

**Soil conservation, an example:
the « Arengha 89 » stoneline ridge system : 12 simple rules for the project teams
*Mure agricultural project, Ethiopia***

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Mars 94 / Mars 98

The « Arengha 89 » method of soil conservation is presented here in 12 « rules », that were made as simple as possible. The drawings make it easier to memorize all the parameters that must be taken into account.

It was prepared for the Mure project team in Ethiopia. As the members of the team already deal with three languages and use two alphabets, they find it difficult to read too long a text or to understand drawings without comments. They'd rather learn a few simple rules that can be adapted to the many situations encountered in the field.

They also find it difficult to visualize the evolution of the field shape in time. Shaping the land therefore remains something quite distant for them.

We thought that these few « rules » could be useful in other circumstances, for other field workers or farmers groups. They are available in French and in English, and presented as an appendix to the technical note « **Agro.1.1.1** ».

Though very simple, these 12 rules are not always easy to put into practice on the field. Yet they were born from the field needs. As the Indian saying goes « no land, no crop » no hedge, no useful rain, no stoneline ridge, no fruitful land.

Each intervention is a particular case. It is therefore necessary to adapt to the situation.



¹ Mure agricultural project manager from April 93 to April 96.

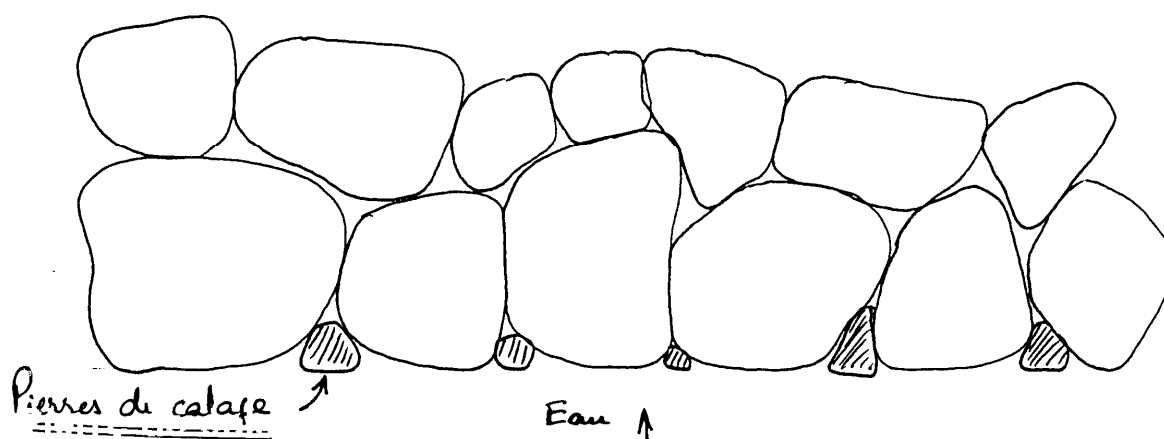
How to make the stoneline ridge: the main pattern

2 stonelines in staggered rows, with wedge stones and crushing.

Comment: most of the time, one line of large stones is enough. The second line, if necessary, can be made of medium-sized stones.

The crushing helps sedimentation. It must be made of coarse and fine gravel or crushed stone.

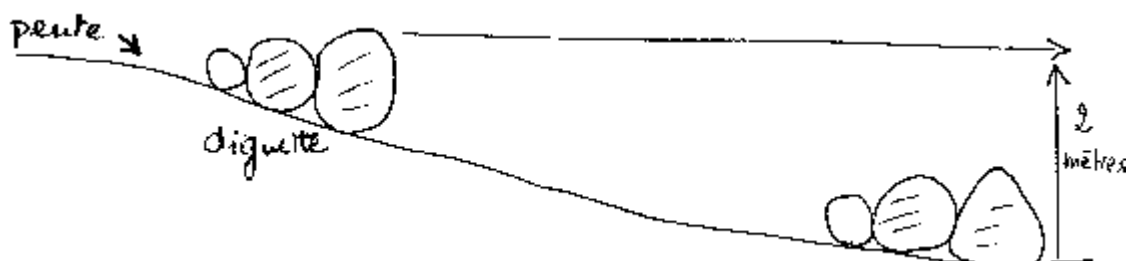
The wedge stone, being the essential part of this method, **must lay flat** (doing the opposite is the most common mistake).



Vertical interval

Between two stonelines, **the average level difference is of 2 meters**, and the average distance between two stonelines is of 20 meters for intermediate slopes between 3% to 10%:

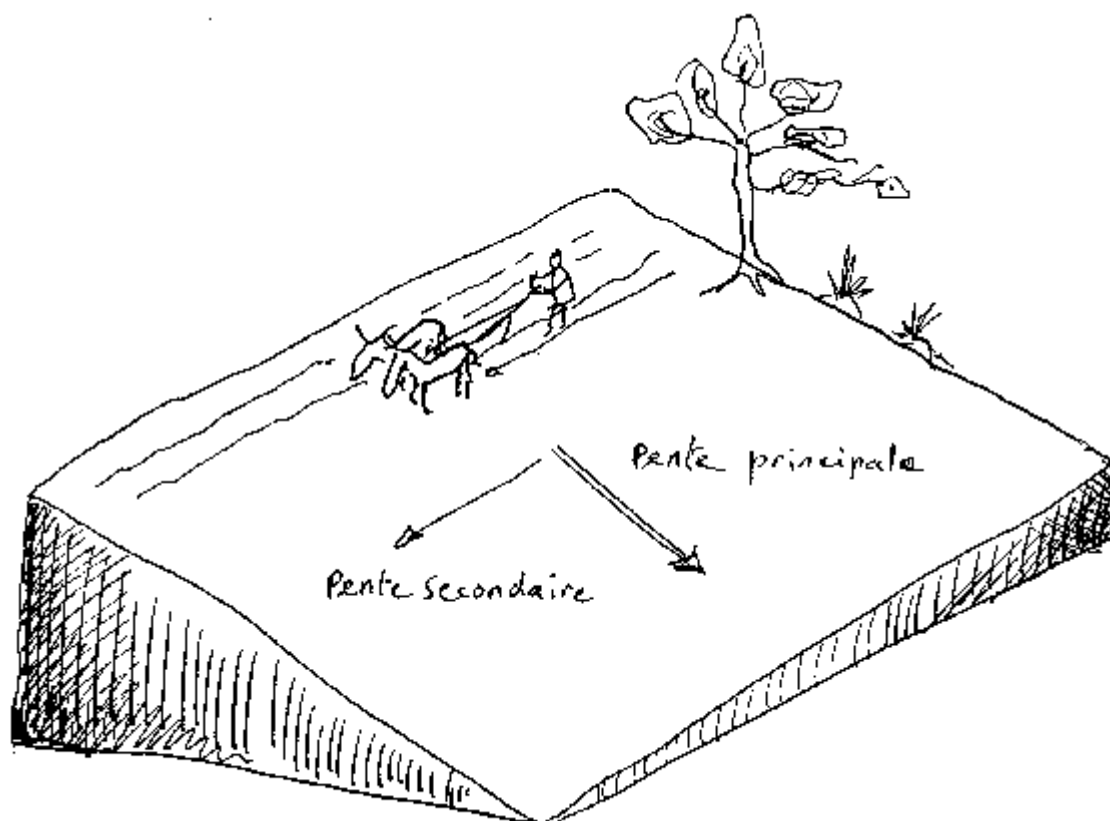
According to the steepness of the slope, the distance between the stonelines may vary. 20 meters is only an average, and implies that the terraces between the stonelines will never be completely flat.



The two-slopes system

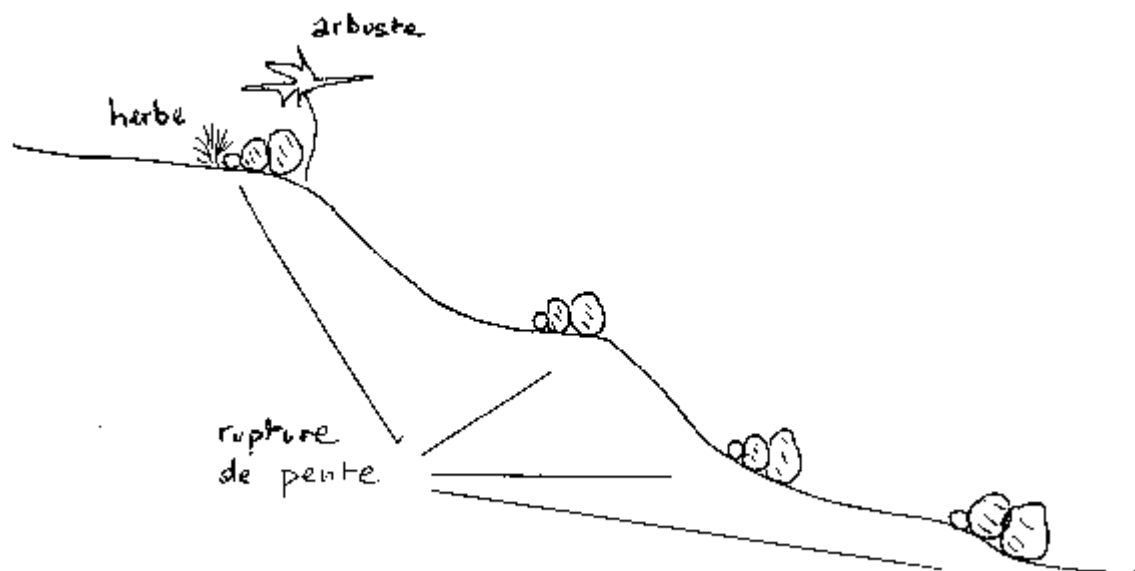
There are no horizontal surfaces in nature - even the ocean is curved - and each land has at least two main slopes. The stoneline ridges are generally placed according to these two parameters: the network of stoneline ridges is built according to the main slope (slope 1); the side ridges are built according to the second slope (slope 2). This is not easy as most fields are quite irregular.

This type of stoneline ridge can nonetheless be built anywhere.



Change of incline

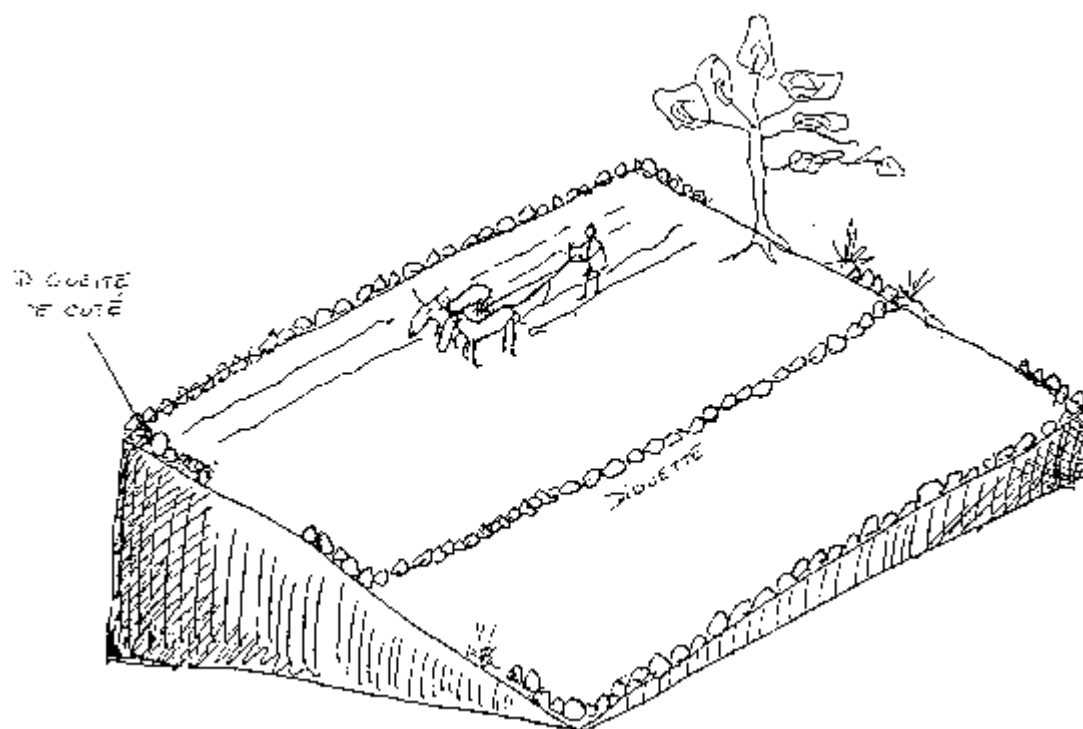
Most of the time, the steepness of the slope changes. It usually is a good place to set up a stoneline.



The side ridges

The side ridges prevent soil and water from running off on the side of the stoneline ridge.

Comments: Side ridges of two meters only are needed in most cases; but sometimes, according to the shape of the field, it may be useful to make a full side-ridge joining the two stonelines ridges. The side ridges have an effect on the second slope (*see The two-slope system, p.4*).



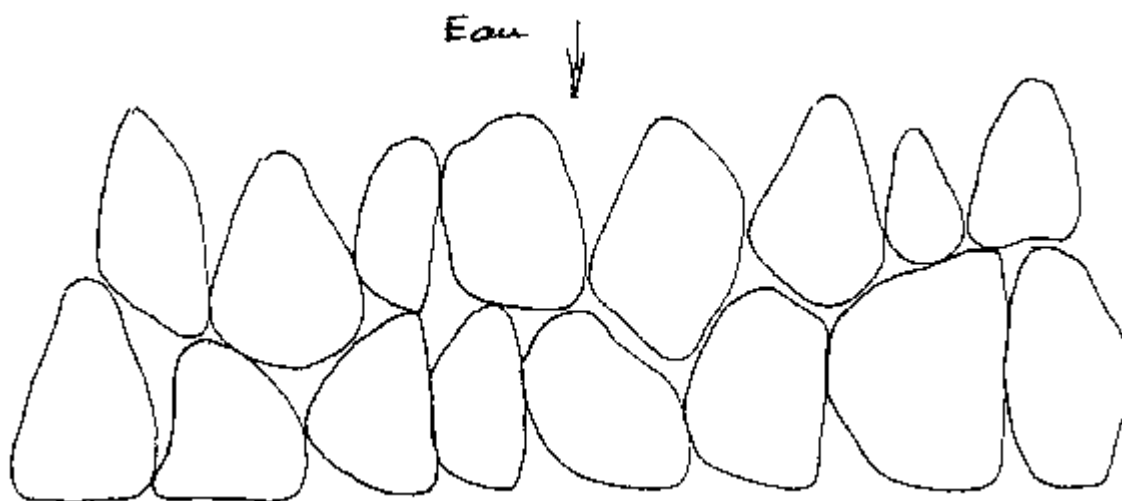
The slow-down

No wedgestone, no crushing

Comment: When too much water is coming, the slow-down will slow down the water current and thus stop erosion and start sedimentation.

The pointed side of the stones must face the water current.

Do not build more than 2 stonelines in staggered row: if more than two are built, it would stop the water flow and the slow-down would be washed away.



Soil reclaiming : the slow-down system

Usually, when there is no more soil left, a complete stoneline ridge is needed, with:

- 2 stonelines in staggered rows
- wedge stones
- gravel or crushing

But in the case of a river bed or deep gully, a **slow-down is needed instead**.

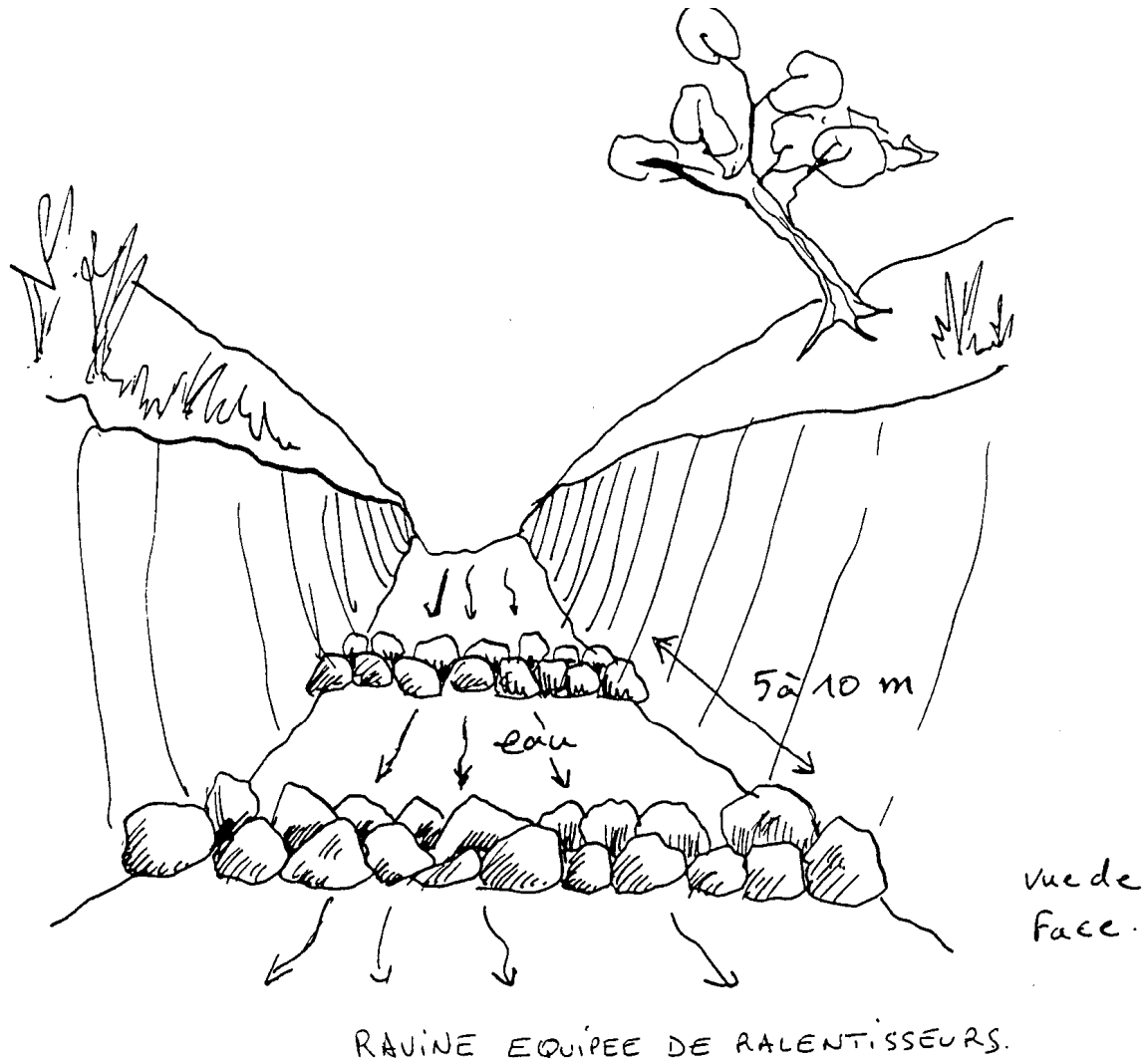
Comment: the « Arengha 89 » method is the only technique that works in such a case.

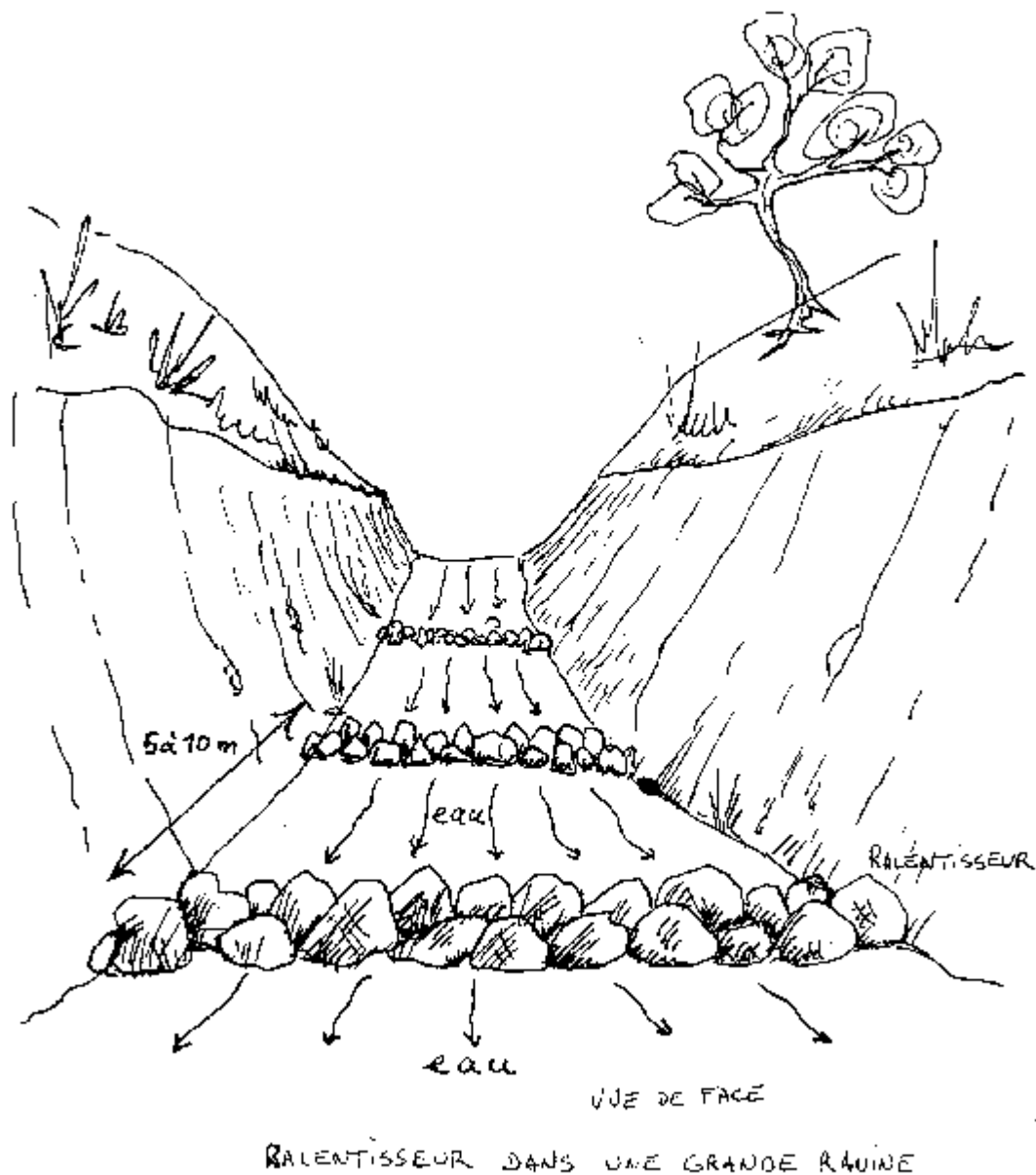
This way the gully will be filled up in 3 or 5 times

Height: always lower than the gully sides

Spacing out: Every 5 or 10 meters, according to the steepness of the slope.

The slow-downs in the gullies constitute the first network of soil conservation. After several rains, this network will be covered by sedimentation and only the second network of stoneline ridges will be seen once the land is shaped.





Slow down in a big gully

It is therefore possible to fill up a big gully in thwo rain seasons, with a network of slow downs set up in several stages.

The slow-down effect or the straining effect

Important rain, high water wave =>	slow-down stone =>	the water speed is slowed down so erosion is stopped. Only a little sediment is kept	slow-down effect
Normal rain, water wave less than 15-cm high =>	1. stoneline ridge 2. Wedge stone =>	The water is filtered through the ridge. Erosion is stopped. More sediment is kept.	straining effect
Usual rain, water wave less than 5-cm high =>	1. stoneline ridge 2. wedge stone 3. crushing =>	All sediment is stopped	straining effect

- Grass acts as a wedge stone.
- Vetiver acts as crushing.

According to: ① the use that will be made of the field:

- crop field
- pasture or grazing land

② the steepness of the slope

③ the degree of erosion:

- grass missing
- soil missing
- gullies

- slow-down,
 - stoneline + wedge stones,
 - stoneline + wedge stones + crushing
- will be used.**

DISTANCE:

the distance between two stoneline ridges will vary :

- more in grazing land
- less in field land

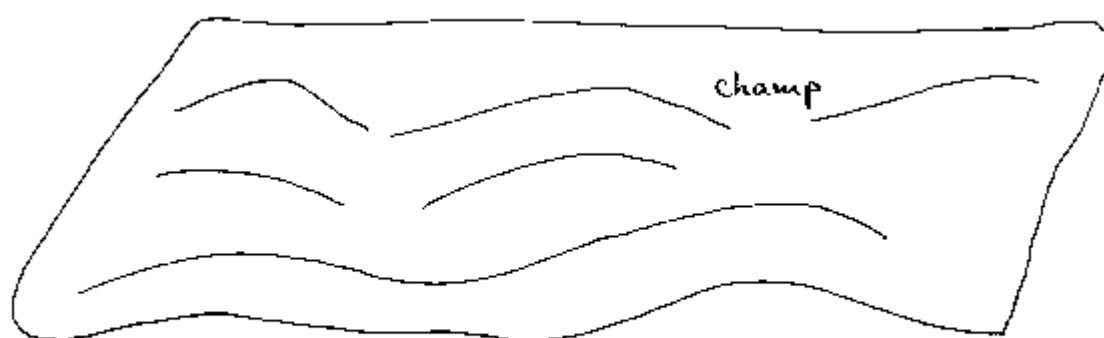
Shaping the land

Comment: « Arengha 89» allows easy land shaping

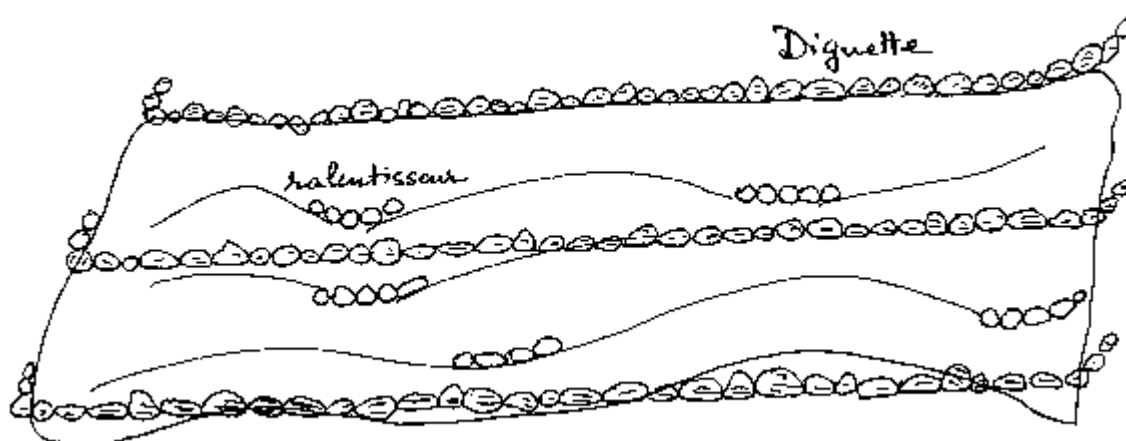
With:

- 1) the general stoneline ridge system for the fields
- 2) the slow-down frame system to fill the large gullies.

it is possible to shape any type of land and even to reclaim badlands.

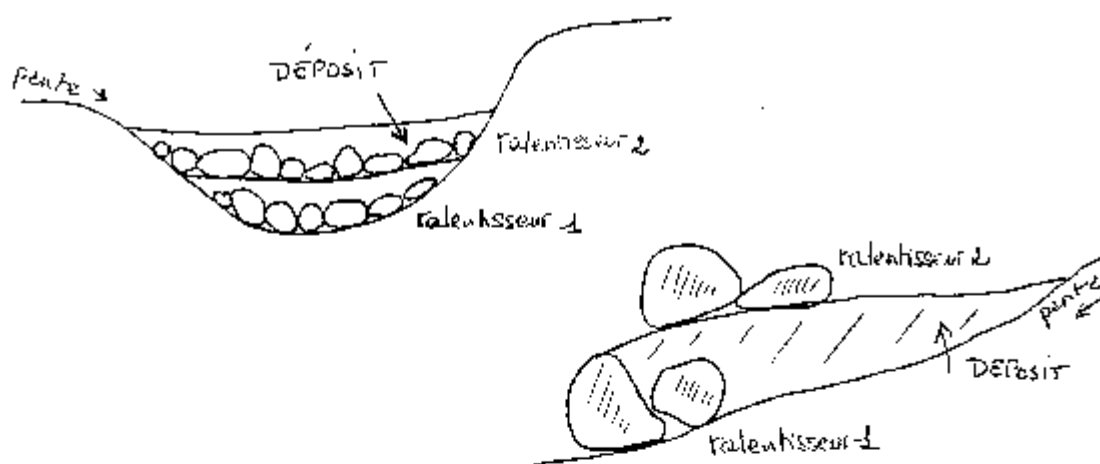


Le ralentisseur est rapidement recouvert de terre (dès la première pluie). Pour combler entièrement la ravine, il faut refaire un ralentisseur par-dessus, comme les marches d'un escalier.



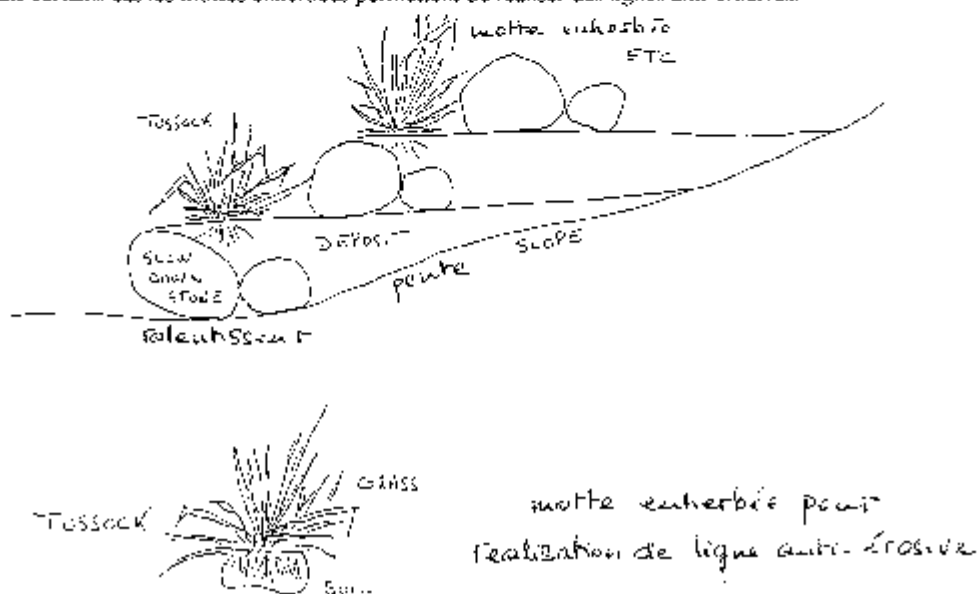
The slow-down will soon be covered by the soil (after the first rain). To fill up the gully, make another slow-down above, using the stairway system, as shown below.

The « stairway system »



Quand le volume d'eau n'est pas trop important des mottes enherbées peuvent être utilisées et ajoutées entre deux lignes de ralentisseurs, en décalant les ralentisseurs un peu vers l'amont.

Dans certains cas les mottes enherbées permettent de réaliser des lignes anti-érosives.



When there is not too much water, grass tussock (= grass + soil) can be used or added between two lines of slow-down. (*vetiver, dwarf elephant grass...*).

In some cases, grass tussock can be used to make anti-erosive lines (*see : Vegetal supporting and counter planting, p.15*)

The 2-to-5 rains shaping rule

This is the most important thing to memorise when the shape of the land is like this:



The shaping will not be made in one time : 3 or 5 rains are needed to make it, depending on the general level difference.

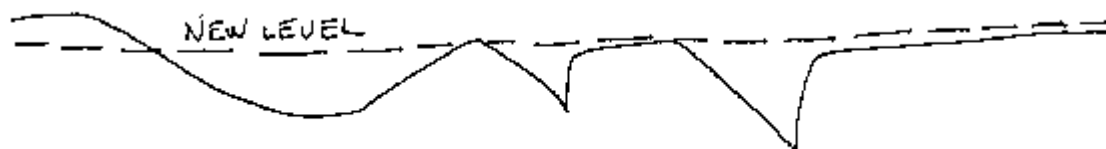
This means:

- 1) Making slow-downs in the gullies
- 2) Making stonelines structures

checking and correcting it after the first big rain

- which means**
- 3) Making new slow-downs on top of the first ones using the stairway system
 - 4) Checking the stonelines structures

In most cases the work is finished after 3 to 5 rains; then the land looks like this:



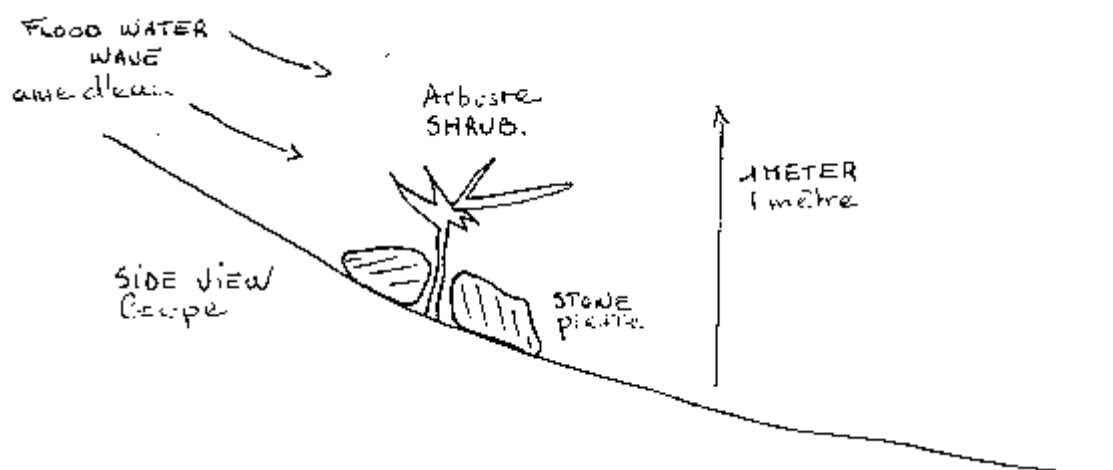
Working « rain-by-rain » is the best way, especially in the case of large gullies or change of level.

To shape the land, one must visualize the evolution of field shape in time; it is the hardest part as many parameters must be taken into account simultaneously.

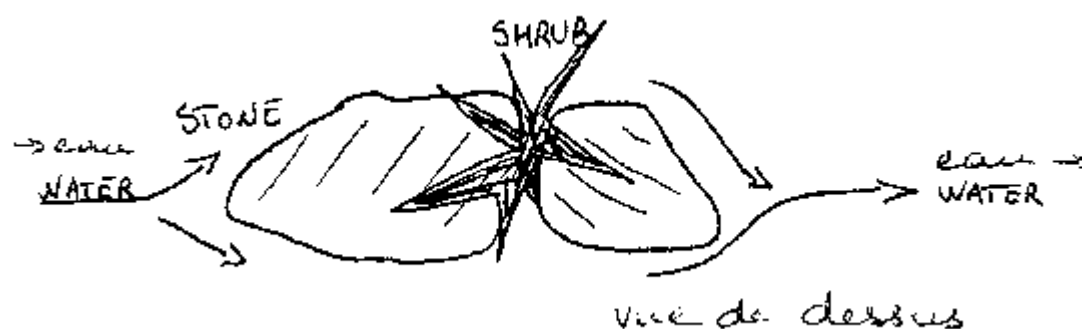
Protecting trees against water waves and flood or the Roman bridge effect

Roman bridges pillars have a sharp side facing the current to divide the water thrust.

In a similar way, by putting two stones as shown below, it is possible to protect a young tree or shrub that has not yet taken root against 1-meter high waves (as can happen in a « wadi »):



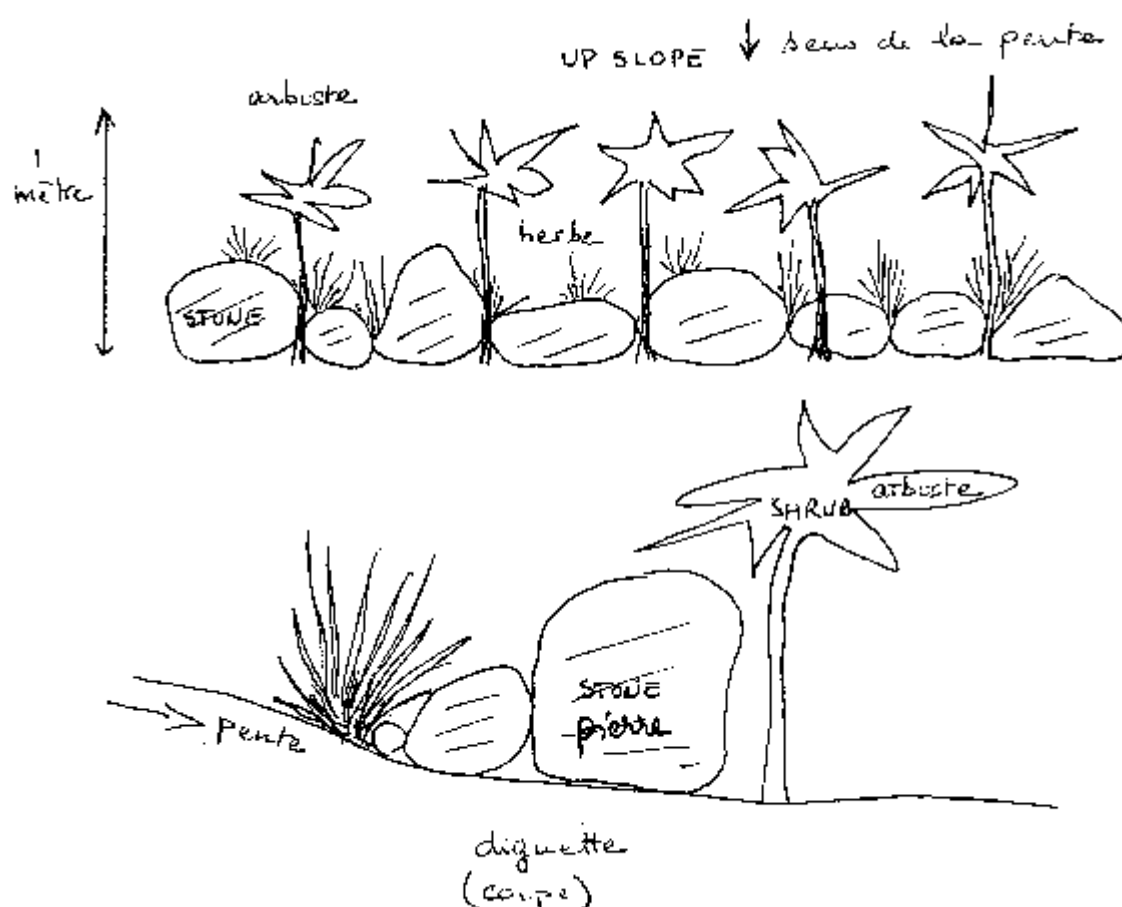
This is how to prevent rain or surface water from uprooting a tree, shrub or grass that was planted recently and that has not yet taken root.



Vegetal supporting and counter planting

Stones might not always be found in sufficient quantity. Using plants is then necessary to make the same type of work. Each land has its own particular vegetation, so one must test as many plants as possible - the idea being to find the plants that suit the place best. Though some plants are sufficiently adaptable to grow almost everywhere, vegetal supporting will vary according to each location.

To reinforce and make the stoneline ridges durable, grass tussock, shrubs or pruned trees can be counter-planted along the stoneline ridges, uphill on normal slopes, below on steep slopes.



Some examples tested in Gesuba: (Wolayta, North Omo, South Ethiopia; 1500 meters altitude; 1000 mm rain fall; temperature from 8 to 35°C; average of 5 months of drought; heavy clay soil and black cotton soil).

- ✿ Vetiver (*vetiveria zizanoides*) planted 15 cm apart . It is the best grass but slow to establish (2 to 3 years)
- ✿ Dwarf elephant grass (*pennisetum purpureum*) is the fastest to grow (a few months) - but easily eaten by cattle
- ✿ Pigeon pea (*cajanus indica*): the best shrub (food and fodder); 1 year is enough (must be pruned 1 meter high to produce well)
- ✿ Rope tree (*agave sisalana*), for defensive hedge; it is the best on heavy clay soil on 1st generation (to protect the second one); quickly set up (1 year)
- ✿ Douyalis caffra (*kochim* in Amharic): to make hedges that become impassable, as it is heavily thorned, but needs 3 years
- ✿ Robe tree (*euphorbia tirucalli*), widely used in Wolayta (South Ethiopia), easy to use in the dry season
- ✿ Sesbania sesban: interesting shrub (fodder)
- ✿ Datura SP²: easy for cutting,
- ✿ Poinsettia: for cutting
- ✿ Euphorbia cotinifolia: for cutting (red round foliage)
- ✿ Caesalpinia decapetala (*Gamogadé* in Amharic), with sharp curved prickles
- ✿ Ziziphus SP: better in sandy soil, drought resistant, 8 months.
- ✿ Dodonea angustifolia (*sankara* in Wolayta)
- ✿ Acacia drepanolobium: whistling thorn, among the best
- ✿ Smallacacia Hockii, by the road to Mancha Wolayta
- ✿ Aloe SP: traditional hedge in Wolayta, three colours.
- ✿ Melia azedarach: fast growing but very poisonous berries
- ✿ Leucaena diversifolia: the best for shading
- ✿ Leucaena leucocephala: for low hedges
- ✿ Calliandra: very fast growing
- ✿ Gliricidia sepium
- ✿ Moringa indica oleifera and stenopetala: grows fast in sandy soil; very much used for food in case of scarcity
- ✿ Pharus prinoides (*guesho*) needs to be planted on an already cultivated land
- ✿ Casuarina equisetifolia: fast thick hedge
- ✿ Dicrhostachys cinerea: one of the best for wood fire
- ✿ Makea sligna: fast growing in heavy soil
- ✿ Lantana camara: turns into weed

² SP = species

Track maintenance and shaping; water control

1. Diagonal: to remove water from the road and drain it into the side ditch:

- the best way is to make it with tussock (grass tuft).
- a height of 10 cm is enough (even less is sufficient).

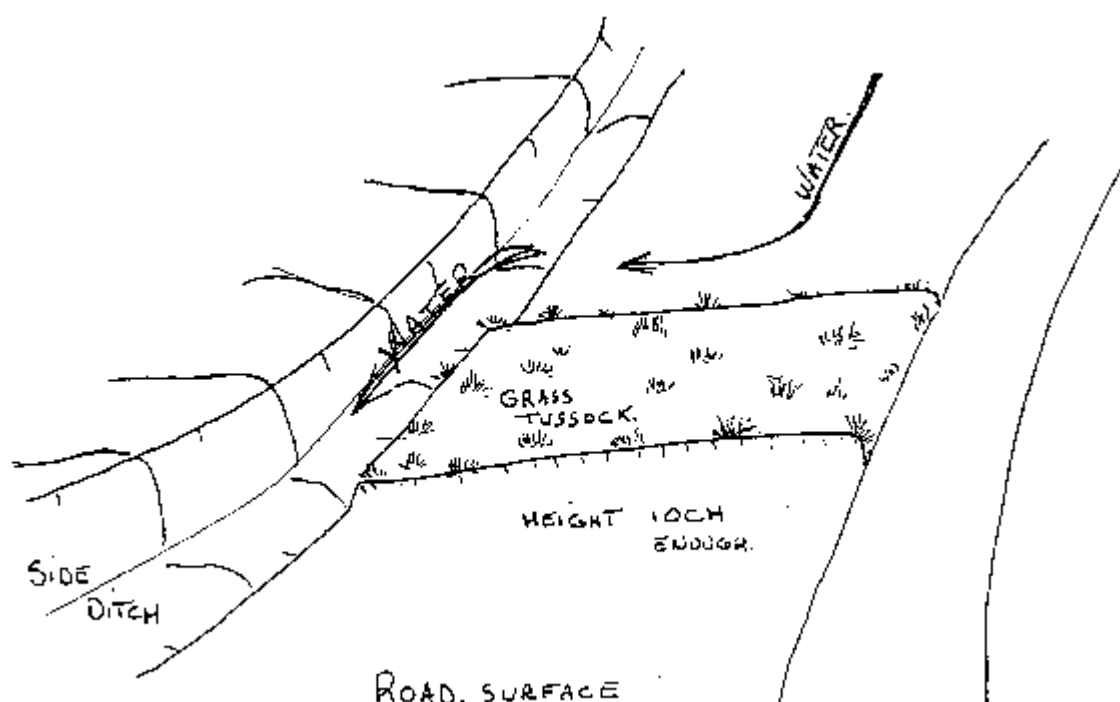
A « diagonal » is a small mound slightly higher than the road, set up across the road to divert water into the ditch, preventing gullies to appear in the middle of the track.

Diverting, draining rainwater from a track is the most important thing to do, in order to prevent gullies and the destruction of the track (a few rains only can destroy a track).

Though necessary, it is not always possible to install ditches on both sides of the track, and it is sometimes necessary to conduct water from one side of the road to the other, so that it can be drained into a water outlet. The idea is to deal with as little water as possible each time, therefore it is better to have as many water outlet as possible on each side of the track.

A ditch cannot remove water from the track. All « diagonals » can.

To avoid the formation of gullies around the water exits (ditch outlet), a slow-down is necessary. On steep slopes, slow-downs in the side ditches prevent gullies. One single stoneline ridge is generally enough (experience helps to decide...)



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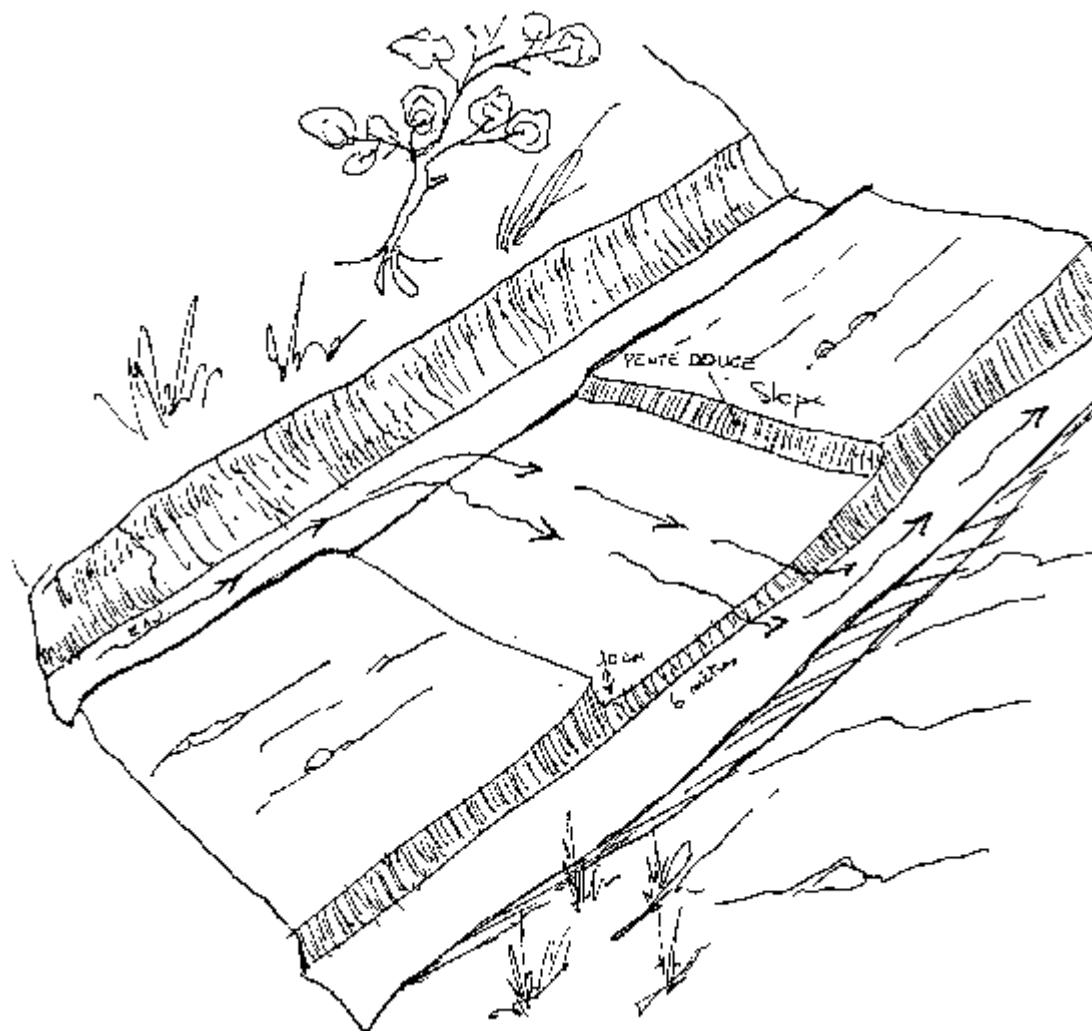
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2. Cut-off drain crossing

It is a waterway, 10 to 20 cm deep, that crosses the track and divert water from one ditch to the other without causing gullies. The water must therefore be spread as much as possible and the waterway must be 6-meter large at least, with two gentle slopes to conduct the water off the road without eroding it.



3. A ridge can replace a ditch in a stony area (next to a water outlet for instance)
A grass ridge can divert the water in a stony area.

References :

Vetiver Grass, the Hedge Against Erosion (Le Vétiver, la protection contre l'érosion) World Bank 1^{re} édition, 1987, 4^e édition déc. 2000, Richard G. Grimshaw

Online in many languages (Hindi, Gujarati, Thaï, and Chichewa!...) at:

<http://www.vetiver.com/>

www.vetiver.com/TVN_GreenFrench.pdf

Vetiver Grass for soil and water conservation and embankment stabilisation, the World Bank, Washington D.C., Richard G. Grimshaw

Vetiver Grass : a thin green line against erosion, National Academy Press, Washington DC

Trees of Kenya, Tim Noad & Ann Birnie Publishers P.O.BOX 40034 Nairobi Kenya : livre, 1 US\$ seulement, **remplace avantageusement une bibliothèque** sur le sujet

Dictionary of economic plants, Uphof, Johannes C. Th. 1968. 2nd ed., rev. and enlarged. Verlag Von J. Cramer, Germany. 591 p. : les 10000 principales plantes utilisées par l'homme.



FOREWORD

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