# THE VETIVER SYSTEM

## A PROVEN SOLUTION

**The Vetiver Network International - www.vetiver.org**

Malaysia - highway stabilization

India - beach stabilization

Fiji - 2m high vetiver created terrace

### The problems we face are growing at a pace that challenges our ability to solve them

- Soil loss results in physical, chemical, and biological degradation and loss of ability to produce food.
- Land slides, unstable slopes and flooding destroy agricultural land and valuable infrastructure.
- Siltation of drains, lakes, reservoirs, and rivers reduce storage capacity and can result in flooding.
- Overuse and misuse of large areas of land, and contamination by toxic runoff from mine dumps, landfills, feedlots, salinization, etc.., require extensive reclamation programs.
- Water polluted by mineral or organic sediments as well as the pollutants mentioned above detrimentally affect drinking water supplies, fresh and saltwater fisheries, and coral reefs.
- Decreased groundwater recharge in watersheds results in local water shortages.
- Inattention to site stabilization and maintenance results in infrastructure failure and losses.

### Solutions are often too complex or costly given existing resources and capacity

- The complexity and high cost of engineering and structural designs; ambitious and impracticable environmental protection and remedial practices - often due to over demanding design engineers and supervisors - and unnecessary high-end quality control measures; as well as, amongst others, bureaucratic accounting and bidding procedures.
- Low potential for sustainability due to lack of funds for maintenance, unsuitability to local conditions/ capacity, or need for continuous subsidies to maintain effectiveness.

### Many of these problems share a common solution in THE VETIVER SYSTEM

# VETIVER GRASS

## A HEDGE AGAINST EROSION

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Ethiopia - soil conservation

Cambodia - river bank stabilization

Australia - wastewater treatment

### The Vetiver System (VS)

- Consists of a simple vegetative barrier (a hedge) comprising upright, rigid, dense, and deeply-rooted clump grass, that slows runoff, allowing sediments to stay on site, eventually forming natural terraces.
- Vetiver grass is already found in more than 120 countries throughout the tropics and sub-tropics.
- It has been used for more than a century in many Asian, African, and Caribbean countries as a traditional "soil binding" technology.
- Today, the VS is used for soil and moisture conservation, bioengineering, and for bioremediation.

### It is not weedy or invasive

- Hedges are propagated and established vegetatively. **Analyses show that recommended cultivars of *Chrysopogon zizanioides* (south India type) are sterile and are not invasive.**

### Deep, tough roots

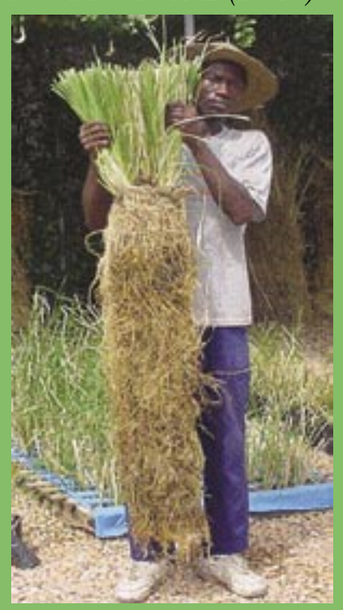
- Vetiver's deep, massive fibrous root system can reach down to two to three meters in the first year.
- This massive root system is likened to "*living nails",* binding the soil together.
- The measured maximum resistance of vetiver roots in soils is equivalent to one-sixth that of mild steel (75 Mpa); stronger than most tree roots; improves soil shear strength by as much as 39%
- The fibrous mat of roots strengthens earthen structures and removes many contaminants from soil and soil water.
- Closely planted slips grow into dense hedgerows with a deep, tough root systems. They can withstand inundation, and effectively reduce flow velocities, forming excellent filters that prevent soil loss.

## THE PLANT -- VETIVER GRASS -- *Vetiveria zizanioides L (Nash) recently reclassified* ***Chrysopogon zizanioides L (Roberty)***

*Chrysopogon zizanioides L (Roberty) previously named Vetiveria zizanioides L (Nash) common name:* ***Vetiver Grass***

Planting slip

*Tissue cultivation of vetiver grass*



6 month vetiver root grown in Senegal

Cross section through a two year old hedgerow. Note sediment build up over original top soil (brown line)

*Longitudinal section through hedgerow*

*Newly planted vetiver hedgerow*

Large differences occur between the roots of vetiver grass species and cultivars. Compare *C. zizanioides* (upper) with *C. nemoralis* (lower)

*Indian vetiver nursery of containerized plants*

*Planting containerized vetiver on steep highway fill slope in Malaysia*

Vetiver inflorescence. In many cases vetiver never flowers, but when it does, it produces rather beautiful non-fertile flowers

## WHY VETIVER GRASS

For a plant to be useful for agriculture and biological engineering, and be accepted as safe, it should have as many as possible of the following characteristics:

- Its seed should be sterile, and the plant should not spread by stolons or rhizomes, and therefore not escape and become a weed.
- Its crown should be below the surface so it can resist fire, over grazing, and trampling by livestock.
- It should be capable of forming a dense, ground level, permanent hedge, as an effective filter, preventing soil loss from runoff. Apparently only clones will grow 'into' each other to form such a hedge.
- It should be perennial and permanent, capable of surviving as a dense hedge for decades, but only growing where we plant it.
- It should have stiff erect stems that can, at minimum, withstand flowing water of 1 foot (30 cm) depth that is moving at 1 foot per second (0.3 meters/second).
- It should exhibit xerophytic and hydrophytic characteristics if it is to survive the extremes of nature. Vetiver grass, once established, is little affected and highly tolerant of droughts or floods.
- It should have a deep penetrating root system, capable of withstanding tunnelling and cracking characteristics of soils, and should the potential to penetrate vertically below the plant to at least three meters.
- It should be capable of growing in extreme soil types, regardless of nutrient status, pH, sodicity, acid sulphate or salinity, and toxic minerals. This includes sands, shales, gravels, mine tailings, and even more toxic soils.
- It should be capable of developing new roots from nodes when buried by trapped sediment, and continue to grow upward with the rising surface level, forming natural terraces.
- It should not compete with the crop plants it is protecting.
- it should not be a host (or intermediate host) for undesirable pests or diseases of any other plants.
- It should be capable of growing in a wide range of climates -- from 300 mm of rainfall to over 6,000 mm -- from air temperatures of -15º C (where the soil does not freeze) to more than 55º C. It should be able to withstand long and sustained droughts (>6 months).
- It should be cheap and easy to establish as a hedge and easily maintained by the user at little cost.
- It should be easily removed when no longer required.

### Vetiver Grass cultivars used around the world for essential oil production, originating from south India, have all these characteristics.

Dense crown of a vetiver grass clump from which roots and shoots emerge

After a fire vetiver hedge remains vertical and quickly recovers with new growth

Erosion sediment trapped by a vetiver hedgerow in Madagascar.


Closely spaced (15 cm between plants at planting) hedgerow at left assures a properly dense hedge


Very dense and very effective vetiver hedgerow

## VS FOR AGRICULTURE

- **On-farm** - in modern and traditional agriculture VS is used to trap sediments, control runoff, increase soil moisture recharge, and stabilize soils during intense rainfall and floods. There is only minimal competition with adjacent perennial and annual crops for moisture or nutrients. VS is used for wind erosion control, forage, and pest control.
- **On-farm** - VS protects rural structures such as roads, ponds, drains, canals and building sites. Also used for land and gully rehabilitation.
- **Off-farm** - VS plays a vital role in watershed protection at large scales - slowing down and spreading rainfall runoff, recharging groundwater reserves, reducing siltation of drainage systems, lakes and ponds, reducing agrochemical loading into groundwater and watercourses, and for rehabilitation of misused land.

Top left: Vetiver hedgerows protecting farm crops on steep slopes in the highlands of N.E. Thailand

Top center: Vetiver hedgerow on Darling Downs, Australia, used to reduce erosive power of flooding on flat land -- as a result more land can be cropped each year

Top right: Farmers from Gundalpet, India, have used vetiver for centuries to reduce soil loss, conserve moisture, provide forage, and increase groundwater recharge

Bottom left: Vetiver hedgerow used to protect crops from high winds in Pintang Island, China

Bottom center: Vetiver used to stabilize a farm road in Malaysia

Bottom right: A irrigation drain/canal stabilized by vetiver hedgerow

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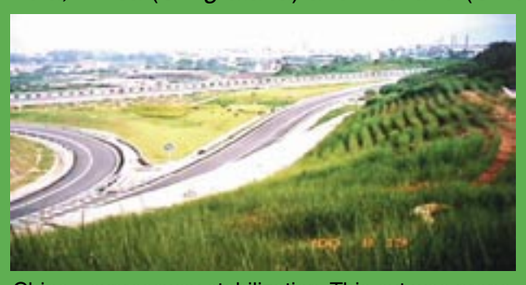
### VS FOR BIO-ENGINEERING

- For the stabilization and protection of infrastructure (roads, railroads, and building sites) VS is proven effective, efficient, and low cost when compared to other 'hard' engineering alternatives using cement, rock, and steel. Vetiver grass roots have an Mpa of 75 (1/6 the strength of mild steel) and will improve soil shear strength at a depth of 0.5 meters by as much as 39%. VS costs from 55% to 85% less than traditional engineering systems. **For successful applications cultivars of *Chrysopogon zizanioides* originally from south India should be used**. These cultivars are of the same genotype as Monto and Sunshine, and are **non-invasive.** They have a more massive root structure than non sterile *C.zizanioides* accessions from north India, Africa (*C.nigratana*) and Thailand (*C.nemoralis*)



The KEY to successful VS applications for infrastructure is the availability of large quantities of good quality vetiver planting material. Above, from left to right, are nurseries from Senegal (containerized), China (bare rooted) and Thailand (from in vitro plantlets)

Venezuela - rehabilitation of bauxite mine tailings. The soils are very acid and prone to slippage. High levels of fertilizer assure good growth

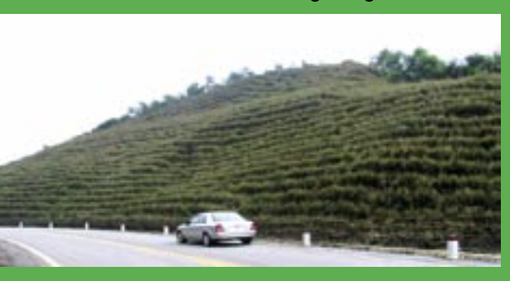


China - expressway stabilization. This cut was prone to massive slip. Stabilization with VS has given complete protection

China - unstable highway fill prior to VS treatment. Road stability was so bad in untreated state that major lateral cracks in the pavement occurred

China - same fill less than a year later. After another two years this fill became fully forested. Untreated cut in background

Spain - unstable and eroding highway fill treated with VS. Untreated eroded fill on right. VS grows well under low rainfall Mediterranean climate



Vietnam: the Ho Chi Minh Highway has been stabilized with vetiver grass. The batters and fills are stable and withstand cyclonic rainfall events


Vietnam - Ho Chi Minh Highway - with and without vetiver stabilization

Thailand - a gas pipeline was laid through tropical forest. On steep slopes the right of way was stabilized with vetiver - native plants regenerated


Disaster mitigation - this railroad in Madagascar was closed down by frequent cyclone damage. Stabilization with vetiver was vital in its rehabilitation

Congo D.R. - huge gullies that destroy urban areas and houses can be rehabilitated and stabilized using the Vetiver System.

### VS FOR WATER RELATED APPLICATIONS

- VS protects ponds, reservoirs, and rivers banks from erosion caused by wave action, it strengthens earthen dams against collapse, and it reduces maintenance costs and ensures the integrity of dam walls, canal and river banks, and drains.
- VS improves groundwater recharge through improved infiltration and reduced rainfall runoff, and the quality of water by removing sediments and chemicals.

Venezuela - Vetiver withstands flooding for long periods. This grass was flooded for 8 months. Vetiver one month after flood receded

China - VS used to stabilize a small river bank located behind hedge allowing the safe production of crops

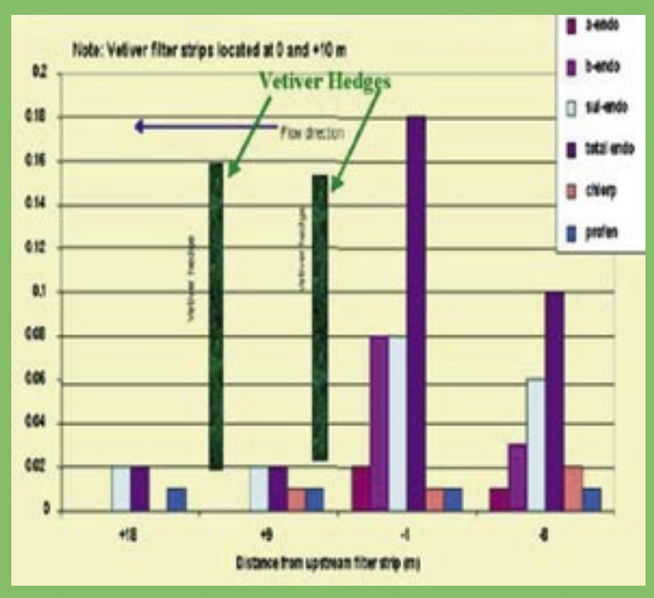
Vietnam - Vetiver is increasingly used to stabilize the banks of fishponds and to purify pond water

Zimbabwe - a fast flowing stream protected from stream bank erosion using VS application

Australia - VS protects the right hand bank of a drain cut through acid sulphate soils of Queensland. Note left hand bank is devoid of any vegetation

China - partially submerged vetiver grass used to stabilize the draw-down slope of a reservoir in Guangdong Province

Australia - this river bank and bridge abutment have been stabilized with vetiver. Vetiver is an excellent interface for concrete and soil




Australia - schematic of research results showing dramatic drop of pesticide levels as pesticide laden water moves through vetiver hedges from right to left. (Green columns = hedges - all other columns pesticide levels)

Cambodia - This very large bank on the Mekong River has been under continuous erosion. The land owner with assistance from TVNI is stabilizing using vetiver hedgerows.

Cambodia - the bank in the previous image has been reshaped and planted with vetiver hedgerows. Very good growth seven months after planting.

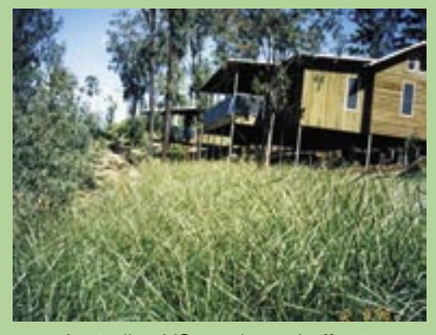
Vietnam - cyclone damage to sea dykes is a major problem. VS has been applied successfully for disaster mitigation

Vietnam - the left hand bank of the canal has been reshaped and stabilized with vetiver, the right bank has yet to be treated.

### VS FOR BIO-REMEDIATION

- Onsite and offsite pollution control from wastes and contaminants is a breakthrough application of VS for environmental protection. Vetiver is being used to rehabilitate a large copper mine in China, coal mines in Indonesia, diamond mine spoils in South Africa, to control erosion and leachate from municipal landfills in China…. and more.
- Research has clearly established vetiver's tolerance to extremely high levels of Al, Mn, As, Cd, Cr, Ni, Cu, Pb, Hg, Se, and Zn.
- Vetiver has been used to reclaim soils and increase site productivity in places that were previously believed to be totally unproductive.

Vetiver grass will remove phosphate and nitrate from polluted water. The beaker on the left is before treatment; on the right 4 days later 90% P and 94% N removed



Australia - VS used as a buffer to absorb seeping sewage from this holiday camp site thus reducing runoff and smells

Australia - VS used to stabilize a gold slimes waste area. The hedges reduce the incidence of wind-blown, cyanide-polluted dust

Australia - VS used hydroponically on a pig effluent pond to reduce high levels of phosphate and nitrate

### VS FOR OTHER USES

- In disaster mitigation and vulnerability reduction, VS has a crucial role to play…. "*The storms were terrible. [Afterward there were] landslides, roads destroyed, agricultural lands washed away; but, where there were vetiver barriers, everything seemed normal". (*pers. comm. Mr. E. Mas, USDA/NRCS after Hurricane George, Puerto Rico)
- For handicrafts, perfumes, and medicinal purposes.
- For paper making, mulch, thatch, reinforcing bricks, biofuel, pest control, carbon sequestering, and many other uses.

Thailand - a selection of handicrafts, including handbags, vases, lamp shades, book covers, hats and other crafts from vetiver grass leaves and stems

Zimbabwe - a nicely thatched meeting house using vetiver grass thatch. The thatch will last three times as many years due to its resistance to insects and fungus attack

## ACT NOW! **Contact TVNI for additional technical information.**

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**Blog:** http://vetivernetinternational.blogspot.com

The Vetiver Network (TVNI) is a nonprofit foundation under United States code 501 (c) (3). It is a volunteer organization that promotes the use of the Vetiver System through dissemination of information and networking worldwide. TVN has helped established over 25 regional and country-based affiliated networks.

**Contact your local vetiver network at:**

**FOR SUCCESSFULL VETIVER SYSTEMS APPLICATION ONLY USE CULTIVARS OF *CHRYSOPOGON ZIZANIOIDES* WITH CHARACTERISTICS OF SOUTH INDIAN GENOTYPES - SUCH AS SUNSHINE, MONTO, KARNATAKA, FIJI, MADUPATTY. THESE NOT ONLY HAVE GOOD ROOT SYSTEMS, BUT ARE KNOWN TO BE NON-INVASIVE AND ARE EXTENSIVELY RESEARCHED**