

Vetiver

A System To Mitigate Storm Damage

Vetiver Grass roots showing the difference between the infertile, non-invasive *Vetiveria zizanioides* (long root system) and a native variety to SE Asia, (short roots), after 12 months of growth.



Potential Role for the Vetiver System in Gulf Coast Infrastructure Protection and Wetland Stabilization

The Vetiver System is an effective, low cost bioengineering technology that strengthens infrastructure protection and marsh replenishment by reliably enhancing control over soil and water management. Vetiver is a uniquely dense, erect, deeply rooted clump grass – long planted around the Gulf Coast -- that is non fertile and non invasive. The concept behind the system is planting vetiver (*Vetiveria zizanioides* = *Chrysopgon zizanioides*) in geometric or natural patterns (such as chevrons or contours) that reinforce the dynamic processes of flow and deposition. Global experience, including Hurricane Mitch in 1998 in Central America, confirms the ability of the Vetiver System to protect vital infrastructure in the face of extreme weather events: http://www.vetiver.org/LAVN_disaster.htm. Several applications of the Vetiver System are relevant for planning recovery from the current hurricane damage in the Gulf of Mexico region, and for preparing mitigation strategies in anticipation of the future. A current summary of the Vetiver System was presented at the International Soil Conservation Conference held in Brisbane, Australia in 2004: http://www.vetiver.com/AUS_Sediment.pdf



Vetiver hedges above mangrove ferns on river dike in Vietnam



The Vetiver Network (TVN) is an international nonprofit 501(c)(3), non-government organization chartered in the state of Virginia, USA. Since 1989, TVN's mission has been to support research on vetiver grass and its many applications, to document vetiver uses, and to disseminate that information widely through its website www.vetiver.org and through more than forty affiliated national level vetiver networks. In recent years, TVN has expanded its scope of activity to include applying the Vetiver System (VS) to specific problem areas. Technical advisors are available from TVN to assist in project design and implementation. Additional information is available by contacting TVN. Contact information for Louisiana and Mississippi scientists familiar with vetiver is also available on request



Vetiver grass has special characteristics that lend themselves to protection of infrastructure and wetlands:

- Stiff, erect stems enable a hedge to stand up to high velocity water flows and prevent scouring of the soil;
- The high density of the leaves and stems forms a porous barrier that traps fine and coarse sediments;
- Fine, dense, penetrating roots anchor the soil profile up to four meters;
- High tolerance to salinity (50% yield reduction at 20 dS/m and maximum of 45 dS/m) facilitates its use to protect coastal sand dunes and beaches and barrier islands against storm surges;
- Perennial hedges have an unlimited lifetime with simple basic maintenance;
- It is a native to wetlands and the hedges can be used to establish vegetative barriers in marshlands capturing sediment to rebuild land; and
- Its non-invasiveness insures that it stays where it is planted and nowhere else.

Recommendation for vetiver hedges on levees is for the waterside levee wall to be planted every 0.5 m. to 1 m. elevation and on the land side from 1-2 m. elevation. Additional cross rows on the waterside wall at about 2-3 m. intervals at right angles to the flow direction. The interval between cross rows varies with expected flow velocity.



Levee protection: Contour hedges of vetiver grass protect levees against soil erosion from wave action and lateral water movement and will protect the land side of the levee from scouring and breaching during an episode of over topping from a storm surge. How does vetiver do all this? By increasing the shear strength of the soil up to 40% with vetiver's massive root system that cannot be dislodged by moving water and by 'nailing' the upper 3 m. of soil in place. The effect is to increase the levee safety factor significantly. Dr. Paul Truong's report documents the use of the vetiver system for dike stabilization on the Mekong river.

Refer to: http://www.vetiver.com/VNN_truong_jan2005.pdf

Louisiana "vetivert" (Khus Khus, the "original scent of New Orleans") is a well-known, domesticated pan-tropical grass that has been a heritage plant of Louisiana culture for 200 years. Vetiver roots have an average tensile strength of 75 Mpa, which increases the shear strength of soil between 30 and 40%. Vetiver grass, a hydrophyte with deep roots that do not tiller to the side, is drought and salt-tolerant.

Protection of civil works: Vetiver grass planted at the interface between soil, concrete such as culverts, bridge structures and moving water, supports and drains, will prevent undermining and loss of structural integrity. After years of testing the ministries of transportation of five southern Chinese provinces have standardized on the Vetiver System to substitute for more expensive conventional civil works, such as bench terracing, gabions, and rip rap for road infrastructure. In Madagascar the vetiver system made it possible for the third steepest railroad in the world to survive regular cyclones without significant interruption and to operate year round. See http://www.vetiver.com/ICV3-Proceedings/MAD_rail_stab.pdf2.pdf

Wetland stabilization, and beach and dune stabilization: Vetiver grass is at home in a marsh environment and grows in littoral areas, including either dry or saturated soils, surviving months of inundation in fresh or brackish waters. Eroding barrier islands and brackish marshes can be protected by systematic vetiver hedge plantings. Vetiver hedges can stabilize earthen structures designed to intercept and precipitate sediment, acting as a pioneer plant that helps native marsh plants become established and giving way to those plants over time. The documentation concerning stabilizing dunes in Vietnam is provided at:

http://www.vetiver.com/ICV3-Proceedings/VNN_sanddune.pdf



A vetiver hedge profile after 30 months. Look to the left of the hedge and one can see more than 40 cm. of soil trapped behind the hedge. The original soil level is indicated by the black subsoil band and the original plant was planted where the white marker is. The hedge width is about 60 cm.



Slope embankment protection



Four meter roots keep soil wall in place



Permanent waterway embankment with vetiver

Special characteristics of Vetiver Grass

What makes vetiver grass special? The answer is found in the roots, in the plant's physiological and ecological characteristics, and in its inherent ability to grow without becoming a weed and without attracting pests.

Vetiver grass has a massive, finely structured root system that is unique among grasses. With no rhizomes or stolons that spread to the sides, the plant's roots grow straight down as a mass as dense as the amount of leaves it produces above the ground. These roots penetrate 3 to 4 meters into the soil before slowly thinning out; but in one case in Thailand, they were found to reach a depth of 6 meters. New roots and shoots develop from the root crown and nodes when the plant is buried by trapped sediment at the face of a contour hedge. The plant will continue to grow and fill in at the surface level, with the new ground level eventually forming a terrace behind the hedge.

It has special characteristics with respect to waste and wastewater management as well. It has a very high tolerance to anoxic environments and high concentration of toxic substances such as heavy metals and ammonia that kill most all other plants. Vetiver grass may be used in constructed wetlands to "polish" pre-treated wastewater effluents or as hedges to intercept and treat highly toxic leachates from landfills or "brownfields" sites.

Physiological characteristics

Vetiver grass is a "climax plant," which survives conditions under which other plants cannot live. It will tolerate prolonged drought, fire, flood, submergence, and extreme temperatures from -15°C to 55°C (in Australia) and higher (in India and Africa). In some cases it may be the only plant to survive. Its ability to regrow quickly after being affected by drought and especially by fire, as well as by frost, salt, and other adverse soil conditions, and is unequalled by other plants.

It can withstand a wide range of pH growing in soils with an acidity of 3.0 and can survive in alkalinities with a pH as high as 10.5 to 11. Vetiver can tolerate a high level of soil salinity, soil sodicity, and acid sulfate, making it a unique plant under these conditions.

'Sunshine' vetiver is a traditional, non-fertile variety with a 200 year history in Louisiana that is propagated vegetatively because it does not produce viable seeds. It was officially released from observation by the Plant Material Center in Golden Meadow, Louisiana in 1995. Refer to <http://plant-materials.nrcs.usda.gov/lapmc/releases.html> The South Eastern Exotic Pest Plant Council, declared in May 2001 that 'Sunshine' vetiver is acceptable, i.e., non-invasive, for use in the southeastern region of the US. Refer to: www.se-eppc.org/fslist.cfm. See also <http://user.aol.com/vetivernet/vip/dnadiv.htm> or contact Mark Dafforn at mdafforn@nas.edu for further information.

Ecological characteristics

Because of its previously stated qualities, vetiver grass can be considered as a nurse plant on wastelands or disturbed lands. Planted as a hedge, or as a series of hedges, vetiver stabilizes the erodible ground (particularly steep slopes) as it creates a micro-climate so other plants have a chance to establish themselves. The Vetiver System is used successfully to rehabilitate mine sites and stabilize highway and railway embankments, bridges, and even in rock quarries.

After the trees and shrubs have established on these sites, they begin to shade the vetiver hedge out, replacing it as the stabilizing agent. Therefore, vetiver is highly regarded as a non-intrusive land rehabilitation pioneer, though 'crowded out' it remains intact. It is a general principle that plants intended for use in environmental protection or agriculture be investigated for their potential to become weeds or intermediate hosts for pests that affect economically important crops. Because the few seeds that vetiver grass produces are not viable and the absence of pests that affect it, the plant has been approved for use in the southeastern US as previously cited.

Potential Role for the Vetiver System in Gulf Coast Infrastructure Protection and Wetland Stabilization

This image shows the massive root zone of an 18 month old clump of Vetiver grass from Southern China. Notice that the roots are fibrous, vertical in nature, and without the presence of lateral roots.

The leaves and stems have been cut off the top. The clump itself is composed of several hundred individual slips or sprigs that grow together to make up the clump.



When planted in hedges along the contour of slopes, this massive underground root zone creates vertical walls as deep as four meters.

Vetiver is not invasive, has non-fertile seeds, and does not have lateral roots. This means that vetiver hedges remain in the same place and do not move. With minimal maintenance, they last for generations

vetiver contacts

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*Flume trial by USDA-ARS
in 1991 showing water
backed up behind hedge
demonstrating the effect of
stiff stems on water flow*



Before hedges



*Drainage canals
before and after in
Quang Ngai, Vietnam
using vetiver hedge
protection*

After hedges

