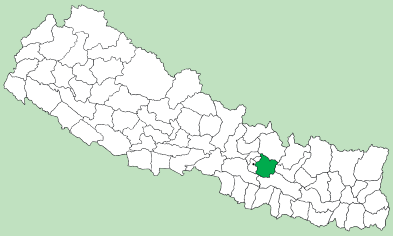
Left: The gully with bio-engineered check dam in the foreground and shrine in the background. (Duncan Scott)
Right: A retaining wall built using earth-filled sacks and bamboo posts. Tree seedlings and local grasses are planted on top of the retaining wall to help stabilize it. (Sabita Aryal Khanna)

Sustainable land management using controlled gullying in 'jagidol' areas

Nepal: "जागिडोल" क्षेत्रमा खोल्सि सुधारद्वारा दीगो भू–ब्यवस्थापन

An indigenous technology to help control channelled water during the rainy season and conserve it during the dry season

For more than two centuries, local farmers have promoted soil and water conservation by protecting the gullies which occur naturally between rice terraces; thus the land area is called 'jagidol' (jagi=rice, dol=gully). The small perennial streams which flow through the terraces are protected by constructing check dams and retaining walls to reduce the danger of erosion and collapse.
During the monsoon, the channels or trenches can become engorged and, since their walls are not reinforced (except for grass planted at the edges), the conduits can be easily eroded. When the erosion is severe enough, the edges of the terraces adjacent to the gullies can collapse. When many gullies collapse at once, the stability of the entire hillside is threatened with catastrophic consequences for the village situated above the planting area. Villagers have traditionally used local materials and expertise to maintain the gullies and reduce soil erosion by building retaining walls across the slope which are strengthened through plantation. The retaining walls are bio-engineered using a combination of bamboo poles, rocks, and soil-filled sacks. Bamboo poles are used for the backbone of the support structure, and rocks and soil-filled sacks are used to line the sides of the channel. Local grasses such as 'sitto' are planted on the top and, as they grow, their roots help to anchor the structure. When the channels are fortified by retaining walls and planting, they become entrenched and, over time, less maintenance is required. As a bonus, when the plants grown along the gullies mature, they provide biomass for the farm and fodder for cattle. During winter, when water is scarce, farmers modify the gully system by constructing check dams which can be used to collect water in one place. These dams are useful for irrigation during the dry season and they also help to prevent bed scouring.



WOCAT database reference: QT NEP 25
Location: Sharada Batase VDC, Kabhrepalanchok District, Nepal
Technology area: 1.1 km²
Conservation measure(s): Vegetative, structural, and management measures
Land Use: Waterways, drainage channels, ponds, dams
Stage of intervention: Mitigation/ reduction of land degradation
Origin: Has been practised for generations by the local communities
Climate: Subhumid/sub-tropical
Related approach: Gullies – a traditional sustainable land management practice (QA NEP 25)
Other related technology: Gully plugging using check dams (QT NEP 14)
Compiled by: Sabita Aryal Khanna, Kathmandu University
Date: December 2010, updated March 2013

The technology was documented using the WOCAT (www.wocat.org) tool.

ICIMOD WOCAT

Classification

Land use problems

As the land is continuously eroded, both farmland and inhabited areas will slowly slide downhill.

Land use

Drainage of waterways

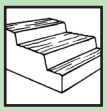
Climate

Subhumid/ tropical

Degradation

Gullies are eroded by water/ landslides can occur

Conservation measures



structural measure

vegetative measure

Stage of intervention

- Prevention
- Mitigation/reduction
- Rehabilitation

Origin

- Land users' initiative: >50 years
- Experiments/research
- Externally introduced
- Other (specify)

Level of technical knowledge

- Low
- Medium: land user
- High

Main causes of land degradation: deforestation/removal of natural vegetation, over-exploitation of farmland, poor crop management

Technical function/impact

Main:
- Controls concentrated runoff (drain/divert)
- Stabilizes soil by controlling runoff during monsoon
- Collects water during the dry season

Secondary:
- Improves ground cover
- Improves management and diversification of land use

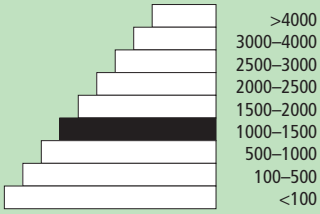
Environment

Natural environment

Average annual rainfall (mm)

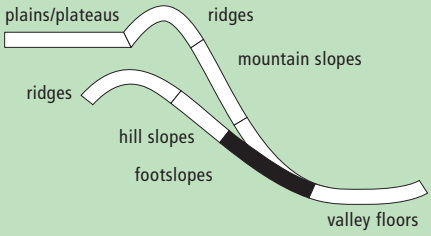
- >4000
- 3000–4000
- 2000–3000
- 1500–2000
- 1000–1500
- 750–1000
- 500–750
- 250–500
- <250

Altitude (masl)

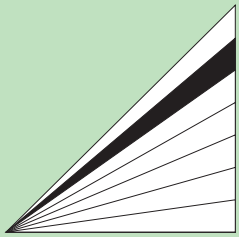


- >4000
- 3000–4000
- 2500–3000
- 2000–2500
- 1500–2000
- 1000–1500
- 500–1000
- 100–500
- <100

Landform



Slope (%)



- very steep (>60)
- steep (30–60)
- hilly (16–30)
- rolling (8–16)
- moderate (5–8)
- gentle (2–5)
- flat (0–2)

Soil depth (cm)

- 0–20
- 20–50
- 50–80
- 80–120
- >20

Growing season(s): two
Soil texture: fine/heavy (clay)
Soil fertility: high
Topsoil organic matter: high (>3%)
Soil drainage/infiltration: Poor
Soil water storage capacity: medium

Ground water table: 5–50 m
Availability of surface water: excess during monsoon
Water quality: good for agricultural use but not for drinking water
Biodiversity: high

Tolerant of climatic extremes: increases/decreases in temperature and seasonal rainfall
Sensitive to climatic extremes: heavy rainfall events (intensity and amount), and increases in seasonal rainfall
If sensitive, what modifications were made/are possible: can be improved by reinforcing the gullies (e.g., use concrete); when gullies are reinforced it is possible to plant a more diverse variety of crops

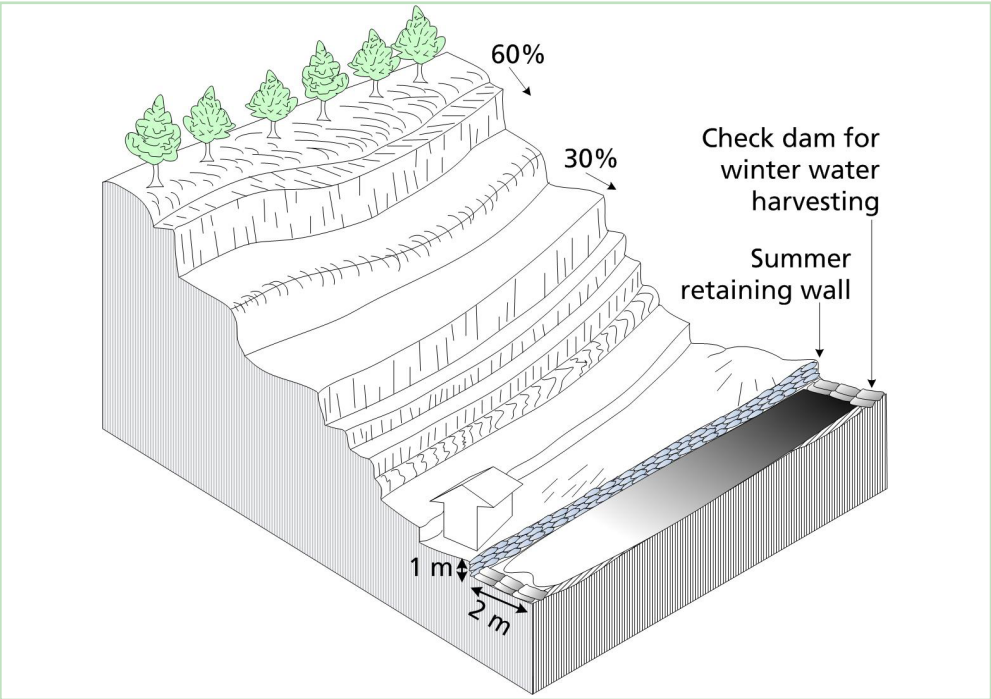
Human environment

Crop land per household (ha)

- <0.5
- 0.5–1
- 1–2
- 2–5
- 5–15
- 15–50
- 50–100
- 100–500
- 500–1000
- 1000–10000
- >10000

Land user: individual households, groups/community (small scale)
Population density: 10–50 persons per km^2
Annual population growth: 0.5–1%
Land ownership: individual, titled, and communal/village
Land/water use rights: land, individual;, water, open access
Relative level of wealth: about 90% have the same level of wealth
Importance of off-farm income: > 50% of households have some off-farm income

Access to services and infrastructure: moderate
Market orientation: subsistence
Mechanization: not mechanized
Livestock grazing on cropland: Some
Livestock density: <1 LU/ km^2
Purpose of forest/woodland use: fuelwood, timber, fodder
Types of other land: wasteland



Technical drawing
A jagidol area showing the approximate slope, bench terraces, and basic geometry of the landscape. With the shrine shown as in the photograph of the site. (Duncan Scott, A. K. Thaku)

Implementation activities, inputs and costs

Establishment activities

Vegetative

Local grasses such as *utis, sito, amrisho, daleghas,* and bamboo, can be planted on top of the reinforcements.

Structural

- Construction of dam with mud-filled sacks
- Construction of stone dam and spillways
- Construction of retaining wall
- Construction of bunds and barrier

Establishment inputs and costs per 1.1 km²

Inputs	Cost (USD)	% met by land user
Labour (150 person days)	670	100%
Equipment	225	100%
Materials	725	100%
TOTAL	**1620**	**100%**

Maintenance/recurrent activities

- Continue to reinforce by planting with local grasses or bamboo on top of the structures until the plantings are well established.

Maintenance/recurrent inputs and costs per 1.1 km² per year

Inputs	Cost (USD)	% met by land user
Labour (50 person days)	250	100%
Equipment	70	100%
Materials	350	100%
TOTAL	**670**	**100%**

Remarks:

- All costs and amounts are rough estimates by the technicians and authors. Exchange rate USD 1 = NPR 72 in December 2010.
- The construction and maintenance of gullies demands attention during a busy agricultural calendar and can significantly add to the labour costs depending on the size and number of gullies and dams that need to be constructed and maintained.

Impacts of the technology

Production and socioeconomic benefits

+ + + Reduced risk of land degradation
+ + + Increased fodder production
+ + Increased crop yield
+ + Reduced risk of crop failure
+ + Increased availability of water for irrigation
+ + Increased production of fodder and biomass

Production and socioeconomic disadvantages

− − − Labour-intensive preparation and maintenance

Socio-cultural benefits

+ + + Improved agriculture benefits the whole community at many different levels including social and cultural
+ + + improved cultural opportunities (eg spiritual, aesthetic, others) for Improvement of conservation/erosion knowledge

Socio-cultural disadvantages

− Conflicts between land owner and other shrine visitors

Ecological benefits

+ + + Improved resilience in the event of extreme events such as droughts, floods, and storms
+ + + Reduced soil loss
+ + Increased water availability
+ + Habitat diversity is maintained and increased
+ + Surface runoff water is more easily collected

Ecological disadvantages

− Increased competition for water, sunlight, and nutrients
− Agricultural pests such as birds, slugs, and rodents, are more easily harboured in and near the edges of gullies

Off-site benefit

+ + + Reduced downstream flooding
+ + + Downstream neighbouring fields also benefit from slope stability and soil conservation

Off-site disadvantages

none

Contribution to human wellbeing/livelihood

+ + Improved agriculture leads to food sufficiency, enhanced economic conditions, and better health throughout the community. When households have more cash income they usually invest it in education for their children.

Benefits/costs according to the land user

When both vegetative and structural measures are implemented together the long-term stability is improved.

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

Acceptance/adoption:
Communities throughout the area have adopted these structural measures for centuries without any external support. Communities downstream are beginning to see the benefits and they are also starting to adopt these measures.

Concluding statements

Strengths and →how to sustain/improve	**Weaknesses** and →how to overcome
This is a well-accepted local practice. → Continue to implement this soil conservation measure.	The traditional materials used in the construction of dams and gullies are prone to damage during flood events. → The technology can be enhanced by the use of better materials and technical support. With research and funding, more robust conservation measures can be implemented.
The use of mud-filled sacs is a recent innovation. → Some advance training may be needed.	In recent times, new activities such as brick making are coming to the villages; the entrepreneurs involved in these activities do not know about (and are not interested in) soil conservation measures. → Increase awareness among newcomers.
Reduced risk of losing crops and agricultural land because of soil degradation. → Continue to add to mud-based structures by vegetative means.	There has never been any external support for these soil conservation activities even if downstream communities also benefit. → Increase awareness among downstream communities. Explore possibilities for external support for controlled gullying.
An added benefit is the production of biomass: grass, fodder for animals, wood, and fuelwood. → Continue to plant more trees.	
Makes water available for irrigation even during the dry season. →Encourage more check dam construction along the gully.	

Key reference(s): None

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