Micro-irrigation canal in Poplar plantation (SLM Project, Helvetas (Bamyan, Afghanistan))

Micro irrigation in poplar plantation (Afghanistan)

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DESCRIPTION

Micro irrigation canal system for supplying water to poplar plantations on sloping lands.

The Micro Irrigation system technology is documented by SLM Project/HELVETAS Swiss Intercooperation with financial support of Swiss Agency for Development and Cooperation (SDC). The presented micro-irrigation system, a structural SLM technology, was applied in Central Highland's Province of Bamyan (Afghanistan). The micro-irrigation technology is applied to bring marginal land under cultivation for economic benefits, with the added benefit of rehabilitating degraded sloping land. The main irrigation canal also conveys water to agricultural land. It is a traditional technology applied by a land user without external support. It is also implemented by many other land users with some variations to the technology.
The technology consists of a network of main irrigation canal, secondary canals from which water is conveyed to sloping micro irrigation canals. The water reaches to the roots of each tree through infiltration/seepage.
The main canal has about 2% gradient and the micro-channels from 2-7% gradient. The slope of the site ranges between 20-40%. A micro irrigation canal is 28 m long, 15 cm wide and 10 cm deep. While the cross section remains same, the length can differ according to the land size.
The site was originally a degraded site with gravel soil. According to the land user, the site was not at all suitable for agriculture due to soil degradation and bad water shortage possibilities. Approximately 25 years after the plantation of poplar trees, the site's physical and biological conditions of the slope have improved due to the establishment of poplar trees. The poplar trees can be used for timber for construction and firewood. The poplar timber has good market in Bamyan and can fetch up to 35 USD per tree.
The micro-irrigation systems, which help establishing poplar plantations, contribute to multiple benefits for the land user's family and also the environment. As the poplar plantations are irrigated, their growth increases and their mortality, due to water shortage, is reduced.
As a result of re-vegetating the relatively steep slope, soil erosion from the site has reduced and the fertility of the soil has improved. Improved soil moisture and fertility has also helped in establishment of a good ground canopy. Many birds visit the site for shelter. The plantation has reached its harvesting stage and the land user is planning to cut the trees for sale, expecting an income of about 10,500 USD from the site.

A close look at this technology shows that the system works well and that it is easily managed by the land user. Some minor improvements, such as reducing the slope gradient of the micro-irrigation canals for reducing canal erosion, construction of pits to capture sediments at the drainage points and planting suitable grasses with good roots along the canal bunds could make the system more effective and sustainable. The measures could also help in reducing the sensitivity of the micro-irrigation canals towards intense rainfall.
The farmers are applying this SLM technology without any external financial or technical support and there is growing trend towards spontaneous adoption. According to the land user's estimate, of about 400 families in his village, 80 families have applied the technology

The basic purpose of the micro-irrigation system is to supply irrigation water to the poplar trees for reducing plant mortality and increasing plant growth.

The main establishment activities include layout of the micro canals across the sloping land using shovels and pick axe without use of any alignment equipment. Approximately 150 persons-days/ha were employed for constructing the micro-irrigation canals and 5 person-days/ha sufficed for on-site maintenance works. About 970 USD/ha was spent on the construction and most of the cost for labour was covered by the family of the owner.

The site is owned by a land user with clear land use rights. The water rights are common and organized as there is a traditional social water management institution (Mirab), which ensures an equitable distribution of irrigation water to all the farmers taking water from the

LOCATION

Location: Bamyan center, Bamyan, Afghanistan

No. of Technology sites analysed:

Geo-reference of selected sites
- n.a.

Spread of the Technology: evenly spread over an area (0.16 km^2)

In a permanently protected area?:

Date of implementation: 10-50 years ago

Type of introduction
- [x] through land users' innovation
- [ ] as part of a traditional system (> 50 years)
- [ ] during experiments/ research
- [ ] through projects/ external interventions

main canal. A command area on a turn-by-turn basis exists. Water users pay service fees to the Mirab mostly in kind. The land users mentioned that they give about 14 kg of wheat and/or potato each year to the Mirab for this site. The land user has to also participate in main canal repair works on a voluntary basis. Bamyan Centre receives about 230 mm rainfall per year. Most of the rain falls in the months of April and May. Winters are severe with temperatures falling below minus 20 degrees. The area receives snowfall up to 180 cm per year in normal years. Bamyan center has an arid and temperate climate with one main growing season of about 6 months, which is from April to September. The plantation site is located at an altitude of about 2300 m. It is north-facing slope with a soil depth of about 30-50 cm. The soil is sandy loam with a medium soil fertility.

Close view of the micro-irrigation canal, Tape Chauni, Bamyan, Afghanistan (SLM Project, Helvetas (HELVETAS Swiss Intercooperation, Bamyan, Afghanistan))

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [x] improve production
- [ ] reduce, prevent, restore land degradation
- [ ] conserve ecosystem
- [ ] protect a watershed/ downstream 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

Forest/ woodlands

- (Semi-)natural forests/ woodlands. Management: Selective felling
- Tree plantation, afforestation. Varieties: Monoculture local variety

Products and services: Timber, Fuelwood

Water supply

- [ ] rainfed
- [ ] mixed rainfed-irrigated
- [ ] full irrigation

Purpose related to land degradation

- [ ] prevent land degradation
- [x] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [ ] adapt to land degradation
- [ ] not applicable

Degradation addressed

biological degradation - Bc: reduction of vegetation cover

water degradation - Ha: aridification

SLM group

- irrigation management (incl. water supply, drainage)

SLM measures

structural measures - S3: Graded ditches, channels, waterways

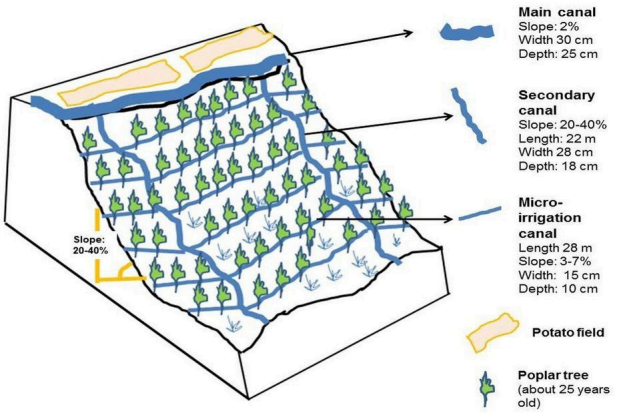
TECHNICAL DRAWING

Technical specifications

Technical specifications of micro-irrigation system for poplar plantation. The system comprises main canal, secondary canals and micro irrigation canals which receive water from and drain into secondary canals.
Location: Tape Chauni. Bamyan Centre
Date: 10 May 2014

Technical knowledge required for field staff / advisors: low
Technical knowledge required for land users: low
Main technical functions: water harvesting / increase water supply
Secondary technical functions: increase of biomass (quantity)

Vertical interval between structures (m): 0.22-0.6
Spacing between structures (m): 1.8-2
Depth of ditches/pits/dams (m): 0.1
Width of ditches/pits/dams (m): 0.15
Length of ditches/pits/dams (m): 0.28
Construction material (earth): Soil from the site is used for canal consturction
Slope (which determines the spacing indicated above): 20-40%
Lateral gradient along the structure: 3-7%



Author: SLM Project, Helvetas, HELVETAS Swiss Intercooperation, Afghanistan

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated:
- Currency used for cost calculation: **Afghani**
- Exchange rate (to USD): 1 USD = 57.0 Afghani
- Average wage cost of hired labour per day: 70.00

Most important factors affecting the costs

Labour is the most determinate factor affecting the costs. All the work is done manually.

Establishment activities

1. Construction of secondary and micro-irrigation canals (Timing/ frequency: Spring)

Establishment inputs and costs

Specify input	Unit	Quantity	Costs per Unit (Afghani)	Total costs per input (Afghani)	% of costs borne by land users
Labour					
labour	ha	1.0	921.0	921.0	100.0
Equipment					
tools	ha	1.0	52.0	52.0	100.0
Total costs for establishment of the Technology				**973.0**	
Total costs for establishment of the Technology in USD				*17.07*	

Maintenance activities

1. Maintenance of canals (Timing/ frequency: Spring/once per year)

Maintenance inputs and costs

Specify input	Unit	Quantity	Costs per Unit (Afghani)	Total costs per input (Afghani)	% of costs borne by land users
Labour					
labour	ha	1.0	30.0	30.0	100.0
Equipment					
tools	ha	1.0	52.0	52.0	100.0
Total costs for maintenance of the Technology				**82.0**	
Total costs for maintenance of the Technology in USD				*1.44*	

NATURAL ENVIRONMENT

Average annual rainfall

- [ ] < 250 mm
- [x] 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
- [x] semi-arid
- [ ] arid

Specifications on climate

Most rainfall is in May. According to provincial agriculture department, Bamyan centre receives about 230 mm rain a year
Thermal climate class: temperate. Winter temperatures can go below minus 20 degree C and maximum in summer up to 34 degree C

Slope

- [ ] flat (0-2%)
- [ ] gentle (3-5%)

Landforms

- [ ] plateau/plains
- [ ] ridges

Altitude

- [ ] 0-100 m a.s.l.
- [ ] 101-500 m a.s.l.

Technology is applied in

- [ ] convex situations
- [ ] concave situations

- [ ] moderate (6-10%)
- [ ] rolling (11-15%)
- [x] hilly (16-30%)
- [x] steep (31-60%)
- [ ] very steep (>60%)

- [x] mountain slopes
- [ ] hill slopes
- [ ] footslopes
- [ ] valley floors

- [ ] 501-1,000 m a.s.l.
- [ ] 1,001-1,500 m a.s.l.
- [ ] 1,501-2,000 m a.s.l.
- [ ] 2,001-2,500 m a.s.l.
- [x] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

- [ ] not relevant

Soil depth
- [ ] very shallow (0-20 cm)
- [x] shallow (21-50 cm)
- [ ] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [x] coarse/ light (sandy)
- [x] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [ ] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Topsoil organic matter content
- [ ] high (>3%)
- [x] medium (1-3%)
- [ ] low (<1%)

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [x] 5-50 m
- [ ] > 50 m

Availability of surface water
- [ ] excess
- [x] good
- [ ] medium
- [ ] poor/ none

Water quality (untreated)
- [ ] good drinking water
- [ ] poor drinking water (treatment required)
- [x] for agricultural use only (irrigation)
- [ ] unusable

Water quality refers to:

Is salinity a problem?
- [ ] Ja
- [ ] Nee

Occurrence of flooding
- [ ] Ja
- [ ] Nee

Species diversity
- [ ] high
- [x] medium
- [ ] low

Habitat diversity
- [ ] high
- [ ] medium
- [ ] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [x] mixed (subsistence/ commercial)
- [ ] commercial/ market

Off-farm income
- [ ] less than 10% of all income
- [x] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [ ] very poor
- [ ] poor
- [x] average
- [ ] rich
- [ ] very rich

Level of mechanization
- [ ] manual work
- [ ] animal traction
- [ ] mechanized/ motorized

Sedentary or nomadic
- [ ] Sedentary
- [ ] Semi-nomadic
- [ ] Nomadic

Individuals or groups
- [x] individual/ household
- [ ] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [ ] women
- [x] men

Age
- [ ] children
- [ ] youth
- [ ] middle-aged
- [ ] elderly

Area used per household
- [x] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [x] small-scale
- [ ] medium-scale
- [ ] large-scale

Land ownership
- [ ] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [ ] individual, not titled
- [x] individual, titled

Land use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [x] leased
- [ ] individual

Water use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

	poor			good
health		✓		
education			✓	
technical assistance	✓			
employment (e.g. off-farm)	✓			
markets		✓		
energy		✓		
roads and transport		✓		
drinking water and sanitation		✓		
financial services	✓			

IMPACTS

Socio-economic impacts

	decreased							increased
fodder production				✓				
wood production						✓		
risk of production failure							✓	

Irrigation helps in Poplar establishment and growth

Important for reducing plant mortality

production area (new land under cultivation/ use)	decreased ... increased	The area was degraded before
energy generation (e.g. hydro, bio)	decreased ... increased	
irrigation water availability	decreased ... increased	For plantations
farm income	decreased ... increased	From sale of poplar trees but only in the long term
workload	increased ... decreased	Irrigation needs more time and labour

Socio-cultural impacts

recreational opportunities	reduced ... improved	
SLM/ land degradation knowledge	reduced ... improved	Other land users see and learn
conflict mitigation	worsened ... improved	
Fuel wood sufficiency	None ... None	Lopped branches are used for fuel wood
contribution to human well-being	None ... None	The technology contributes to increased household income in the long term and also towards increased production of fodder, fuel wood and timber.

Ecological impacts

soil moisture	decreased ... increased	
soil organic matter/ below ground C	decreased ... increased	Due to build of humus and ground cover
biomass/ above ground C	decreased ... increased	Due to plantations
plant diversity	decreased ... increased	due to increased soil moisture
animal diversity	decreased ... increased	habitat for birds
pest/ disease control	decreased ... increased	
wind velocity	increased ... decreased	Due to plantations (indirect impact)

Off-site impacts

buffering/ filtering capacity (by soil, vegetation, wetlands)	reduced ... improved	Due to plantations
wind transported sediments	increased ... reduced	Plantations impact
damage on public/ private infrastructure	increased ... reduced	Due to less sedimentation and runoff from the site

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns	very negative	very positive
Long-term returns	very negative	very positive

Benefits compared with maintenance costs

Short-term returns	very negative	very positive
Long-term returns	very negative	very positive

The returns in the form of cash start coming after 10-12 years with this poplar variety following a selective felling and replanting approach.

CLIMATE CHANGE

Gradual climate change

annual temperature increase	not well at all	very well

Climate-related extremes (disasters)

local rainstorm	not well at all	very well
drought	not well at all	very well
general (river) flood	not well at all	very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- [ ] single cases/ experimental
- [ ] 1-10%
- [ ] 11-50%
- [ ] > 50%

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- [ ] 0-10%
- [ ] 11-50%
- [ ] 51-90%
- [x] 91-100%

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

- [ ] Ja
- [ ] Nee

To which changing conditions?

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

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- The technology helps successful establishment of poplar trees and also natural grasses on sloping lands.

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

- Micro-irrigation technology is important for the establishment and maintenance of poplar plantations. The technology is adapted for afforestation of sloping land.
- The technology does not require much maintenance once the plantations are well established. A special attention need to be given to the secondary canals.
- No external support for establishing or maintaining the technology.
- The technology helps in improving the site's micro climate which leads to more plant and animal (bird) diversity.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- There is no information available regarding the land user's view on the weaknesses of this technology.

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

- The canals break at some weak points. Also the slopes of the micro channels is more at many places leading to some soil erosion. Proper alignment of micro-irrigation canals.
- Rill and gully erosion due to rapid and uncontrolled flow of excessive drainage in secondary canals. Plant grasses with robust root system along the canals. Strengthen points where water spills from the micro-irrigation canals into the secondary canals with vegetative measures and sediment pits.
- Due to small sizes of the channels, irrigation needs more time and labour. Improvements in micro irrigation canals will reduce this problem considering. Interested organisations could carry out action research on how to improve this system by also incorporating efficient water use measures.
- The technology can be applied only when there is a reliable source of running water. Action research on soil and water conservation techniques for plantations in areas where there is no easy access to irrigation water.

REFERENCES

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Full description in the WOCAT database
https://qcat.wocat.net/af/wocat/technologies/view/technologies_1603/

Linked SLM data
n.a.

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