

THE VETIVER SYSTEM

INTRODUCING THE VETIVER SYSTEM, VETIVER NETWORKING,
AGRICULTURAL APPLICATIONS, AND FUTURE USES FOR
ENERGY/FUEL AND CARBON SEQUESTRATION



Vetiver Grass - the “Rolls Royce” of Plants

Richard Grimshaw OBE



THE VETIVER SYSTEM

- The Vetiver System (VS) is a collection of applications that have significant economic and environmental benefits that are dependent on the use of vetiver grass, *Chrysopogon zizanioides*.
- VS is generally applied in the form of a linear narrow filtration barrier (hedgerow), occasionally in stand alone form, using sterile cultivars of vetiver of south Indian origin that are not invasive.
- Vetiver System applications developed in India and elsewhere in the tropics and semi-tropics are based on research and experimental data using non invasive cultivars such as “Sunshine”, “Monto”, and “Natal” or cultivars that are closely related with identical DNA.
- Vetiver Systems include applications that cover soil and water conservation, agriculture, slope stabilization, pollution control, disaster mitigation, land reclamation, handicrafts, and other economic uses.



This is the plant that this workshop will focus on.

***Chrysopogon zizanioides*
Vetiver Grass -- Khus Khus**



The Hedge: a barrier above and below ground

The Plant - sturdy and stiff

**The Root - 1 year old
Deep and Strong**



WHY VETIVER?

- We know that there are many plants that bind and protect the soil. We encourage their use where their characteristics meet the need.
- Very few of these plants have been properly studied as to their mechanism of function, alternative applications (if any) and long term reliability. Reliable data under different soils and climate generally do not exist.
- Even fewer plants can create long lasting, non spreading and effective filter hedgerows that do not compete with adjacent plants.
- Fewer still have dense and deep root systems that create subsurface barriers.
- Vetiver is one of the very few plants that can combine these above and below ground functions.
- Even fewer plants have application over wide ranges of climate and soil.
- Although there may be a few plants that may be identified and used (as in the case of Switch Grass in the United States), these plants do not combine the needed barrier function and longevity, with at the same time tolerance to: extreme and adverse condition and toxic pollutants.
- Most, if not all, alternative plants, in one way or other, exhibit some degree of invasive.
- Vetiver grass when used under the Vetiver System combines these positive characteristics, functions and needs, and is not invasive.
- It would seem that at this time that no serious and quantified alternatives to vetiver grass have been demonstrated.



SPECIAL CHARACTERISTICS OF VETIVER GRASS

- Grows under extreme and wide range of conditions
- Long living perennial grass
- Air temperatures: -15°C to $>55^{\circ}\text{C}$
- Soil pH from <3 to >10
- Annual Rainfall <300 mm to $> 5,000$ mm
- Tolerant to all heavy metals
- Saline tolerant (salinity threshold $\text{EC}_{\text{se}} = 8 \text{ dSm}^{-1}$)
- Fire tolerant
- Tolerant to long and total submergence in water
- Resistant to most pests and diseases
- Powerful (75 MPa root strength) and deep root system
- Non competitive and non invasive. According to the PIER level of invasiveness criteria, non fertile vetiver cultivars are rated - 8. An acceptable level for plant importation by the most strict countries is +1



VETIVER GRASS CHARACTERISTICS



Just to underscore the differences between vetiver grass species, this photo from Vietnam compare *Chrysopogon zizanioides* (non fertile, south India cultivar) with *Chrysopogon nemoralis*. You can see why we promote the south Indian cultivars!!



HOW IT STARTED

A picture is worth a 1000 words!!



Vetiver hedgerow planted on a 20% slope had developed a terrace with a 2 meter riser after 30 years



FIFTY YEARS LATER

Vetiver hedgerows near Rakiraki, Fiji



FARMERS KNEW IT FIRST!!

Indian farmers in Mysore have been using the grass for generations for erosion control and farm boundary demarcation. Very few people had realized this. Cut every three weeks for forage



VETIVER SYSTEMS TIMELINE 1986 - 2008

World Bank initiative
1986 - 1994

TVNI initiative
1995 - 2008



POTENTIAL BENEFITS TO GROWER OR OWNER - cost savings or net income gain

APPLICATION TYPES

Agriculture

- Soil and water conservation
- Land Rehabilitation
- Soil Fertility improvement
- Pest Control
- Farm infrastructure Protection
- On Farm pollution control
- Fish pond enhancement

Non agriculture

- Slope protection and stabilization
- Land Rehabilitation
- Water quality improvement
- Pollution control
- River bank, dam, canal, drain, levee protection
- Mine tailing rehabilitation
- Municipal waste stabilization
- Health (drying up wet areas)
- Constructed wetlands
- Coastal protection

Specialized planting

- Plant material production
- Root production (oil)
- Medicinal

Climate change

- Bio-mass for fuel
- Carbon sequestering

	Investment savings	Maintenance reduction	Production increase	Fodrage	Mulch	Paper	Energy Biomass	Handicrafts	Aromatic Oil	Medicinal	Industrial materials	Planting material	Carbon credits	Social Benefits
Soil and water conservation	+	+	+	+	+	+	+	+			+	++	+++	+
Land Rehabilitation			+	+	+	+	+	+			+	++	+++	+
Soil Fertility improvement	+	+	+	+	+	+	+	+			+	++	+++	+
Pest Control	+	+	+	+	+	+	+	+			+	++	+++	+
Farm infrastructure Protection	+	+	+	+	+	+	+	+			+	++	+++	+
On Farm pollution control	+	+		+	+	+	+	+			+	++	+++	+
Fish pond enhancement	+	+	+	+	+	+	+	+			+	++	+++	+
Slope protection and stabilization	+	+		+	+	+	+	+			+	++	+++	+
Land Rehabilitation	+	+		+	+	+	+	+			+	++	+++	+
Water quality improvement	+	+		+	+	+	+	+			+	++	+++	+
Pollution control	+	+		+	+	+	+	+			+	++	+++	+
River bank, dam, canal, drain, levee protection	+	+		+	+	+	+	+			+	++	+++	+
Mine tailing rehabilitation	+	+		+	+	+	+	+			+	++	+++	+
Municipal waste stabilization	+	+		+	+	+	+	+			+	++	+++	+
Health (drying up wet areas)	+	+		+	+	+	+	+			+	++	+++	+
Constructed wetlands	+	+		+	+	+	+	+			+	++	+++	+
Coastal protection	+	+		+	+	+	+	+			+	++	+++	+
Plant material production				+	+	+		+				+	+++	+
Root production (oil)								+				+	+++	+
Medicinal										+			+++	+
Bio-mass for fuel							+						+++	+
Carbon sequestering				+	+	+	+	+		++			+++	+

+ entirely feasible

++ possible but not always recommended

+++ definitely sequesters carbon, carbon credits not yet established

Potential benefits to grower/owner in relationship to type of Vetiver System application



VETIVER SYSTEMS AND AGRICULTURE

On farm environmental and production benefits

- Soil and water conservation
- Soil fertility improvement
- Increased crop and livestock benefits
- Reduced input costs
- Pest management
- Plantation crop management
- On farm pollution control
- On farm infrastructure protection



VETIVER SYSTEMS AND AGRICULTURE

Farm cash benefits

- Thatch, mulch and forage sales
- Vetiver plant propagation for non-agric use
- Handicraft material
- Aromatic oil production`
- Medicinal and other uses



SOIL AND WATER CONSERVATION

The Problem

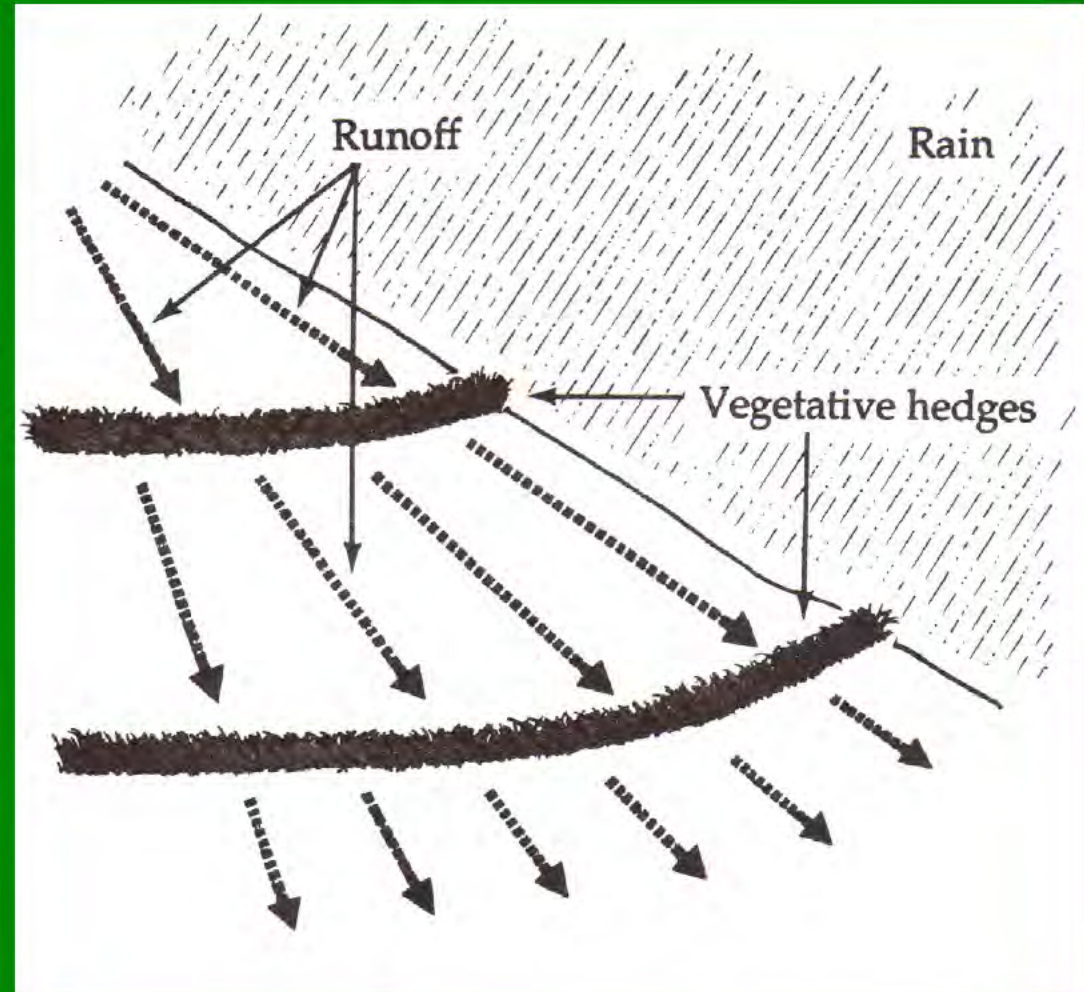
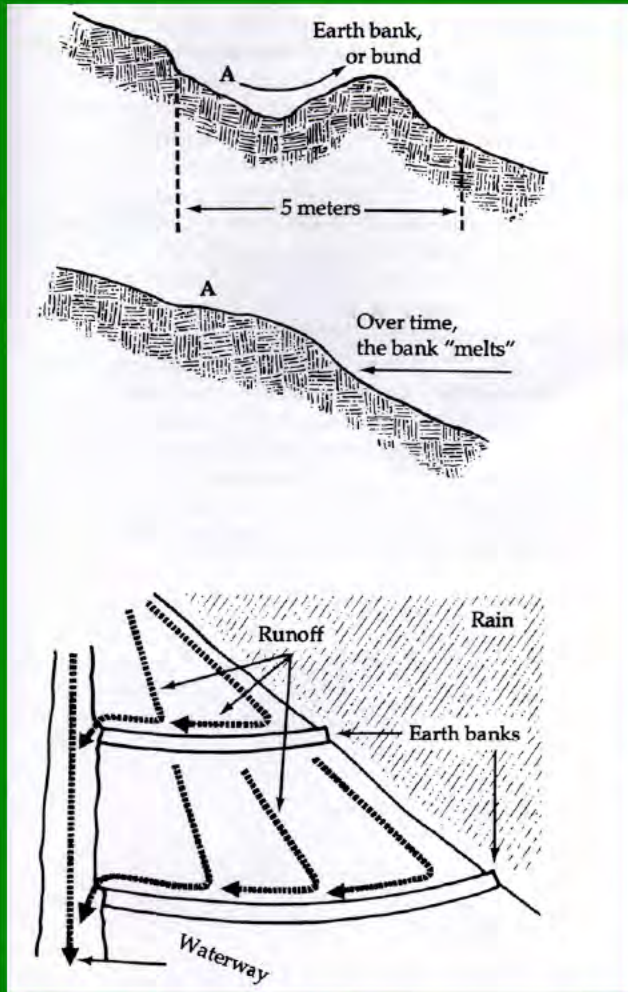


Sabi Valley, Zimbabwe:

- Trees do not prevent erosion - their roots may be massive, but they are not dense enough.
- This land had once been stabilized with engineered earth contour banks. They were not maintained and stopped functioning. The water-way that was supposed to move water from the diversion banks could not take the water velocity and became this huge gully



SCHEMATIC COMPARISON BETWEEN "HARD" AND "SOFT" CONSERVATION METHODS



Source: *Vetiver Grass A Hedge Against Erosion (Greenfield)*



SOIL AND WATER CONSERVATION



Sehore - Madhya Pradesh. India

North-west Ethiopia - 1,500 asl



EROSION CONTROL UNDER FLOOD CONDITIONS



- Darling Downs, Queensland, Australia. Black cracking soils. Max slope 2%. Vetiver hedgerow with adjacent sorghum crop



- Same hedge system after flooding, note silt build up in low spot. Ultimately low spot will fill in. This very stiff hedge withstood flash flood conditions.



EROSION CONTROL

Right: 1.5 meters of sediment was trapped behind this vetiver hedgerow in Malaysia in one year



Introducing Vetiver Grass to Highland



Left: Vegetables grown in the highlands of NE Thailand with vetiver protection



EROSION CONTROL



Vetiver for soil, water conservation and mulching in a intensive highland vegetable growing area of Thailand



Table 3: Effects of VS on soil loss and runoff on agricultural lands

Countries	Soil loss (t/ha)			Runoff (% of rainfall)		
	Control	Conventional	VS	Control	Conventional	VS
Thailand	3.9	7.3	2.5	1.2	1.4	0.8
Venezuela	95.0	88.7	20.2	64.1	50.0	21.9
Venezuela (15% slope)	16.8	12.0	1.1	88	76	72
Venezuela (26% slope)	35.5	16.1	4.9			
Vietnam	27.1	5.7	0.8			
Bangladesh		42	6-11			
India		25	2			
Average		14.4	3.9		23.3	15.5

(Truong and Loch, 2004)



SOIL FERTILITY IMPROVEMENT



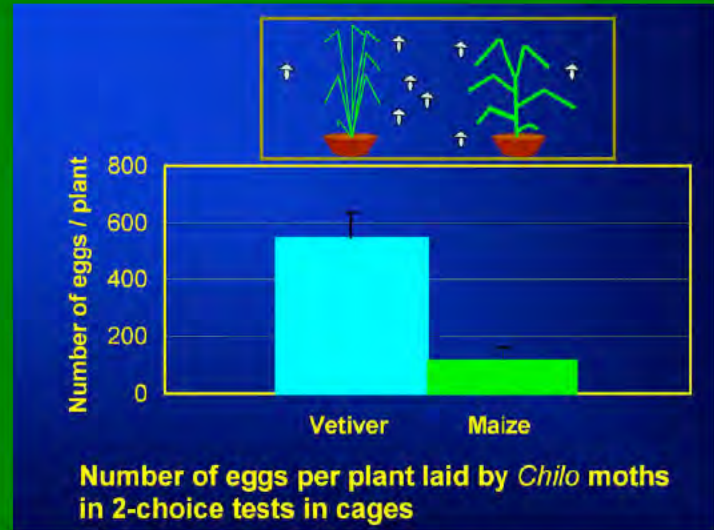
- Left: Citrus tree on the red soils of south China mulched with vetiver
- Center: Vetiver roots penetrating "C" horizon hard pan - improves drainage, organic matter and nutrient recycling
- Right: Vetiver roots can even penetrate this iron oxide weathering "rock" to extract moisture and nutrients



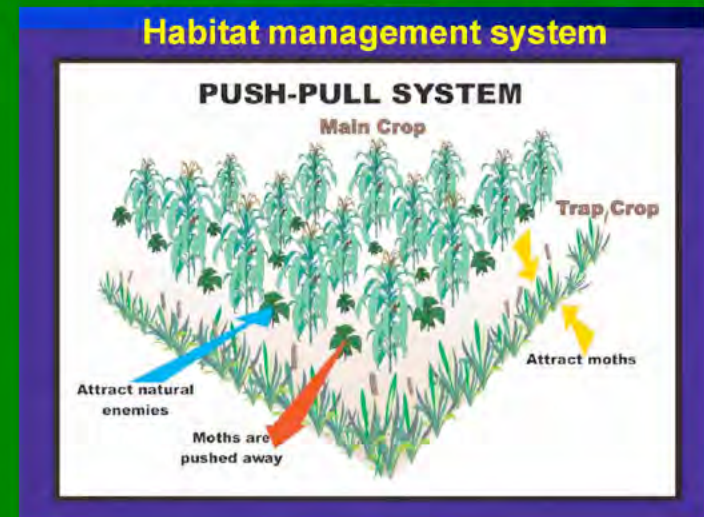
PEST MANAGEMENT



Left: damage to sorghum above and maize below caused by stem borer - *Chilo sp.*



Stem borer moth prefers laying its eggs on vetiver grass. The larvae hatch and fall off the leaves and die. Also vetiver acts as habitat for beneficial wasps and other useful insects.



FARM POLLUTION CONTROL



- Vetiver can be used on farms to clean up liquid waste from animal production units such as pig or dairy cattle enterprises. In this case floating vetiver pontoons remove excess nitrates and phosphates and BODs. The grass has to be cut regularly and the leaves can be fed to cattle. The lower picture shows the roots of floating vetiver - a biotic lung!
- Vetiver can also be used to stabilize and clean up farm rubbish dumps



LAND REHABILITATION



Farm gully stabilized with vetiver hedges - Fiji



FARM INFRASTRUCTURE



Vetiver can be used to protect farm drains (upper left- Zimbabwe), farm irrigation channels (lower left - Madagascar) and farm roads (above - Panama)



LIVESTOCK FORAGE



Vetiver can produce high levels of biomass. As much as 100tons per ha. It grows fast, and if regularly cut and grazed provides good fodder. The right hand lower picture is very fast growing vetiver and could be stripped grazed, or even cut for silage. It is growing on an old land fill. The heavy metals are in the roots and not in the leaves. Safe to graze



NUTRITIONAL VALUES OF VETIVER, RHODES AND KIKUYU GRASS, AUSTRALIA

Analytes	Units	Vetiver grass			Rhodes	Kikuyu
		<i>Young</i>	<i>Mature</i>	<i>Old</i>	<i>Mature</i>	<i>Mature</i>
Energy (ruminant)	kCal/kg	522	706	969	563	391
Digestibility	%	51	50	-	44	47
Protein	%	13.1	7.93	6.66	9.89	17.9
Fat	%	3.05	1.30	1.40	1.11	2.56
Calcium	%	0.33	0.24	0.31	0.35	0.33
Magnesium	%	0.19	0.13	0.16	0.13	0.19
Sodium	%	0.12	0.16	0.14	0.16	0.11
Potassium	%	1.51	1.36	1.48	1.61	2.84
Phosphorus	%	0.12	0.06	0.10	0.11	0.43
Iron	mg/kg	186	99	81.40	110	109
Copper	mg/kg	16.5	4.0	10.90	7.23	4.51
Manganese	mg/kg	637	532	348	326	52.4
Zinc	mg/kg	26.5	17.5	27.80	40.3	34.1



THATCH



Thatching grass is become quite scarce in some parts.
Vetiver makes excellent and long lasting thatch as seen in
this meeting house in Zimbabwe



MULCH



Vetiver used for mulch for tea (India), coffee (Ethiopia) and banana and cocoa (Vietnam). Vetiver makes very good mulch, its seedless, long lasting and quite high in nutrients. There is potential for selling vetiver mulch to urban gardeners.



HANDICRAFTS



Venezuela



Indonesia



China



Thailand



PROPAGATION



With the increasing demand for vetiver planting material for non-agricultural applications there is a good opportunity for both large and small growers to grow nursery vetiver for sale. One needs big nurseries for this!!

The one immediately above is in south China and is 10 ha in area and has the potential for producing 10 - 15 million slips per year. Large nurseries can be machine planted, where labor prices are high.



BIO-FUEL CHARACTERISTICS

Characteristics of an ideal biomass energy crop present (+) in corn, short rotation coppice and *Miscanthus*, developed in part from Long (1994).

Crop characteristic	Corn	Short-rotation coppice	<i>Miscanthus</i>
C ₄ photosynthesis	+		+
Long canopy duration		+	+
Perennial (no need for annual tillage or planting)		+	+
No known pests or diseases			+
Rapid growth in spring to out compete weeds		+	+
Sterile; prevent 'escape'			+
Stores carbon in soil (soil restoration and carbon sequestration tool)		+	+
Partitions nutrients back to roots in fall (low fertilizer requirement).			+
Low nutrient content i.e. < 200 mg MJ ⁻¹ nitrogen and sulphur (clean burning)		+	+
High water use efficiency	+		+
Dry down in field (zero drying costs)			+
Good winter standing (harvest when needed; zero storage costs)		+	+
Utilizes existing farm equipment	+		+
Alternative markets (high quality paper, building materials and fermentation)	+	+	+



BIOMASS FOR ENERGY FEEDSTOCK



Vetiver will produce up to 100 tons of biomass per ha per annum, depending on soil type and water availability. Biomass can be a stand alone enterprise or it can be a bi-product of some other application. In both these images the vetiver is about 1 year old.



On large flat areas it can be machine planted using a modified vegetable planter. See below



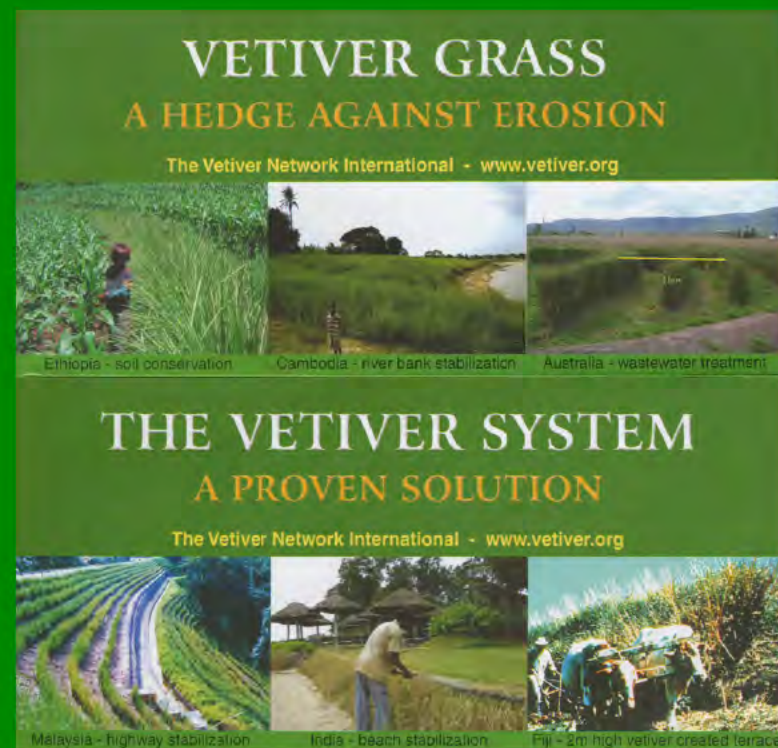
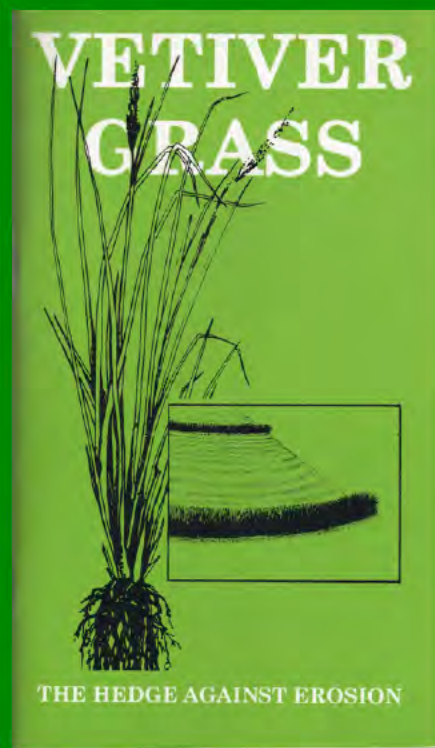
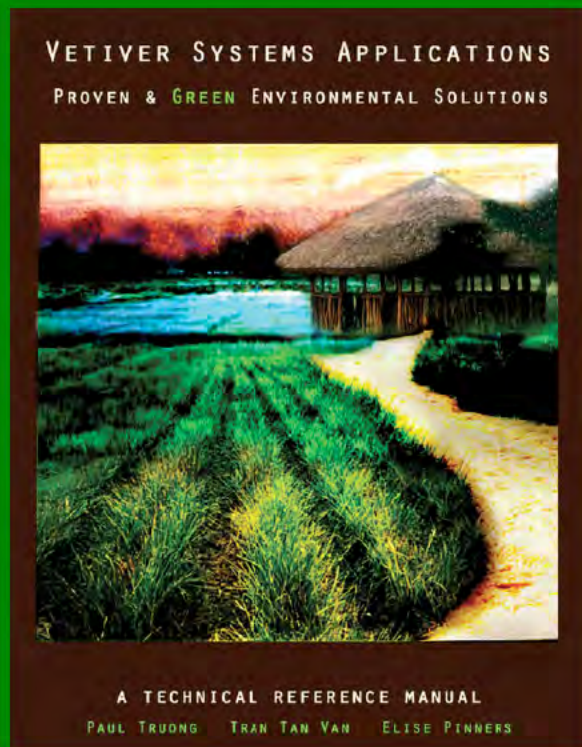
VETIVER FOR CARBON SEQUESTERING



This amount of vetiver grass root (12 plants) will sequester more carbon than 3 fast growing poplar trees. Per unit area of land vetiver will sequester 4.5 times more carbon than poplar.



PUBLICATIONS



Publications are important product of the Network. Left: is the newly published technical manual (the Brown Book). Center: John Greenfield's handbook for farmers and agricultural extension workers (the Green Book). Right: TVNI's double sided brochure/poster (16" x 25"). Users are welcome to reprint, translate, and distribute them.



VETIVER GRASS

THE “ROLLS ROYCE” OF PLANTS



MADE IN INDIA

USE IT !!

