the filter is one of the major problems to be considered and solved. (Ouessar M.)

Implementation activities, inputs and costs

Establishment activities

- Drilling
- Installation

Establishment inputs and costs per ha

Inputs	Costs (US$)	% met by land user
Labour	7000.00	0%
Construction material		
- Other Construction material	1000.00	0%
TOTAL	**8000.00**	**0.00%**

Maintenance/recurrent activities

- Desilting of the filter
- Repairs

Maintenance/recurrent inputs and costs per unit per year

Inputs	Costs (US$)	% met by land user
Labour	500.00	0%
Construction material		
- Other Construction material	100.00	0%
TOTAL	**600.00**	**0.00%**

Remarks:
Labour is the most determining factor affecting the costs.

Assessment

Impacts of the Technology

Production and socio-economic benefits	Production and socio-economic disadvantages
++ increased drinking water availability ++ increased water availability / quality ++ increased irrigation water availability quality	

Socio-cultural benefits	Socio-cultural disadvantages
+ conflict mitigation + improved conservation / erosion knowledge	

Ecological benefits	Ecological disadvantages
+++ recharge of groundwater table / aquifer ++ improved harvesting / collection of water ++ reduced hazard towards adverse events ++ reduced salinity	++ risks of contamination of aquifers

Off-site benefits	Off-site disadvantages
++ increased water availability ++ reduced downstream flooding + reduced damage on public / private infrastructure	++ reduction of surface water to reach downstream areas

Contribution to human well-being / livelihoods

++ increased availability of water for drinking, agriculture and livestock

Benefits /costs according to land user

Benefits compared with costs	short-term:	long-term:
Establishment	very positive	positive
Maintenance / recurrent	very positive	positive

Long-term benefits are slightly reduced due to silting problems.

Acceptance / adoption:

0% of land user families have implemented the technology with external material support. It is solely constrcuted by the government agencies.

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Enhance groundwater level and quality (reduce salinity) →	Silting up of the filter → Maintenance of the filters.
Replenishment of the aquifer → Good selection of the site and drilling methods	Malfunction due to aquifer geometry and characteristics → Good selection of the sites
	Retain water for dowstreams users → Proper watershed management plan

WOCAT

Dryland watershed management approach

Tunisia

Integrated land and water management approach, including vegetative, management, and agronomic measure

Aim/objectives: The overall purpose of the approach is to prevent soil and water loss by combined measures and to provide a better environment. Soil and water conservation (SWC) technologies, based on harvesting area of surface water and underground water, are implemented to conserve soil and water and to improve the production and the biodiversity.

Methods: This approach is designed for the exploitation of water runoff for agricultural development, particularly for fruit trees cropping (mainly olives).This can be achieved through erosion reduction and aquifer recharge via runoff water infiltration into the terraces, slope angle and length reduction, runoff retaining, infiltration increase and soil loss reduction. The system is based on various runoff water harvesting systems, as jessour, tabias. It is marked by fruit tree development, notably olives. On the terraces, the fruit trees are arranged in inter-rows with the three main species encountered in the study areas. Generally, olive trees are planted, with in between rows almonds and/ or fig trees. SWC technologies play an importance role in arid zones. Since the 1970s, the Tunisian state has encouraged the local population to conserve water and soil in arid zone. Successive programmes and strategies of water and soil conservation have been developed and were implemented in all three natural regions of Tunisia (North, Centre and South).These techniques can be implemented by farmer with governmental subsidies or by government intervention in the projects and programmes of water and soil conservation. During the last decade, the Tunisian government implemented the first national strategy for soil and water conservation (1990-2000) and the second national strategy for soil and water conservation (2001-2011). These strategies mobilized important funds at national and regional levels. About 672.5 ha of SWC technologies were built and about 550 ha of SWC technologies are planned for the second national strategy.

Stages of implementation: 1) Assessment of the current natural resources and socio-economic conditions; 2) Proposition of actions at local and regional level; 3) Aggregation and coherence at the national level; 4) implementation of national action plan at local and regional level.

Role of stakeholders: Different levels of intervention are observed from the individual farm, through the community level, the extension / advisory system, the regional or national administration, or the policy level, to the international framework. The participative approach is usually applied in the construction of SWC technologies.

left: The system is based on various runoff water harvesting systems, as jessour, tabias. (Photo: Cyprien Hauser)

right: Stakeholders discussing in the field various aspects of SLM approach (Photo: Mongi Sghaier)

Location: south-east of tunisia, Oum Zessar Watershed
Approach area: 350.00 km^2
Type of Approach: recent local initiative / innovative
Focus: on conservation only
WOCAT database reference: A_TUN009en
Related technology(ies): Gabions dams, Jessour, Rangeland resting, Recharge well, Tabia
Compiled by: Naceur Mahdi, Institut des Régions Arides de Médenine
Date: 2009-06-09
Contact person: Mohamed ouessar, Med.Ouessar@ira.agrinet.tn Institut des Régions Arides, 4119 Medenine, Tunisia

Problem, objectives and constraints

Problems

The problems originate in the scarcity of water which is leading to conflicts over resource use between farmers. Oversized techniques leading to prevention of runoff from upstream to downstream reduce agricultural production and therefore the farm income, which causes a lack of cash to invest in SLM. In some cases irreversible land degradation is the result. The problems are mainly related to the lack of technical knowledge, the high costs of investment and the lack of tangible and assessable impacts of SWC activities, technically or socially.

Aims/Objectives

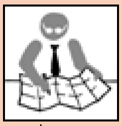
The objectives of the approach are to control soil and water loss to reduce floods and enhance fertility, to enhance rainfed agriculture productivity, to improve the livelihoods of farmers, to contribute to the production increase among farmers and pastoralists, to recharge the groundwater and to extend the area of cropland.

Constraints addressed

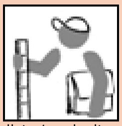
	Constraint	Treatment
technical	Designing parameters	Training , Ehancing SWC specialists guidance
institutional	Land fragmentation, complexity of land tenure,	Users organisation, participation
financial	High cost investment	Public projects (National strategy of SWC), subsidies

Participation and decision making

Stakeholders / target groups

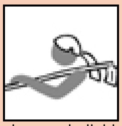


planners



SLM specialists / agricultural advisors

land users, groups



land users, individual

Approach costs met by:

local community / land user(s) ()	20%
national non-government ()	5%
government ()	55%
international ()	20%
Total	**100%**

Annual budget for SLM component: US$ 10,000-100,000

Decisions on choice of the Technology(ies) mainly by land users supported by SLM specialists

Decisions on method of implementing the Technology(ies): mainly by SLM specialists with consultation of land users

Approach designed by: national specialists, international specialists, land users

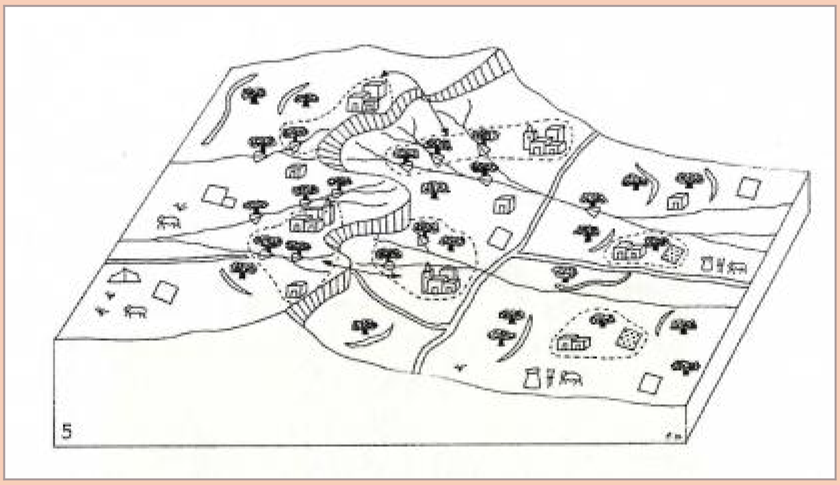
Implementing bodies: local community / land users, government

Land user involvement

Phase	Involvement	Activities
Initiation/motivation	Interactive	Farmers and local population are very familiar with traditional SWC applied. Therefore the receptiveness to these techniques is very high. There is state encouragement through subsidies.
Planning	Interactive	Workshops/seminars; After a programme is granted, the implementing agency and local communities work together.
Implementation	Payment/external support	Responsibilities are divided into major steps; In practice, local communities are the major part to manage and carry out.
Monitoring/evaluation	Interactive	Participative evaluation; Interviews/questionnaires.
Research	Interactive	It can give some suggestions or questionnaires.

Differences between participation of men and women: Yes, moderate
Special attention has been paid to make women participate in the approach. Nevertheless, men have much more technical knowledge and skills than women.
If SWC technologies have to be constructed by manual labour, men can achieve more..

Involvement of disadvantaged groups: Yes, great
Poor and old people are especially involved through their participation in the special programme against unemployment in rural area. Some unemployed young people may benefit from agricultural development programmes.



Organogram: The treatment of the catchment starts from the upstream and continues to piedmont areas, and ends in the downstream section of the catchment. Attention should be given to ensure sufficient water allocation to all the sections of the catchment as well as to the different users (rainfed agriculture and rangelands, irrigated areas, drinking water, industry and tourism). (Patricia Home)

Technical support

Training / awareness raising:
Training provided for land user, field staff/agricultural advisor
The capacity building programme and activities have benefited farmers representing the diversity of land users (women and men); representatives of NGO; local and external stakeholders, engineers and technicians responsible of the services of agriculture and forest.
Training was site visits / farmer to farmer, demonstration areas, public meetings
Training focused on Training focused on teaching them how to design and build SWC technologies, how to implement these technologies and about the participatory approach.

Advisory service:
Name: Integrated watershed management
Key elements:
1. Training and demonstration open days
2. Demonstration plots implemented in private farms
3. Target farmers groups are visited by specialist to help and advise them.

1) Advisory service was carried out through: government's existing extension system 2) Advisory service was carried out through: government's existing extension system; Extension staff: mainly government employees 3) Target groups for extension: planners; Activities: training
The extension system is quite adequate to ensure continuation of activities. The extension system is adequate to ensure continuation of activities. At each governorate level, there is a SWC division which is in charge of SWC activities, including its extension.extension

Research:
Yes, great research. Topics covered include technology, approaches
Mostly on station and on-farm research.
Land users have been involved. SWC technologies construction is based on scientific design, according to local conditions.

External material support / subsidies

Contribution per area (state/private sector): Yes. construction material

Labour: Voluntary, rewarded with other material support. rewarded with in-kind support by government subsidies

Inputs:
- Equipment (machinery, tools, etc) - machinery. Partly financed
- Agricultural (seeds, fertilizers, etc) - fertiliser. Not financed
- Construction material (stone, wood, etc) - stone. Partly financed

Credit: Credit was available at interest rates (999% per year) the market rates. Credit was promoted through agricultural banks with various interest rates, usually lower than market rates

Support to local institutions: Yes, moderate support with financial
support with financial resources, capacity building, training, institutional support. The financial schema is made of three main components: self-financing from farmers and beneficiaries, subsidies from the government and credit from bank.

Monitoring and evaluation

Monitored aspects	Methods and indicators
management of Approach	measurements by project/programme based recent local initiative / innovative - Impact assessment
area treated	Ad hoc measurements by project/programme based recent local initiative / innovative
bio-physical	Ad hoc measurements by project/programme based recent local initiative / innovative - Indicators are runoff loss, sediment load, soil moisture
socio-cultural	Ad hoc observations by project/programme based recent local initiative / innovative - Investigation of land users perceptions of cultural change
economic / production	Ad hoc measurements by project/programme based recent local initiative / innovative - investigation/ of yield, income of land users, rainfed productivity

Changes as result of monitoring and evaluation:

There were few changes in the approach. for example at the institutional level.

Impacts of the Approach

Improved sustainable land management: Yes, moderate; Land users can harvest water and irrigate crops in dry seasons. Meanwhile, the cropland area is enlarged.

Adoption by other land users / projects: Yes, many

Improved livelihoods / human well-being: Yes, great; because of increased farm income.

Improved situation of disadvantaged groups: Yes, great; for disadvantaged women and men, there are employment opportunities and food self-sufficiency

Poverty alleviation: Yes, great; this appraoch increase farm income, food self-sufficiency and employer opportunities

Training, advisory service and research:

- Training effectiveness

  Land users* - good
  SLM specialists - good
  Politicians / decision makers - good

  Training was effective for all target groups.

- Advisory service effectiveness

  Land users* - good
  Politicians / decision makers - good

  The land users accept the approach when they get the real benefit. The decision makers accept the approach when they realize that the approach can produce combined social, economic and ecological benefits.

- Research contributing to the approach`s effectiveness: Moderately
  The method is success in both theory and practice

Land/water use rights:

Help - greatly in the implementation of the approach. The approach helped in the privatization of the land and has therefore greatly reduced the land/water use rights problems. This in turn has rendered the local interventions much more efficient.
The approach did reduce the land/water use rights problem (greatly).

Long-term impact of subsidies:

Positive long-term impact - Moderately
Negative long-term impact - Greatly
As more and more payment is currently being made to land users on the basis of the area treated, land users rely more and more on being paid for investments into SWC. The willingness to invest in SWC measures without receiving financial support has decreased. Thus the use of incentives in the current approach is considered to have a negative long-term impact.

Concluding statements

Main motivation of land users to implement SLM:

Well-being and livelihoods improvement - Employer opportunities

Production - increase yield; Food self-sufficiency

Increased profit(ability), improve cost-benefit-ratio - increase farm income

Payments / subsidies - invest in SWCT

Sustainability of activities:

It is uncertain whether the land users will be able to sustain the approach activities.

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Reduction of soil erosion → ensure the durability of the works implemented	Low impact on livelihood conditions → improve efficiency of SWC activities and participatory approach
More participation and involvement of local population → Improve participatory approach and increase confidence between partners	Abandonment of the works, less maintenance → Continue to support farmers and local institution and organisation. Repairing and maintaining in time.
Many people involved and trained at different levels (pyramid system) → participatory approach	High costs: farmers depend on external support from the government; they are not willing to invest their labour without payments → New approach should give farmers loans for construction as now they use machines to do the work. In addition, search for cheaper SWC technologies and for improving the benefits.
Improvement of livelihood → spreading and improvement of a more holistic SLM approach focusing on livelihoods	Less confidence between partners and less participation → improve dialog and communication; improve efficiency of SWC activities and participatory approach.