Terraces with improved seed and fertilizer application (Afghanistan)

Palbandi bo tukhmhoi behbudyofta va ku'd

Terraced plot in Sari Joy (Mia Jan Maroofi)

DESCRIPTION

Terraces are established on mountain slopes used mainly for cropping wheat, with the purpose of soil protection from erosion, preserving runoff, sediments and nutrients on-site. Improved seeds and fertilizer are applied on the terraces for increasing crop yield, but also vegetation cover and biomass production, and thus prevent further land degradation.

Project supported implementation of terraces with application of improved seeds and fertilizer has taken place in the villages Sari Joy, Jawaz Khana and Dashti Mirzai, located in Chokar watershed of Rustaq District in Northern Afghanistan. The Chokar watershed is a mountainous area situated between 600 - 2,500 m above sea level. The climate is semi-arid with harsh and cold weather in winter and hot and dry summers. The annual precipitation in average years is 580mm. Land degradation affects all forms of land use and includes low vegetation cover, heavy top soil erosion from water, and poor soil fertility. Unsustainable agricultural practices, over-exploitation and high pressure on the natural resources are adversely impacting on the socio-economic well-being of local communities as well as contributing to the risk for being adversely affected by drought as well as landslides and flash floods triggered by heavy rainfall.

The data used for the documentation of the technology is based on field research conducted in Chokar watershed, namely in the villages: Sari Joy, Jawaz Khana and Dashti Mirzai. These villages represent the upper, the middle and the lower zone of Chokar watershed, respectively. They differ considerably in access to services and infrastructure, but in general are poorly served. The communities depend mainly on land resources for sustaining their livelihoods. In a good year with high yields, wheat-self-sufficiency lasts about 5 months.

Since 2012 the Livelihood Improvement Project Takhar (LIPT) implemented by Terre des hommes (Tdh) Switzerland has initiated a range of NRM interventions. The project introduced terraces as sustainable land management practices on private plots, situated on rolling (11-15%) and hilly (16-30%) slopes to protect the land from soil erosion and prevent the loss of water and fertile topsoil, seeds and fertilizers. The average plot size for terrace implementation is 2 Jerib (0.4 hectares) with contour strips of 40m x 4m. The height of the risers is 1m-1.5 m. Terrace benches are built along the contour by moving the soil above the bench downwards. The levelled benches of the terrace are cultivated with wheat. The risers of the terrace are mostly used for growing fodder crops, mostly alfalfa, which also helps to stabilize the terrace. If medicinal herbs (ferula) are included they are cultivated along the bench contours.

Maintenance activities include small repair work on the riser by adding some amount of soil and re-sowing of alfalfa seeds on those spots.

Terraces allow application of improved seeds and fertilizers without them being washed off. The land-users report noticeable increase of wheat yield from the terraced plot with application of improved seeds and fertilizer compared to the non-terraced plot. An average plot of 0.2 ha on non-terraced hilly cropland used to give about 70 kg of wheat (350kg/ha). On terraces the yield has increased/ doubled to 140 kg on the same plot area (700kg/ha).

The expectations regarding terraces remain high as over the time the land user hope their land will become more stable and improved soil moisture and fertility will have positive impact on the productivity as well. However, so far no cost-benefit assessment has been conducted allowing attribution of individual measure to the wheat increase.

Many land users are interested in the terrace technology due to a number of environmental and economic benefits expected, however the costs for building the terrace are considered high by an average local land user. They have to rely on external support in order to have sufficient resources for implementation. Women considered an advantage that during the establishment phase, men were paid by the project to work on their own land (or other villagers land) when building the terraces. Thus, there was no need for men to go for seasonal labour migration and they stayed at home.

LOCATION

Location: Chokar Watershed: Sari Joy (upper watershed), Jawaz Khana (middle watershed), Dashti Mirzai (lower watershed), Takhar Province, Rustaq District, Afghanistan

No. of Technology sites analysed: 10-100 sites

Geo-reference of selected sites

- 69.85151, 36.99307
- 69.8599, 36.99288
- 69.85908, 36.98401
- 69.85951, 37.00393
- 69.86123, 36.99128
- 69.73747, 36.91776
- 69.72755, 36.91261
- 69.72692, 36.91439
- 69.84418, 37.00255
- 69.84744, 36.99752
- 69.72682, 36.91757
- 69.85151, 36.99307
- 69.71925, 36.90521
- 69.73147, 36.90648
- 69.72571, 36.9058
- 69.72609, 36.90644
- 69.71959, 36.90681
- 69.7314, 36.20869
- 69.73793, 36.90923

Spread of the Technology: evenly spread over an area (approx. 0.1-1 km2)

In a permanently protected area: No

Date of implementation: less than 10 years ago (recently)

Type of introduction

- through land users’ innovation
- as part of a traditional system (> 50 years) during experiments/ research
- through projects/ external interventions
CLASSIFICATION OF THE TECHNOLOGY

Main purpose
- ✓ improve production
- ✓ reduce, prevent, restore land degradation
- ✓ conserve ecosystem
- ✓ protect a watershed/dowstream areas – in combination with other Technologies
- ✓ preserve/improve biodiversity
- ✓ reduce risk of disasters
- ✓ adapt to climate change/extremes and its impacts
- ✓ mitigate climate change and its impacts
- ✓ create beneficial economic impact
- ✓ create beneficial social impact

Land use
- Cropland
  - ✓ Annual cropping
  - ✓ Perennial (non-woody) cropping
- Number of growing seasons per year: 1

Water supply
- ✓ rainfed
- ✓ mixed rainfed-irrigated
- ✓ full irrigation

Purpose related to land degradation
- ✓ prevent land degradation
- ✓ ✓ reduce land degradation
- ✓ ✓ restore/rehabilitate severely degraded land
- ✓ adapt to land degradation
- ✓ not applicable

Degradation addressed
- ✓ soil erosion by water - Wt: loss of topsoil/surface erosion, Wg: gully erosion/gullying, Wo: offsite degradation effects
- ✓ physical soil deterioration - Pi: soil sealing
- ✓ biological degradation - Bc: reduction of vegetation cover, Bq: quantity/biomass decline
- ✓ water degradation - 

SLM group
- ✓ cross-slope measure

SLM measures
- ✓ agronomic measures - A2: Organic matter/soil fertility
- ✓ vegetative measures - V2: Grasses and perennial herbaceous plants
- ✓ structural measures - S1: Terraces

TECHNICAL DRAWING

Technical specifications
Terraces are established predominantly on a privately owned land in a mountainous landscape with varying steepness of slopes. The average size of a plot is 2 Jerib, which is equal to 0.4 ha. The design of the terrace depends on the steepness of the slope. Mostly rolling (11-15%) and hilly (16-30%) slopes are used for building terraces.

Using an A-frame, the terrace is designed by dividing the slope into contour strips. Depending on the slope steepness, the terrace bench is around 4m wide and the height of the risers is 1m-1.5m. The terrace benches are built along the contour by moving the soil of upper bench to the lower bench. The leveled benches of the terrace are cultivated with wheat. The risers of the terrace are mostly used for growing fodder crops, such as alfalfa, which also helps to stabilize the terrace. If medicinal herbs are included, such as ferula, they are cultivated along the bench contours.

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs
- ✓ Costs are calculated: per Technology area (size and area unit: 1 ha)

Most important factors affecting the costs
- Due to the remoteness of the villages where the Technology has
Establishment activities

1. Selection of the area for establishing a terrace (Men) (Timing/ frequency: Autumn)
2. Designing of the terrace using A-frame, assisted by trained technician/project staff (Men) (Timing/ frequency: End of autumn after rainy days)
3. Leveling the soil with a shovel (Men) (Timing/ frequency: Autumn/Winter)
4. Sowing of alfalfa seeds on the risers (Men/Women) (Timing/ frequency: After 20 days of sowing wheat)
5. Sowing of wheat seeds on benches (Men/Women) (Timing/ frequency: Winter/Spring)
6. Sowing of ferula along the contours (Men/Women) (Timing/ frequency: Winter/Spring)

Total costs for establishment of the Technology in USD 1'275.48

Total costs for establishment of the Technology in USD 19.04

Maintenance inputs and costs (per 1 ha)

<table>
<thead>
<tr>
<th>Specify input</th>
<th>Labour</th>
<th>Equipment</th>
<th>Plant material</th>
<th>Fertilizers and biocides</th>
<th>Total costs per establishment of the Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Costs per Unit</td>
</tr>
<tr>
<td>Designing of the terrace using A-frame</td>
<td>person-day</td>
<td>10.0</td>
<td>0.9</td>
<td>90.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Leveling the soil with a shovel</td>
<td>person-day</td>
<td>150.0</td>
<td>5.3</td>
<td>795.0</td>
<td>51.0</td>
</tr>
<tr>
<td>Sowing of wheat and alfalfa seeds</td>
<td>person-day</td>
<td>10.0</td>
<td>5.3</td>
<td>50.0</td>
<td>51.0</td>
</tr>
<tr>
<td>Sowing of ferula</td>
<td>person-day</td>
<td>2.0</td>
<td>5.3</td>
<td>10.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Maintenance activities

1. Ploughing the land with animal traction (Men) (Timing/ frequency: Winter/Spring/Annually)
2. Sowing of wheat seeds on benches (Men/Women) (Timing/ frequency: Winter/Spring/Annually)
3. Application of fertilizer (Men/Women) (Timing/ frequency: Fall)
4. Weeding (Women) (Timing/ frequency: Summer)
5. Harvesting wheat (Men and women together) (Timing/ frequency: Summer/Fall)
6. Harvesting alfalfa (Men and women together) (Timing/ frequency: Summer/Fall)
7. Collecting and delivering harvested wheat (Men and women) (Timing/ frequency: Fall)
8. Collecting and delivering harvested alfalfa (Men and women) (Timing/ frequency: Fall)
9. Repairing terrace risers with a shovel (Men) (Timing/ frequency: Winter/Spring/After heavy rain or snow)
10. Sowing alfalfa seeds on the repaired area (Men/Women) (Timing/ frequency: Winter/Spring/When required)

Total costs for maintenance of the Technology 677.3

Total costs for maintenance of the Technology in USD 10.11

NATURAL ENVIRONMENT

Average annual rainfall
- 250 mm
- 251-500 mm
- 501-750 mm
- 751-1,000 mm
- 1,001-1,500 mm
- 1,501-2,000 mm
- 2,001-3,000 mm
- 3,001-4,000 mm
- > 4,000 mm

Agro-climatic zone
- Humid
- Sub-humid
- Semi-arid
- Arid

Specifications on climate
Average annual rainfall in mm: 580.0
Average annual precipitation for the area was calculated with 580 mm, with minimums in dry years (2000 and 2001) of 270 mm and maximums in wet years (2009/2010) of 830 mm. The absolute maximum rainfall was calculated for 1986 with 1024 mm. The data series covers the time from 1979 to 2014.

Landforms
- Plateau/plains
- Ridges
- Mountain slopes
- Hills slopes
- Foot-slopes
- Valley floors

Slope
- Flat (0-2%)
- Gentle (3-5%)
- Moderate (6-10%)
- Rolling (11-15%)
- Hilly (16-30%)
- Steep (31-60%)
- Very steep (>60%)

Soil texture (topsoil)
- Coarse/ light (sandy)
- Medium (loamy, silty)

Soil texture (> 20 cm below surface)
- Coarse/ light (sandy)
- Medium (loamy, silty)
- Fine (medium, loamy, silty)

Topsoil organic matter content
- High (>3%)
- Medium (1-3%)

Technology is applied in convex situations concave situations not relevant

Terreaces with improved seed and fertilizer application
Benefits compared with establishment costs

Off-site impacts

Ecological impacts

Socio-cultural impacts

Access to services and infrastructure

Socio-economic impacts

Market orientation

Level of mechanization

Sedentary or nomadic

Area used per household

Scale

Land ownership

Land use rights

Characteristics of land users applying the technology

IMPACTS

Socio-economic impacts

Quantity before SLM: 350 kg / ha
Quantity after SLM: 700 kg / ha

The integration of measures including agronomic (improved seed and fertilizer) and structural (terraces to control water flow and loss of top soil, including nutrients and seeds) results in an increase of crop yield already in the first year. The effects cannot be attributed to one or the other measure specifically.

The yield of the main staple crop (wheat) has been reported to be double on terraced plots with application of improved seed and fertilizer. In addition, fodder crops, such as alfalfa grown on the risers, can be harvested.

Technicians in the villages were trained in the use of A-frames. Implementers of terraces voiced that they themselves would not be able to replicated the designing of terraces.

Female headed households are not included. Technology is implemented on private land, therefore people without land are excluded. However, they have the opportunity to earn income as a hired worker for the SLM implementers.

In situ water harvesting

Both an increase in vegetation cover during the growing season when most erosive rains are observed as well as permanent vegetation cover from perennial alfalfa plants can be observed.

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

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Terraces with improved seed and fertilizer application
Benefits compared with maintenance costs

Costs: As larger parts of the establishment of the technology were covered by the project, farmers consider this part of the total costs and are likely underestimated. Benefits: Two plots were terraced in 2012, and 5 plots in 2013. However, most terraces were implemented in 2014 (11 plots) and 2015 (8 plots). The Rustaq NRM study was conducted in autumn 2016. 1-2 years of cultivating the terrace system is too short a period for providing evidence on short- and long-term returns.

CLIMATE CHANGE

Climate-related extremes (disasters)

<table>
<thead>
<tr>
<th>local rainstorm</th>
<th>drought</th>
</tr>
</thead>
<tbody>
<tr>
<td>not well at all</td>
<td>very well</td>
</tr>
<tr>
<td>not well at all</td>
<td>very well</td>
</tr>
</tbody>
</table>

ADOPTION AND ADAPTATION

<table>
<thead>
<tr>
<th>Percentage of land users in the area who have adopted the Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single cases/ experimental</td>
</tr>
<tr>
<td>1-10%</td>
</tr>
<tr>
<td>11-50%</td>
</tr>
<tr>
<td>&gt;50%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Of all those who have adopted the Technology, how many have done so without receiving material incentives?</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10%</td>
</tr>
<tr>
<td>11-50%</td>
</tr>
<tr>
<td>51-90%</td>
</tr>
<tr>
<td>91-100%</td>
</tr>
</tbody>
</table>

Number of households and/or area covered

10.7 ha has been terraced within the 3 study villages with LIFT project support.

Has the Technology been modified recently to adapt to changing conditions?

Yes

No

To which changing conditions?

climatic change/ extremes
changing markets
labour availability (e.g. due to migration)

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Yes

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To which changing conditions?

climatic change/ extremes
changing markets
labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNED

Strengths: land user's view

- Notable higher crop yields on the plots where improved seeds and fertilizer are applied on newly established terraces. Farmers have high expectations for the years to come and for yields of annual crops (such as wheat) to remain high.
- Diversity of crops planted on terraces is valued by the land users. For example, cultivating wheat and alfalfa on the terraced plot provides household with the key crop and also fodder for the livestock and thereby contributes to securing food for the family and maintaining better health of their cattle. Additionally, some farmers have started intercropping Ferula, a medical herb and cash crop.
- Farmers perceive soil quality on terraced plots with fertilizer application to improve. An improvement in soil fertility (which may relay first of all to the effects of fertilizer application) and increased soil moisture have been reported. Single statements also related to effectiveness of applying fertilizer on terraced plots, as here fertilizer is not washed away during rains.
- Terraced plots are considered less vulnerable to the effects of rainstorms and dry spells, than non-terraced plots on slopes where annual crops are cultivated.
- Women considered an advantage that during the establishment phase, men were paid by the project to work on their own land when building the terraces. Thus, there was no need for men to go for seasonal labour migration and they stayed at home. At the same time the terracing of the land is seen as an opportunity to improve the land resources on their families plots. An increase in women's workload while bringing food to the field during establishment was considered to be acceptable, especially compared to the expected increase in yields.

Strengths: compiler’s or other key resource person’s view

- The application of fertilizer on terraces is expected to show multiple effects; yields from these fertility depleted croplands can be increased. This includes an increase in biomass production, which may be used as green manure on the field or as animal feed or as straw. Further, vegetation cover during the growing period can be increased, which helps to protect the soil from erosive rains.
- The project paid establishment of terraces on farmers’ plots provided 20 days of employment per 2 jerib (0.4 ha) plot for farmers in their home villages. At the same time the terracing is a long-term investment into the land resources. Terracing provides an opportunity to decrease soil degradation and even to rehabilitate degraded lands. Application of improved seeds and fertilizer contribute in the establishment year to increased crop and fodder yields.

Weaknesses/ disadvantages/ risks: land user's view

- How to overcome

  - The implementation costs are high and land users state that it is impossible for them to cover establishment costs on their own.
  - Farmers expect to only produce the actual yield harvested from the terraces in the first years after the implementation.
  - Both men and women from households that have implemented terraces state that during the establishment year the household experienced an increased workload, that is not well compatible with other non-cultivation activities.
  - The production area for annual crops only is slightly reduced. → So far not all farmers seem to use the production area fully. Intercropping with perennial plants is recommended in order to use the risers of the terraces for fodder production. Some farmers have started intercropping Ferula as cash crop.
  - Sufficient own land is required. → How does the amount of cropland affect the innovation readiness of a farmer? Better understanding in order to guide farmers willingness to take a risk for investing in a new SLM technology, and especially terracing, and influencing factors.

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's view

- How does the amount of cropland affect the innovation readiness of a farmer? Better understanding in order to guide farmers willingness to take a risk for investing in a new SLM technology, and especially terracing, and influencing factors.

- The technology requires technical knowledge for implementation and maintenance, which is key for successful adoption, replication and up-scaling. The project trained technicians to support land users with the design of terraces. While the project aided implementation of terraces has improved the general knowledge and awareness of the land users on the benefits of SLM practices, most farmers will not be able to design terraces on their own.
- Technically correct design of the terrace presents a challenge and might not be always achieved. Forward sloping terrace benches may lead to channelled runoff and have the risk of rills and gully formation.
- There is an attribution gap regarding the increased wheat yields, especially with regard to individual contribution of the terraces, the application of improved seeds and fertilizer, and the combined effects (role of terraces in making improved seed and fertilizer application effective). → A cost benefit analysis (CBA) needs to be conducted to determine short- and long-term returns of the SLM technology. On farm trials are necessary for assessing impacts of the different measures (agricultural, vegetative and structural measures) before-and-after, as well as with-without the SLM technology.
- Terrace maintenance is crucial. If not maintained properly for a longer period of time, the damaged terrace can lead to further land degradation through channelled runoff, severe erosion and possible risks of disaster for the surrounding settlements on the slopes.
- The technology is established mainly by better-off households, which own more land than the average SLM implementer.

REFERENCES

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Linked SLM data
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Wocat SLM Technologies
Terraces with improved seed and fertilizer application
Project
- Livelihood Improvement Project Takhar, Afghanistan (LIPT)
- Potential and limitations for improved natural resource management (NRM) in mountain communities in the Rustaq district, Afghanistan (Rustaq NRM Study)