
Slope stabilisation and progressive terracing with vetiver grass (Joana Eichenberger)

# Progressive bench terraces formed by a vetiver hedge system and trees (Haiti)

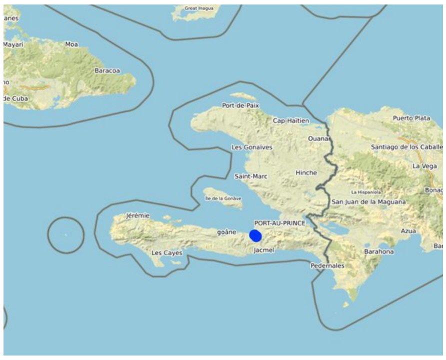
Ranp vivan (fran. rampes vivantes)

## DESCRIPTION

**Progressive terracing technology is established through successive deposits of sediments behind (upstream) any anti-erosional structure, in this case contour strips of vetiver grass (vetiveria zizanioides). To better stabilize the slopes in the long-term, trees are planted downstream of the vetiver hedges.**

Vetiver hedges are applied to prevent degradation and increase slope stabilization on areas prone to erosion. In Haiti, the Swiss Red Cross (SRC) has used cross-slope vetiver hedges as a restoration measure where soil has been degraded by surface erosion. Terraces are progressively formed and these reshape steep-sloped terrain into a succession of platforms with little or no gradient. Over time, these areas receive deposits of sediments from upstream: these sediments are captured by the terraces. Vetiver grass is used to establish anti-erosive structures because it is a common, deep-rooted species that can also be cut and used as mulch. Below the vetiver hedges, fruit trees may be planted to better stabilize the soil and simultaneously improve food security. However, if the soil is too degraded, forest trees are an alternative as they are less demanding. Between the vetiver hedges, land users can cultivate crops. It is recommended not to plant root crops (potatoes, cassava etc) or even groundnuts, but rather to plant legumes that bear fruit above ground and fix nitrogen, and perennial crops. Vetiver may be cut and used for mulching on the terrace beds.
This technology has several on- and offsite benefits. Besides stabilizing slopes and reducing landslide risks, vetiver strips are proven to reduce and retain surface runoff in ditches just above the hedges. Therefore, rainfall water can infiltrate more easily and recharge groundwater. Another onsite advantage is the accumulation of fertile sediments on the terrace beds, which support cropping. Offsite benefits include downstream protection for communities and agricultural fields against landslides, floods and siltation. Despite these advantages, land users claim there is significant loss of arable area when applying this technology. Farmers tend to exploit their plots of cultivated land, and only apply vetiver terraces when the soil is completely degraded. This, however, means that the soil needs time to regenerate before it can be cultivated again. Therefore, although very protective, this technology is not necessarily productive immediately after its implementation on heavily degraded soil. Furthermore, the vetiver grass itself has little use for the land users. Although its roots contain aromatic oil that is highly sought after in the cosmetic industry, land users should not dig up vetiver roots as this would severely weaken the stabilizing function of the technology.

## LOCATION




**Location:** Léogâne, Département de l'Ouest, Haiti

**No. of Technology sites analysed:** 10-100 sites

**Geo-reference of selected sites**

- -72.63595, 18.38481
- -72.636, 18.38739
- -72.65844, 18.40364

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

**In a permanently protected area?:** No

**Date of implementation:** 2014

**Type of introduction**

- ☐ through land users' innovation
- ☐ as part of a traditional system (> 50 years)
- ☐ during experiments/ research
- ✓ through projects/ external interventions

In Haiti, progressive terracing is rather a measure of restoration of severely degraded land. This photograph has been taken one month after the implementation of the technology. (Joana Eichenberger)

Behind each line of vetiver there is a small channel where water and sediments accumulate. (Joana Eichenberger)

## CLASSIFICATION OF THE TECHNOLOGY

### Main purpose

- ✓ 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
- ✓ adapt to steep slopes

### Land use

**Cropland**

- Annual cropping: oilseed crops - groundnuts, cereals - maize, legumes and pulses - beans, root/tuber crops - sweet potatoes, yams, taro/cocoyam, other
- Perennial (non-woody) cropping: banana/plantain/abaca, pigeon peas

Number of growing seasons per year: 2
Is intercropping practiced? Yes

**Forest/ woodlands**

- Tree plantation, afforestation. Varieties: Mixed varieties

Tree types (deciduous): n.a.
Products and services: Fruits and nuts, Nature conservation/ protection

### 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

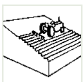
**soil erosion by water** - Wt: loss of topsoil/ surface erosion, Wg: gully erosion/ gullying, Wm: mass movements/ landslides, Wo: offsite degradation effects

**water degradation** - Ha: aridification, Hs: change in quantity of surface water, Hg: change in groundwater/aquifer level, Hp: decline of surface water quality

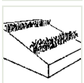
### SLM group

- agroforestry
- cross-slope measure
- ecosystem-based disaster risk reduction

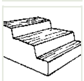
### SLM measures



**agronomic measures** - A2: Organic matter/ soil fertility



**vegetative measures** - V1: Tree and shrub cover, V2: Grasses and perennial herbaceous plants

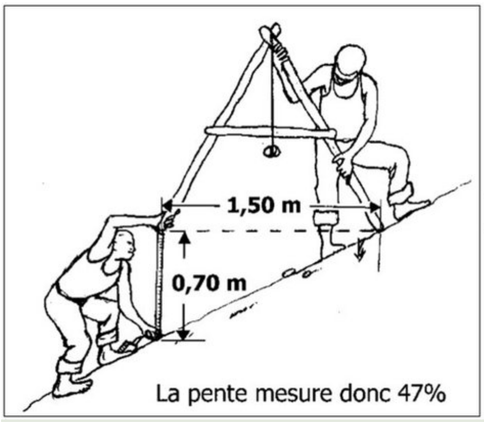


**structural measures** - S1: Terraces

## TECHNICAL DRAWING

### Technical specifications

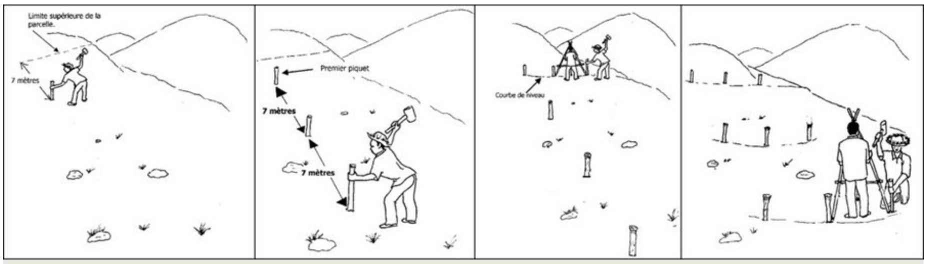
In order to implement this technology, the average slope has to be measured first. This is done with a "A-level"-called instrument. By placing one foot to the A-level and raising the lower foot (downstream in the direction of the slope), the A-level should be placed in a horizontal position. The slope corresponds to p=h/l*100, for p = slope, h = distance from the downstream foot of A-level to the ground, and l = distance between the two feet of level A. The average slope defines the distance between the vetiver lines. The steeper the slope, the smaller the distance.




| Pente | Ecartement conseillé |
|---|---|
| < 10 % | 12 – 15 m |
| 10 – 25 % | 10 – 12 m |
| 25 – 40 % | 8 – 10 m |
| 40 – 60 % | 6 – 8 m |
| > 60 % | ~ 5 m |

Author: Régis and Roy

After having calculated the average slope of the terrain, one can start picketing the contour lines where the vetivers will be planted. First, an alignment in the direction of the slope from upstream to downstream is done by planting stakes. The first stake is placed at the upper limit of the plot, the distance the other stakes is a function of the average slope of the terrain (here: 50% --> 7m). This alignment forms the baseline. Once the baseline is set, the contour lines can be picketed. This is done again with the A-level instrument.

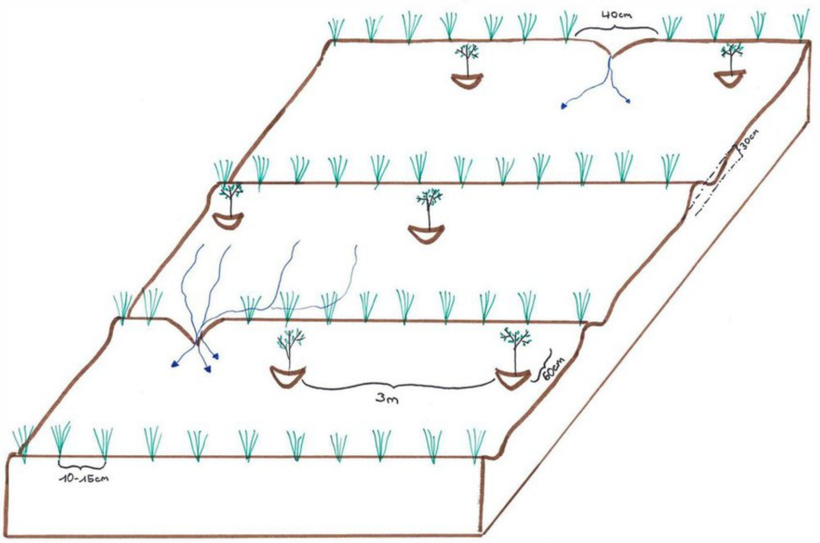



Author: Régis and Roy

In a third step, channels (about 30cm deep) are dug following the picketed contour lines. The material removed is used to form ridges downstream of the channels. On the ridges, vetiver cuttings are planted every 10-15cm.

Author: Joana Eichenberger

It is recommended to leave a space of approx. 40cm in each line (see drawing). These spaces a) facilitate the passage for the land users once the vetiver grass is high and b) make it possible for extra water to escape (if there is too much water accumulated in the channels, the ridgesmay break). 60cm downstream of the vetiver hedges, fruit or forest tree seedlings are planted every 3m. After about three months, the roots of the vetivers are deep enough. Depending on the soil degradation's degree, land users may begin to cultivate the spaces between the lines.




Author: Joana Eichenberger

## ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

**Calculation of inputs and costs**
- Costs are calculated: per Technology unit (unit: **Vetiver line** volume, length: **200m**)
- Currency used for cost calculation: **HTG**
- Exchange rate (to USD): 1 USD = 62.0 HTG
- Average wage cost of hired labour per day: 200 HTG per person and day

**Most important factors affecting the costs**
1) Skilled labourers 2) Maintenance costs depends very much on the weather: if it rains too much, runoff destroys the ridges by forming gullies and removing the vetiver cuttings which were not sufficiently rooted. If it does not rain enough during the first weeks, the vetivers can not form roots, dry out and must be replaced.

**Establishment activities**
1. If necessary: deforest the plot (Timing/ frequency: None)
2. Measure the slope with A-level and calculate the necessary distance between the lines of vetiver (Timing/ frequency: None)
3. Mark out the contour lines (put a stake every 3m) (Timing/ frequency: Beginning of the rainy season so that the vetiver can grow well -> March / April)
4. Dig a channel following marked contour lines (Timing/ frequency: March / April)
5. Plant the vetiver seedlings every 10-15cm on the ridges of soil below(downstream) the canal (Timing/ frequency: March / April)
6. Plant the tree seedlings every 3m below (downstream) the vetiver lines (Timing/ frequency: March / April)

**Establishment inputs and costs (per Vetiver line)**

| Specify input | Unit | Quantity | Costs per Unit (HTG) | Total costs per input (HTG) | % of costs borne by land users |
|---|---|---|---|---|---|
| **Labour** | | | | | |
| Unskilled labourer | person-days | 20.0 | 200.0 | 4000.0 | 100.0 |
| Skilled labourer | person-days | 5.0 | 1000.0 | 5000.0 | |
| **Equipment** | | | | | |
| Machete | pieces | 1.0 | 5.0 | 5.0 | 100.0 |
| Pickaxe | pieces | 3.0 | 5.0 | 15.0 | 100.0 |
| A-level | pieces | 1.0 | 5.0 | 5.0 | 100.0 |
| Hoe | pieces | 5.0 | 5.0 | 25.0 | 100.0 |
| **Plant material** | | | | | |
| Vetiver grass | cuttings | 2000.0 | 2.0 | 4000.0 | |
| Trees | cuttings | 67.0 | 50.0 | 3350.0 | |
| **Total costs for establishment of the Technology** | | | | **16'400.0** | |
| *Total costs for establishment of the Technology in USD* | | | | *264.52* | |

**Maintenance activities**
1. Replant dead cuttings (Timing/ frequency: 2 times a year)
2. Reparing broken ridges (Timing/ frequency: 2 times a year)
3. Verify if ridges are ok (Timing/ frequency: In the beginning once a month, after that only once every three months)
4. Cultivate normally (Timing/ frequency: From tree months after implementation)

**Maintenance inputs and costs (per Vetiver line)**

| Specify input | Unit | Quantity | Costs per Unit (HTG) | Total costs per input (HTG) | % of costs borne by land users |
|---|---|---|---|---|---|
| **Labour** | | | | | |
| Land user and his family (monthly check, 1/2 day of work for 200m) | person-days | 6.0 | 200.0 | 1200.0 | 100.0 |
| Replanting dead cuttings and reparing ridges (2 times a year total 5 working days for 20 people) | person-days | 100.0 | 200.0 | 20000.0 | 100.0 |
| **Equipment** | | | | | |
| Hoe | pieces | 1.0 | 5.0 | 5.0 | 100.0 |
| **Plant material** | | | | | |
| Vetiver cuttings replaced after rainy season (5%) | cuttings | 65.0 | 2.0 | 130.0 | |
| Vetiver cuttings replaced after dry period (40%) | cuttings | 533.0 | 2.0 | 1066.0 | |
| **Total costs for maintenance of the Technology** | | | | **22'401.0** | |
| *Total costs for maintenance of the Technology in USD* | | | | *361.31* | |

## 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**
The windward sides (north-facing slopes) receive more rain than the leeward sides.

Léogâne has a tropical climate with a rainy season ranging from April to November (with two peaks in April-May and August-October) and a dry season from the end of November to March. The relative decrease in rainfall in June and July is called the "mid-summer drought". Due to climate change, the rainy season tends to start later than it used to.
Mean annual temperature: 25-27°C

### Slope
- [ ] flat (0-2%)
- [ ] gentle (3-5%)
- [ ] moderate (6-10%)
- [ ] rolling (11-15%)
- [x] hilly (16-30%)
- [x] steep (31-60%)
- [ ] very steep (>60%)

### Landforms
- [ ] plateau/plains
- [ ] ridges
- [x] mountain slopes
- [x] hill slopes
- [ ] footslopes
- [ ] valley floors

### Altitude
- [ ] 0-100 m a.s.l.
- [x] 101-500 m a.s.l.
- [x] 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.
- [ ] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

### Technology is applied in
- [ ] convex situations
- [ ] concave situations
- [x] not relevant

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

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

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

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

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

*Water quality refers to:*

### Is salinity a problem?
- [ ] Yes
- [x] No

### Occurrence of flooding
- [ ] Yes
- [x] No

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

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

## CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

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

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

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

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

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

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

### Gender
- [ ] women
- [x] men

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

### Area used per household
- [x] < 0.5 ha
- [x] 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
- [x] medium-scale
- [ ] large-scale

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

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

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

### Access to services and infrastructure

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

## IMPACTS

### Socio-economic impacts

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Crop production | decreased | | | | | ✓ | | | increased |

When established on very degraded land, land users have to patient and wait the soil to recover. But in the long run agricultural production will increase.

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| crop quality | decreased | | | | | ✓ | | | increased | When established on very degraded land, land users have to patient and wait the soil to recover. But in the long run crop quality will increase. |
| risk of production failure | increased | | | | ✓ | | | | decreased | |
| product diversity | decreased | | | | ✓ | | | | increased | |
| production area (new land under cultivation/ use) | decreased | | | | ✓ | | | | increased | |
| drinking water availability | decreased | | | | | | ✓ | | increased | |
| farm income | decreased | | | | | ✓ | | | increased | When established on very degraded land, land users have to patient and wait the soil to recover. But in the long run farm income will increase. |

**Socio-cultural impacts**

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| food security/ self-sufficiency | reduced | | | | ✓ | | | | improved | When established on very degraded land, land users have to patient and wait the soil to recover. But in the long run food security will increase. |
| SLM/ land degradation knowledge | reduced | | | | | ✓ | | | improved | |

**Ecological impacts**

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
|---|---|---|---|---|---|---|---|---|---|
| water quantity | decreased | | | | | | ✓ | | increased |
| water quality | decreased | | | | | ✓ | | | increased |
| surface runoff | increased | | | | | | ✓ | | decreased |
| evaporation | increased | | | | | ✓ | | | decreased |
| soil moisture | decreased | | | | | ✓ | | | increased |
| soil cover | reduced | | | | | | ✓ | | improved |
| soil loss | increased | | | | | | | ✓ | decreased |
| soil accumulation | decreased | | | | | | | ✓ | increased |
| soil crusting/ sealing | increased | | | | | | ✓ | | reduced |
| vegetation cover | decreased | | | | | | ✓ | | increased |
| flood impacts | increased | | | | | | ✓ | | decreased |
| landslides/ debris flows | increased | | | | | | ✓ | | decreased |
| drought impacts | increased | | | | | ✓ | | | decreased |
| impacts of cyclones, rain storms | increased | | | | | ✓ | | | decreased |
| emission of carbon and greenhouse gases | increased | | | | | ✓ | | | decreased |
| micro-climate | worsened | | | | ✓ | | | | improved |

**Off-site impacts**

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
|---|---|---|---|---|---|---|---|---|---|
| water availability (groundwater, springs) | decreased | | | | | | ✓ | | increased |
| reliable and stable stream flows in dry season (incl. low flows) | reduced | | | | | ✓ | | | increased |
| downstream flooding (undesired) | increased | | | | | | ✓ | | reduced |
| downstream siltation | increased | | | | | | ✓ | | decreased |
| damage on neighbours' fields | increased | | | | | | ✓ | | reduced |
| damage on public/ private infrastructure | increased | | | | | | ✓ | | reduced |

## COST-BENEFIT ANALYSIS

**Benefits compared with establishment costs**

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
|---|---|---|---|---|---|---|---|---|---|
| Short-term returns | very negative | | | | | ✓ | | | very positive |
| Long-term returns | very negative | | | | | | ✓ | | very positive |

**Benefits compared with maintenance costs**

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
|---|---|---|---|---|---|---|---|---|---|
| Short-term returns | very negative | | | | | ✓ | | | very positive |
| Long-term returns | very negative | | | | | | ✓ | | very positive |

When established on very degraded land, it is necessary to wait a few months / years until land users can enjoy the benefits of this technology.

## CLIMATE CHANGE

**Climate-related extremes (disasters)**

| | | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|---|
| tropical storm | not well at all | | | | ✓ | | very well |
| local rainstorm | not well at all | | | | ✓ | | very well |
| drought | not well at all | | | | ✓ | | very well |
| landslide | 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%
- 91-100%

**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)
- ✓ Terrain conditions

The Swiss Red Cross has tried out this technology by using sugar cane instead of vetiver. But since vetiver has deeper roots and is more resistant to dry periods, the SRC abandoned the variation with sugar cane. If the ground is too degraded it is not necessary to make long lines of vetiver with always the same distance between one and the other (see the photo under description). We must adapt to the terrain.

## CONCLUSIONS AND LESSONS LEARNT

**Strengths: land user's view**

- vegetable matter for mulching
- sediment retention
- increased soil moisture

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

- smoothens the slope
- recuces soil erosion
- improves soil fertility

**Weaknesses/ disadvantages/ risks: land user's view** → how to overcome

- Land users believe this technology recuces the arable surface. → It is necessary to increase the land users awareness regarding the benefits of the technology, like for example the productivity which increases.
- The implementation of the technology is very labour-intensive. → Show that other technologies give even more work (e.g. progressive terraces with dry stones)

**Weaknesses/ disadvantages/ risks: compiler's or other key resource person's view** → how to overcome

- The technique with vetiver grass depends on rain and as a result it is more vulnerable than dry stone technology. → The dry stone technology is only applied where there are stones locally available. Otherwise buying the stones and transporting them would cost too much.

## REFERENCES

**Compiler**
Joana Eichenberger

**Date of documentation**: Oct. 19, 2017

**Reviewer**
Hanspeter Liniger

**Last update**: June 16, 2020

**Resource persons**
Jean Carls Dessin - SLM specialist
- Technician

**Full description in the WOCAT database**
https://qcat.wocat.net/en/wocat/technologies/view/technologies_3223/

**Linked SLM data**
Approaches: Afforestation https://qcat.wocat.net/en/wocat/approaches/view/approaches_3284/
Cca: Unknown name https://qcat.wocat.net/en/wocat/cca/view/cca_4380/
Approaches: Afforestation https://qcat.wocat.net/en/wocat/approaches/view/approaches_3284/

**Documentation was faciliated by**
Institution

- Swiss Red Cross (Swiss Red Cross) - Switzerland

Project

- n.a.