

Moisture Conservation: Fundamental to Rainfed Agriculture

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There are two basic types of agriculture, irrigated and rainfed. Irrigated agriculture depends on engineered structures and field layouts to make the best possible economic and technical use of water that has been pumped or stored, usually at considerable cost. Rainfed agriculture, the type of farming to which the world's rural poor are by-and-large tied, depends on, and is virtually a 'victim' of, the whims of the weather. It is important that the requirements of each are not confused.

Rainfed Agriculture

Droughts have been increasingly reported in many low-rainfall areas of developing countries in the last five years. In India in 1987, the state of Karnataka reported the worst drought in more than 100 years. Yet in one of the worst hit areas of the state, farmers produced the best crop yields ever - at no extra cost to themselves. How was this done? It was achieved by the simple process of plowing and planting on the contour and so conserving moisture in-situ. Without effective moisture conservation in-situ, up to and even more than 60% of rainfall in low-rainfall areas can be lost through run-off. Farmers in Karnataka saw they could overcome this on their own fields by forming small contour furrows each capable of holding 50 mm of rainfall (and in which the seed would be planted). In normal rains, there is virtually no run-off with such furrows; the water that does not evaporate soaks into the soil and is available to the crop.

Soil conservation

Effective soil conservation is more important today than it has ever been, yet, in the rainfed areas, it is largely neglected. Man first recognised that soil erosion was a problem in the USA back in the early 1930s, when farmers had to walk off their farms in the Tennessee Valley, because they had created a 'dust bowl'. This had been caused by over-cultivation leading to massive sheet erosion by wind and water. In this case, soil erosion was recognised by the US Government's Department of Agriculture, and treated as an engineering problem. It was therefore given an engineered solution - contour banks and diversion banks to intercept the run-off and direct it to a safe disposal area (usually a natural stream or drainage line, though if these were not available, waterways were constructed).

In some areas where disposal was a problem, absorption banks were constructed to hold the water till it either soaked into the ground or evaporated. The contour concept was correct, but all the other measures were unnatural, static measures designed and constructed to hold or convey the run-off water elsewhere, thus increasing its volume and erosive capacity and reducing both effective soil and moisture conservation.

In over 30 years of working in developing countries, the author has seen expensive engineered soil conservation works fail repeatedly, in the process causing more damage than would have been the case if they had not been constructed. It was increasingly clear to him that the engineered system was not the answer - it was too costly, it was temporary, it diverted water from fields, and small farmers did not like it, especially as the earth banks removed a five meter strip of land from production and most obvious of all, the engineered system is 'unnatural'. Despite such evidence, the engineered soil conservation system has been accepted - and taught - worldwide. It has never been seriously questioned. It is the method of soil conservation. Until now there has been no satisfactory alternative soil and moisture conservation system. However, under a World Bank-supported project in India (Pilot Project for Watershed Development in Rainfed Areas) an alternative system of soil and moisture conservation in-situ that is particularly suited to developing countries (though the principles are applicable to any rainfed area) has been developed. This system is based on soil stabilization through vegetative contour barriers of Vetiver grass, *Vetiveria zizanioides*, 'khus' in India. These Vetiver hedges are already in use for more than 100 years by farmers in the Gundalpet area of the State of Karnataka, India. (Ed. note: Also indigenous soil conservation techniques and practices in Africa like stone bunds, stone terraces, pits, trash barriers, soil bunds, mulching, etc., are better adapted to the needs, constraints and possibilities of small farmers (Chris Rey, 1987, ILEIA 1986)).

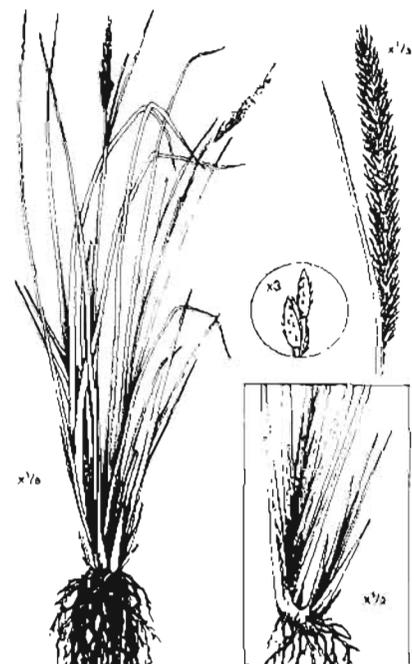
Vetiver Grass

The author worked with Vetiver grass in the Fiji Islands over thirty years ago, and has followed its progress since. The idea of using Vetiver grass as a vegetative means of soil and moisture conservation originated in the West Indies over 50 years ago. While it was

extremely successful there, it has remained largely unrecognized elsewhere as a soil and moisture conservation measure, possibly for the same reasons as the author never promoted it: - 'the island was too small, the soils too specific and the climate too special for anything that did well under those conditions to be recommended for wider acceptance.'

Over the years, the author searched for Vetiver grass in Africa, Southeast Asia and South America, finding it growing at some research stations as an essential oil plant (its roots produce oil of vetiver, a perfume base) but never in sufficient quantity or showing a sufficient range of adaptability to promote the grass for trial. However, in 1985 he was stationed in India where Vetiver grass is native. A challenge was therefore to determine if it could be grown successfully in semi-arid areas of India - if so, it could be grown almost anywhere.

A search was immediately started for Vetiver grass. It was not difficult to find. Indeed, it exhibited a wide range of adaptability, from over 2,000m in the Himalayas where it is covered with snow during winter to the blistering deserts of Rajasthan, the swamps outside Delhi and the wastelands of Andhra Pradesh. Convinced that this was the grass with the greatest potential for soil and moisture conservation, the author returned to Fiji



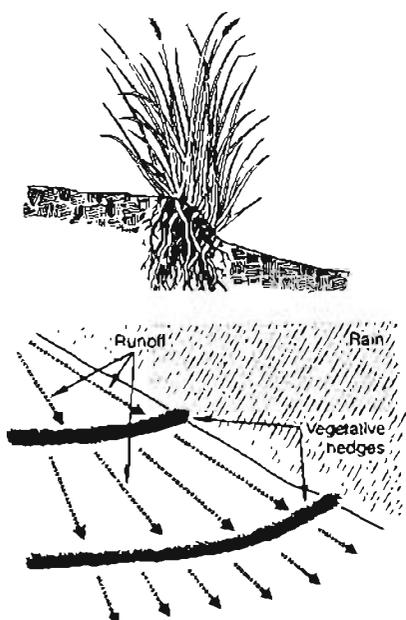
Vetiver grass.

to examine its performance there and talk with farmers who had by now over 30 years experience with Vetiver grass. Before recommending it for extensive trial in India, it had to be confirmed that Vetiver grass did not become a weed in farmers' fields; that it lasted as a hedge, so filtering soil from run-off; that it did not compete with farmers' food crops; and that it was not an intermediate host for pests or diseases of economic crops. Findings were favorable on each of these concerns. It was clear that Vetiver grass is the right, indeed the only, plant for the long-term control of soil erosion and to promote in-situ moisture conservation.

Moisture Conservation

Since in India farmers have generally had bad experience with engineered soil conservation measures and are often reluctant to hear about 'soil conservation', the system is described to them as 'moisture conservation'. Farmers' attention was obtained initially by the fact that at no extra cost, they could increase their yield by 50% if only they plowed and planted on the contour. In the first year, results were excellent (see Table 1). In the second year, farmers in Karnataka who practiced only contour planting produced excellent crops of groundnuts and pigeon pea, while their neighbors using the traditional system of planting with the slope (less than 2% in this case) produced nothing at all; even a 'catch-crop' of late-planted chick pea failed. In fact, the experience suggested that the area classified as a severe drought zone was really a man-made problem of 'not understanding moisture conservation', and taking advantage of it.

Moisture conservation in-situ is not itself sufficient, however. Fields must be stabilised with vegetative (Vetiver



The vegetative method of soil and moisture conservation uses nature to protect itself. In this case, Vetiver grass is being used. Only a 50 cm strip is taken out of production.

grass) barriers to protect them from high intensity storms. In arid areas Vetiver hedges take three seasons to establish, but once established, they are permanent. (In the wet tropics the hedges establish in five months).

An established Vetiver hedge (and no suitable alternative plant has been identified) will completely stop sheet erosion (this is erosion of the superficial layer of the soil). Rather than concentrating run-off water into streams and so becoming more erosive, vegetative hedges slow run-off, spread it out, and filter out the silt while letting the water ooze through the entire length of the hedge, but not allowing it to concentrate anywhere. Silt trapped behind the grass barrier spreads back across the field. Vetiver grass grows through the silt in its immediate surroundings, so over the years forming a natural terrace. In Fiji on 50% slopes, terraces three to four metres high have formed behind the grass hedges; this is soil that would have been lost to the farmer, and the country, forever.

The Vetiver grass-based, 'moisture conservation in-situ' (MCI-S/Vetiver) system can be used worldwide. As a result of the work in India, the system has already been introduced to Nigeria, Somalia, Sri Lanka and Indonesia, the Philippines, Thailand, Burma, Nepal and now China. The U.S. Department of Agriculture sent a representative to New Delhi to collect cultivars of the plant for introduction and trial in the U.S., but now Vetiver has been found growing in Louisiana and Florida. The system is applicable for rainfed tree-crops as it is for other crops.

The work underway in India represents a major break-through in food production for small farmers worldwide, giving them a better chance for survival in the 21st century. The vegetative system is cheap, replicable and sustainable. It is 'the farmer's system', he can do all the planting and maintenance without any assistance. It costs at the very most one-tenth the cost of engineered systems. Moreover, it extends the range of cultivation. With engineered soil conservation systems, arbitrary limits on cultivation are set for the production of food crops; 12% was the maximum 'safe' slope with up to 65% slope for forests only. With this system of contour plowing (or hand-cultivating) and planting between the stabilising hedges, food crops and sugarcane have been produced safely on 100% (45 degrees) slopes. Vast areas of land, hitherto classified as unstable, can now be safely used for production so long as the vegetative hedges are established and maintained. The time has come to widely promote this vegetative soil and moisture conservation system.

Recent Information

Since originally writing this article, six months ago, the author has travelled extensively round the world gathering information on Vetiver grass; where it grows, and what problems it may have

had, and how successful it has been at preventing sheet erosion. The following points are highlights of the most recent findings:

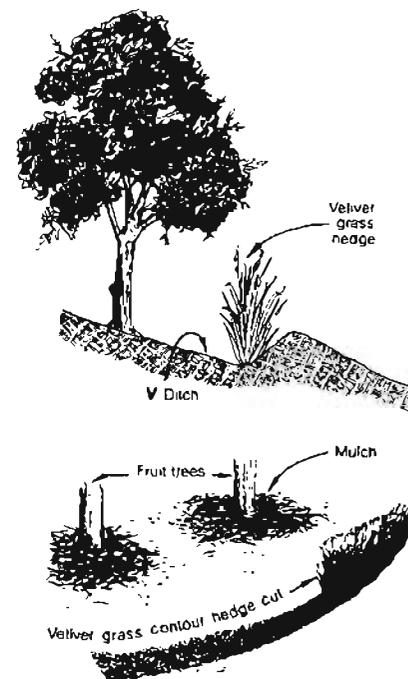
a) Vetiver hedges have been maintained and used extensively for the prevention of boundary soil erosion by farmers in the Gundalpet area of the State of Karnataka, India, for over 100 years! They never let the plants form seed heads, but keep the hedges cut short (30-50 cm) so that they can also feed the fresh regrowth to their cattle. It has never been a problem to them, and has prevented soil erosion. They can control the hedges' width at about 50 cms, on these 'flat areas' and it is permanent. This has been the most interesting finding so far, and confirms all our hopes for this system, and its longevity.

b) On the Island of St. Vincent, in the West Indies, Vetiver grass has been stopping erosion on all slopes up to and over 100% for over 50 years, and in some areas, has built up natural terraces to an average height of four meters.

c) It was observed in Trinidad, stabilising road embankments totally preventing any erosion on the 100% slopes of 'scree', shale, and red yellow podsollic soil, and this in 2,000 mm rainfall areas.

d) It has been found growing successfully on the side of the ring road, round Kathmandu, meaning that it can withstand the rigors of climate in that area, and that it can be successfully grown from there right down to the equator. It has also been recorded growing throughout the Terai of Nepal.

e) We are now taking MCI-S into the Himalayas, but there we are using



The collection of runoff has the effect of doubling or tripling the amount of annual rainfall.

Yield (kg/ha) of Sorghum

Treatment	Lowest	Highest	Average
1. Project recommended contour cultivation for in-situ moisture conservation	1151	5320	2187
2. Sown in soil conservation earth banked area (bunded) across the slope	960	2512	1500
3. Bunded areas sown with the slope	836	1828	1345
4. Sowing in unbunded areas across the slope	980	1910	1283
5. Sowing in unbunded areas, traditional practices, no attempt at moisture con-servation (control field)	285	725	510

Table 1. Crop cutting trials in 1986.

Practices 2 and 3 cost the farmer an average of Rs. 4,000/ha to establish. Practices 1, 4 and 5 are of equal cost to the farmer. Practice 1 just requires a change of management to plough on the contour.

indigenous shrubs that have their crowns (offsets) beneath the surface (so that the shrubs will not die by browsing animals) and transplanting them as hedges throughout the watershed areas. These shrubs act as Vetiver grass does, and supply essential fuelwood in a three-year cycle. We have so far identified more

than 100 different indigenous plants for this purpose.

f) It has satisfactorily established on the almost 'bauxite' borrow pit of a large dam in the Kandi Hills, Sri Lanka, where it was planted using 'crowbars' to make the planting holes.



In West Africa, among others Burkina Faso, Andropogon grass is sometimes used as contour hedge, (Photo: Bertus Haverkort)

g) It has stopped 'rill erosion' on the sides of a dam at ICRISAT in Hyderabad, where it was planted (as a hedge) into granitic gravel on the 45 degrees side-batter of the dam, less than 12 months previously - and this during a drought (it received no water from the dam, which was dry!).

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- ILEIA, 1986. **Dry Land Management**. Take a fresh look at local traditions. 18 pp., ILEIA, P.O. Box 64, 3830 AB Leusden, The Netherlands.
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Answers to questions raised in the field after the first edition of the field handbook on khus usage.

- Q: Where can the grass be found as a source of planting material?
A: Between the latitudes 22 degrees North and South, it can be found in most areas where there is a permanent waterbody; be it stream, lake or swamp, it survives as a climax plant.
- Q: Does Vetiver grass survive drought?
A: The plant is extremely drought tolerant; 'slips' for planting have withstood 60 days without rain. In arid areas it is essential that hedges are formed on the contour to ensure their survival by intercepting all runoff.
- Q: Does Vetiver seed?
A: Vetiveria zizanioides does not produce viable seeds (seeds that germinate); V. nigriflora (the Nigerian species) does seed, but it is reported that the spread of seedlings is easily controlled.
- Q: Do the roots spread into the farmer's field and compete with his crops?
A: Vetiver grass sends its roots straight down. Farmers with over 30 years' experience of the plant in their fields say that they have never had any problems of competition with their field crops.
- Q: Is irrigation (watering) required to establish Vetiver hedges?
A: Irrigation is not required if the slips are planted at the beginning of the normal rainfall. After planting, the slips will withstand two months without further rain if planted in wet soil.
- Q: Is Vetiver an alternate host for crop pests and diseases like 'Striga'? (Striga hermonthica is a plant parasite living on plant roots).
A: Not one instance of Vetiver being an alternate host for any pests or diseases has been revealed. This is supported by farmers with over 30 years' experience of the plant as a soil conservation measure.