Radical Terraces
Rwanda - Amaterasi y'indinganire

Locally referred to as 'radical terracing', the method involves earth moving operations that create reverse-slope bench terraces which have properly shaped risers stabilized with grass or trees on embankment to avoid collapse.

In Rwanda, a unique method of back-slope terracing originally introduced by missionaries growing wheat in the Northern Province in the 1970s, has been widely adopted by smallholder farmers in many parts of the country. The farmers are careful to isolate the topsoil, then they re-work the subsoil to create the required reverse-slope bench, after which the topsoil is spread over the surface. The riser is planted with short runner grass for stabilization, all within the same day. Radical terracing is usually done manually with hoes and shovels, mostly by communal group-work involving hundreds of farmers (see left photo). Thus, a hillside can be terraced in one day. Where radical terraces have been constructed, the effects have been dramatic, achieving optimum water and soil conservation on slopes exceeding 50%, while adoption rates have been quite extensive. This high adoption of radical terracing is related to the existing policies and programs such as land consolidation, land management and crop intensification programs. These policies/programs boost the use of radical terraces by providing farmers more opportunities to easily access inputs such as improved seeds and manure for increasing the productivity of constructed radical terraces. Recent studies (e.g. Fleskens, 2007, Bizoza and de Graaff 2012 and Kagabo et al. 2013) assert that radical terraces in the highlands of Rwanda are only financially viable when the opportunity cost of labour and manure are below the local market price levels and when agriculture area on these radical terraces can be substantially intensified. Ten to 30 metric tons of manure (organic) are required to restore the soil fertility of newly established radical terraces.
In Rwanda, radical terraces are principally designed (1) to reduce soil losses through enhanced retention and infiltration of runoff, (2) to promote permanent agriculture on steep slopes and (3) to promote land consolidation and intensive land use.
Newly established radical terraces should be protected at their risers and outlets, especially in the first or second year of the establishment. After establishing a terrace, a riser is shaped and grasses or shrubs/trees are planted soon after. Napier grass is commonly planted and is used as forage for livestock. Risers on radical terraces are seen as a new production niche of forage as a result of land shortage and a strict zero grazing policy.
Radical terraces have the potential of improving farmers' livelihoods and increasing the resilience of a degraded environment.

left: Radical terraces under development by communal group work (Umuganda) (Photo: Kagabo Desire and Nganzi Guy)
right: A watershed terraced with radical terraces (Photo: Ngenzi Guy and Desire Kagabo)

Location: Rwanda
Region: Kayonza District (Eastern province)
Technology area: 10.3 km^2
Conservation measure: vegetative, structural
Stage of intervention: mitigation / reduction of land degradation
Origin: Developed Government, recent (<10 years ago)
Land use type:
Cropland: Annual cropping
Cropland: Perennial (non-woody) cropping
Climate: subhumid, tropics
WOCAT database reference: T_RWA003en
Related approach: Top down approach (A_RWA001en)
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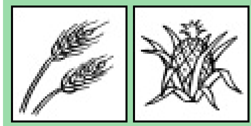
Classification

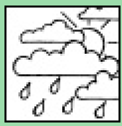
Land use problems:
- Soil erosion due to high runoff on the steep slopes, deforestation, intensive cultivation and lack of suitable land management methods. (expert's point of view)
Low crop production, soil erosion and lack of fodder (land user's point of view)

Land use



Annual cropping
Perennial (non-woody) cropping
rainfed

Climate

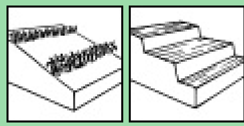


subhumid

Degradation

Soil erosion by water: loss of topsoil / surface erosion

Conservation measure



vegetative: Grasses and perennial herbaceous plants
structural: Bench terraces (slope of terrace bed <6%)

Stage of intervention

- ▒ Prevention
- ■ Mitigation / Reduction
- ░ Rehabilitation

Origin

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

Level of technical knowledge

- ■ Agricultural advisor
- ▒ Land user

Main causes of land degradation:
Direct causes - Human induced: over-exploitation of vegetation for domestic use, overgrazing
Direct causes - Natural: other natural causes, Extreme topography: steep slopes in many cases over 50%
Indirect causes: population pressure

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

Secondary technical functions:
- control of concentrated runoff: impede / retard
- reduction of slope angle
- reduction of slope length

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): 120 days (September-January), 90 days (March - June)
Soil texture: coarse / light (sandy)
Topsoil organic matter: low (<1%)
Soil drainage/infiltration: good

Soil water storage capacity: low
Ground water table: > 50 m
Availability of surface water: poor / none
Water quality: poor drinking water
Biodiversity: low

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

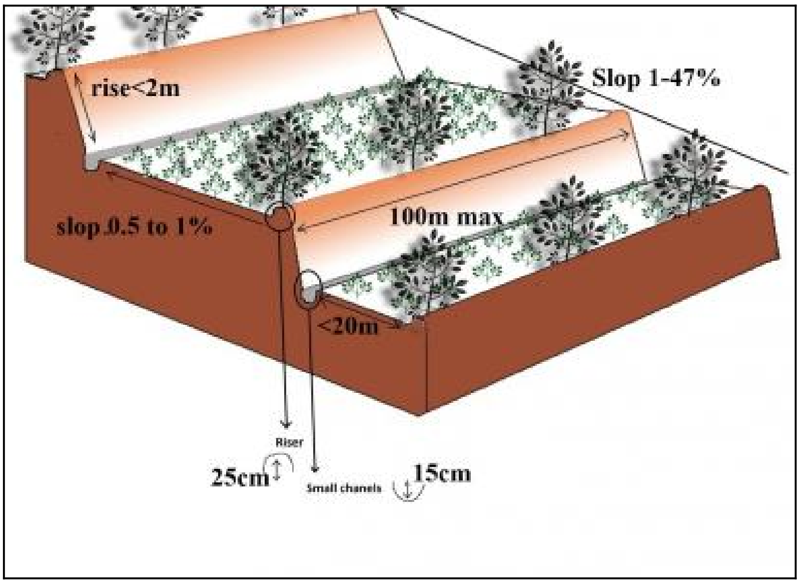
Human Environment

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, men and women
Population density: 50-100 persons/km2
Annual population growth: 2% - 3%
Land ownership: individual, titled
Land use rights: individual
Water use rights: open access (unorganised)
Relative level of wealth: poor, which represents 75% of the land users; 60% of the total area is owned by poor land users

Importance of off-farm income: less than 10% of all income:
Access to service and infrastructure: low: employment (eg off-farm), market, energy, drinking water and sanitation, financial services; moderate: education, technical assistance, roads & transport; high: health
Market orientation: subsistence (self-supply)



Technical drawing

The farmers are careful to isolate the topsoil, then they re-work the subsoil to create the required reverse-slope bench, after which the topsoil is spread over the surface. The riser is planted with short runner grass for stabilization, all within the same period. (Kagabo Desire and Ngenzi Guy)

Implementation activities, inputs and costs

Establishment activities

- Cuttings of grasses
- Transport of grass cuttings
- Planting of grass cuttings
- Land surveying (slope determination, soil structure and texture analysis)
- Construction of bunds (risers) with soil from upper and lower sides
- Level terraces bed (surface soil moved from upper to lower part of terraces)
- cutting subsurface soil, leveling and refilling surface soil
- Make lips on edges of terraces
- Compact risers
- Plant grasses including agro-forestery trees.
- Input/ application of farmyard manure and liming

Establishment inputs and costs per ha

Inputs	Costs (US$)	% met by land user
Labour	525.43	10%
Equipment		
- tools	212.00	1%
Agricultural		
- seedlings	16.00	100%
- Lime	200.00	0%
- Mineral fertilizers	235.00	0%
- Farmyard Manure	468.00	0%
TOTAL	**1656.43**	**4.27%**

Maintenance/recurrent activities

- Weeding
- Manure application
- Grass streaming
- Cleaning of channels and drains
- Regular repair of destroyed risers

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US$)	% met by land user
Labour	6.66	100%
TOTAL	**6.66**	**100.00%**

Remarks:
Factors that affect the cost are labor, soil structure and slope
The cost is calculated using the rate of US dollars at present time and were estimated according to the cost of construction of one radical terrace. At present the labor is 1.6$ per day. This was calculated on 25/07/2011.

Assessment

Impacts of the Technology

Production and socio-economic benefits	Production and socio-economic disadvantages
+++ increased crop yield ++ increased fodder production	+++ Disturbs the fertile top soil ++ Require high quantity of FYM and mineral fertilizers + Reduce crop area

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

Ecological benefits	Ecological disadvantages
+++ reduced surface runoff +++ reduced soil loss ++ reduced emission of carbon and greenhouse gases + increased water quantity + increased soil moisture + reduced hazard towards adverse events	+++ The biodiversity is reduced

Off-site benefits	Off-site disadvantages
+++ reduced downstream flooding ++ reduced downstream siltation ++ reduced damage on neighbours fields ++ reduced damage on public / private infrastructure	

Contribution to human well-being / livelihoods

\+ The technology is newly established and the soil need enough farmyard manure and inputs to re-stabilize and regain its fertility.

Benefits /costs according to land user

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

Acceptance / adoption:

70% of land user families (140 families; 100% of area) have implemented the technology with external material support.
5% of land user families (10 families; 10% of area) have implemented the technology voluntary.
There is little trend towards (growing) spontaneous adoption of the technology. The real advantages of the technology are observed after 5 to 6 years with good maintenance of structures

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
It controls soil erosion → There is a need to plant grasses or trees on risers to stabilize terraces	The establishment of radical terraces is expensive → The construction of radical terraces should be subsided by the government.
It increases soil water holding capacity → Organic manure should be added to the terrace to effectively increase the soil water holding capacity.	The initial soil structure is disturbed (lost of soil organic matter) → Heavy investments are needed to replenish the soil fertility, especially by adding organic manure.
It increases fodder availability as new niches for fodder production are created. → High value nutritive fodder should be planted (napier grass, calliadra, tripsucum, etc.) on risers	The establishment of radical terraces decreases cropped land. → Grow high value crops and use adequate quantity of inputs.
It increases crop productivity → Terraces should be well maintained by providing more inputs and regular maintenance of bench struactures	With poor maintenance or poor design of radical terraces, landslides may occur. → To be much more rigorous in the design and implementation/development of terraces by making sure that professionals are involved in the whole process of establishing terraces.
It reduces soil runoff → Good maintenance of structures	It reduces the cropped land → Farmers should be supported in accessing high value crops and inputs to maximize crop yield.