Impact of Vetiver System Applications in Land Use and Agriculture

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Outline

1. Introduction.
2. Characteristics of vetiver.
3. Applications of the VS in land use.
4. Applications of the VS in agriculture.
5. Discussion.

1. Introduction

1.1 The need for more land

1.1.1 For land use

1.1.2 For agriculture

1.2 The problem of land deterioration

1.2.1 Soil erosion

1.2.2 Exploitation of cultivated land

1.2.3 Mine tailing

2. Characteristics of Vetiver

2.1 High Biomass Production.

2.2 Minimal Competition for Nutrient and Moisture.

2.3 Strong Symbiotic Association with Microorganisms in the Rhizosphere.

2.4 Highly Resistant to Diseases and Pests.

2.5 Highly Resistant to Agrochemicals.

2.6 Living Nail.

2.7 Living Wall.

2.8 Living Dam.

2.1 High Biomass Production

- Vetiver is a C_4 plant with high rate of photosynthesis at high light intensities and high temperatures due to the increased efficiency of photosynthetic carbon reduction cycle.
- It has a fast growing rate and high biomass production, which is higher than that of tropical and subtropical pasture crop.

2.2 Minimal Competition for Nutrient and Moisture

- Vetiver roots grow vertically, providing minimal competition for nutrient and soil moisture to accompanying crops.
- Even at greater depth, the horizontal spreading of lateral roots was in the range of 0.15-0.29m with an average of 0.23m (Mickovski et al., 2005).
- Its roots spread about 0.25m wide.
- Widely used for windbreak to vegetable plots in China, orchard trees in Australia, companion crop of mungbean in India.

2.3 Strong Symbiotic Association with Microorganisms in the Rhizosphere

- **Vetiver can establish a strong symbiotic association with a wide range of soil microorganisms in the rhizosphere**
- **These microbes provide N, P and plant growth hormones for vetiver development**
- **Up to 40% of nitrogen content in vetiver was obtained from the symbiotic N fixing bacteria**
- **Vetiver improves the soil quality, in term of nutritional, physical and biological properties, through its symbiotic association with soil microorganisms**
- **Under the pressure of hostile condition of heavy metal contaminated soils, the cultivation of vetiver can increase the microbial populations in such soils**

2.4 Highly Resistant to Diseases and Pests

- No major reports related to the diseases and pests of vetiver
- There are occasional reports on infestation by *Fusarium* fungus in Colombia and West Papua (Indonesia)
- Few potential pests of vetiver were recorded in South Africa
- Several pests have been recorded elsewhere in the world
- The most notable of these were stem borers, white grubs, termites and cicadas
- In South Vietnam, patches of dead vetiver on a canal bank adjacent to rice fields were ascribed to stem borers, possibly a *Chilo* sp., cicadas in New Zealand, stem borer (*Chilo* spp.) on planting near rice field in Vietnam, army worms on planting near sugarcane field in Australia and a hemiptera sucking bug in Venezuela

2.5 Highly Resistant to Agrochemicals

❖ **The growth of vetiver was not adversely affected by herbicides such as atrazine or diuron, at rates up to 2000 μgL^{-1}**

❖ **Both herbicides can persist in environments for several months and have adverse effects on aquatic ecosystems at very low concentrations:**

- **atrazine > 0.5 μgL^{-1}**
- **diuron > 0.03 μgL^{-1}**

2.6 Living Nail

- Vetiver roots are able to penetrate deep layer of soil whose texture may be quite hard and impervious to water, thus making water to pass through such layer
- Lime cultivation in hardpan soil in Ratchaburi, Thailand produced no yield
- But a good yield after interplanting with vetiver
- Vetiver's strong root system is able to penetrate hardpan soil like living nail

2.7 Living Wall

❖ The vetiver clumps are able to slow down the rapid movement of water and wind

❖ The direct benefits of this living wall are:

- increasing organic matter and moisture in front of the hedgerows

- acting as a sieve in not allowing any debris to pass through but to accumulate in front of the vetiver hedgerows

2.8 Living Dam

❖ **Both the roots and the clumps act as living dam, whose benefits are:**

- **adhering soil particles, thus reducing soil erosion**
- **increasing the amount of organic matter collected in front of the hedgerows**
- **increasing moisture content in front of the hedgerows as the result of the accumulation of organic matter and water**
- **filtering out toxic substances brought by the wind and, after being absorbed in the plant tissues will slowly disintegrate, while clear and clean water is able to pass through**

3. Applications of the VS in Land Use

3.1 Soil and Water Conservation.

3.2 Reclamation.

3.3 Rehabilitation.

3.4 Soil Stabilization.

3.1 Soil and Water Conservation

- Vetiver hedges are one of the most effective measures for reducing sediment flows from leaving farm land and other areas

- These same hedgerows also effectively act as rainfall runoff “spreaders”, spreading out concentrated water flows, thus acting as a form of “irrigation” to plants that otherwise might not get their fair share of water.

3.1 Soil and Water Conservation (Con't.)

On sloping areas, it has become a popular practice to grow rows of vetiver along edges of steep terrace or along hillside ditches and buns to prevent damage to these costly structures.

Several approaches have been attempted, namely:

3.1.1 Contour planting across the slope.

3.1.2 Controlling gully erosion.

3.1.3 Preventing damage to step terraces and hillside ditches and buns.

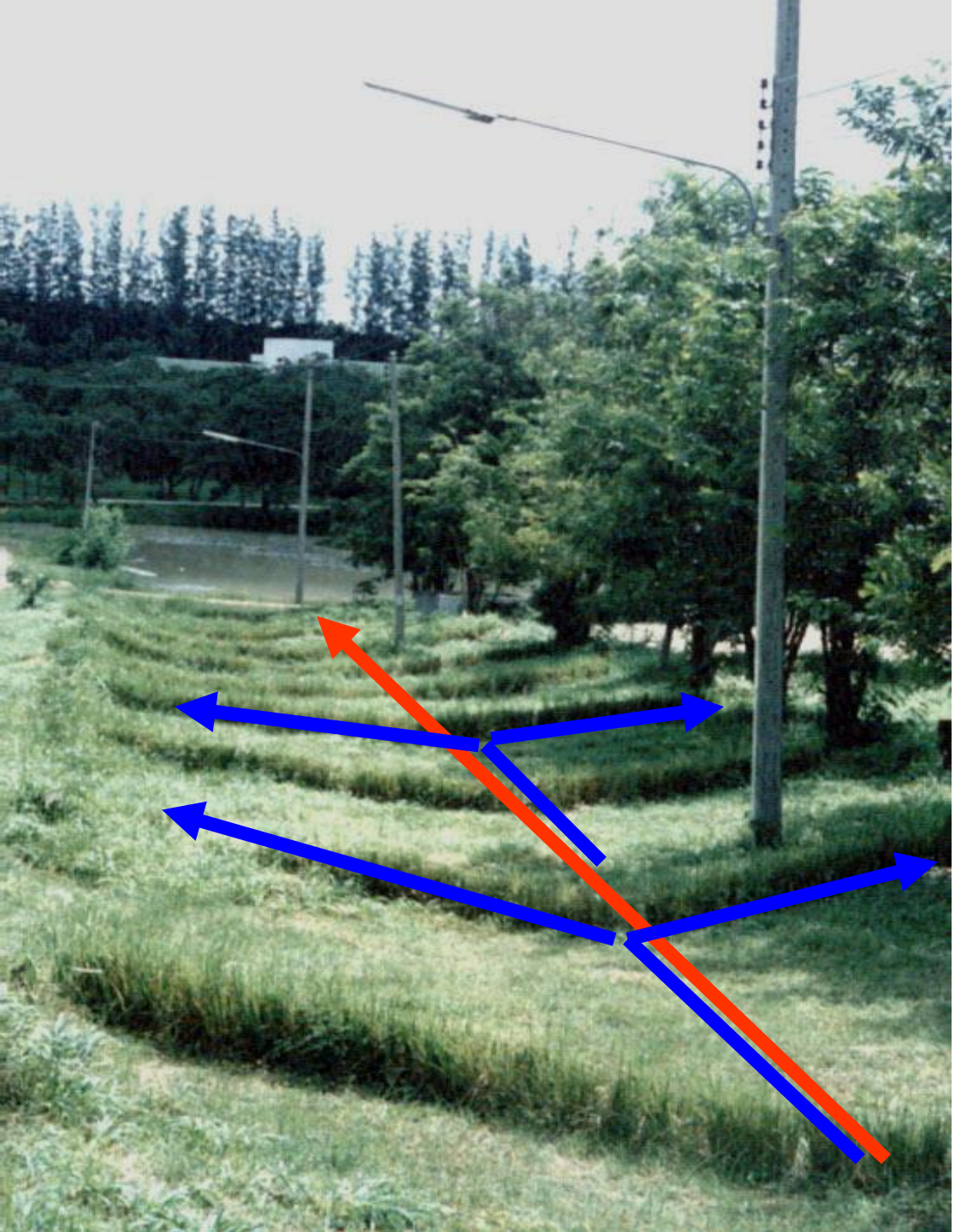
3.1.1 Contour planting of vetiver across the slope

- Vetiver traps the silt and reduces the speed of the runoff
- Thus more water has time to seep down to lower layers of the soil, while the rest flows through
- Over time sediment accumulates at the front of the hedgerow increases and eventually forms a natural terrace
- In NE Thailand, corn plantation along and across slope has different amount of soil loss ranging from 7.81 to 5.91 tons/ha, and plowing and planting corn across slope could decrease soil loss around 33.6%
- Vetiver strip across could decrease soil loss in average to 4.81 tons/ha
- In the 2nd year, vetiver planted in double row and developed into dense strip could reduce soil loss by 50-90%

3.1.2 Controlling gully erosion

- By planting vetiver on contour line above the gully and lining up bags of sand or earth to serve as breakers to reduce runoff velocity while vetiver is taking firm root

- Vetiver can also be planted in overflow ditches along the contour lines to retain water and help spread it to crop cultivation area



Vetiver planted in V-shaped form across the gully line to serve as:

- **Water distribution**
- **Water conservation**
- **Soil sedimentation**

3.1.3 Preventing damage to step terraces and hillside ditches and buns

- On sloping areas, it has become a popular practice to grow rows of vetiver along edges of steep terrace or along hillside ditches and buns to prevent damage to these costly structures

3.2 Reclamation

- **Reclamation is the process of using VS to reclaim deteriorated land originated as the result of natural process or obtain useful materials such as heavy metals, chemicals, etc. from wasteland areas**
- **With its unique quality of possessing deep-root system and tolerating drought, vetiver is an ideal plant to stabilize slope and build up soil through the accumulation of debris carried down from higher areas and deposited at the front of vetiver hedgerow**

3.3 Reclamation (Con't.)

3.3.1 Reclamation of deteriorated land.

3.3.2 Reclamation of hardpan soil.

3.3.1 Reclamation of Deteriorated Land

❖ Vetiver can be used to reclaim deteriorated land, including wasteland, desert, degraded soil, etc.

❖The reclaimable areas through the use of vetiver include steep-slope lands, sandy soil, skeleton soil, acid sulphate soil, saline soil, shallow soil, etc.

3.3.2 Reclamation of Hardpan Soil

❖Vetiver root system is very strong and can penetrate hardpan soil, thus making the water able to pass through in both up and down directions

❖ “Breakthrough through breaking through”

3.3 Rehabilitation

3.3.1 Rehabilitation of polluted soils with heavy metals from mine tailings.

3.3.2 Rehabilitation of deteriorated soils.

3.3.3 Rehabilitation of contaminated soils.

3.3.1 Rehabilitation of Polluted Soils with Heavy Metals from Mine Tailings

- Vetiver is highly tolerant to heavy metals such as Al, Mn, As, Cd, Cr, Ni, Pb, Hg, Se, and Zn

3.3.2 Rehabilitation of Deteriorated Soils

- Vetiver can be used to rehabilitate deteriorated soils where erosion had stripped off the topsoil and made the soil dry, hard and devoid of natural cover
- Growing vetiver can help reduce runoff velocity, allows water to permeate deep into the soil and provides sufficient moisture for plants to grow

3.3.3 Rehabilitation of Contaminated Soils

- Areas contaminated with agrochemicals such as pesticides, fertilizer residues can be rehabilitated through the use of vetiver
- Vetiver is more efficient in absorbing certain heavy metals and agrochemicals in view of the capacity of its root system to reach greater depth as well as tolerance to those substances better than most other plants' roots

3.4 Soil Stabilization

Due to its unique root system, vetiver can stabilize loose soil in various situations:

- **steep slope**
- **coastal dune**
- **beach dune**
- **river bank**
- **reservoir bank**
- **road batter**
- **shoreline**

Shoreline Stabilization

❖ In Brazil, vetiver is grown on almost pure beach sand to stabilize the beach front.

❖It will stop a lot of rubbish, effluent and runoff entering the beach and the sea.


in South Africa





Land stabilization and landscaping on an industrial estate in South Africa

Vetiver planted on lake and pond edges for erosion control and bio-filter in Thailand

4. Applications of the Vetiver System in Agriculture

4.1 Soil erosion prevention.

4.2 Soil fertility improvement.

4.3 Soil moisture conservation.

4.4 Soil organic matter improvement.

4.5 Pest control.

4.6 As ornamental plants.

4.7 As field boundaries, etc.

4.8 As agricultural by-products.

4.1 Soil Erosion Prevention

- **Vetiver is very well known for its soil erosion prevention in the sloping land**
- **Contour strip planting on cassava in 18 villages located in 8 provinces in Thailand was found to prevent soil erosion, and provided better yield of cassava after 7 years of investigation through a farmer participatory approach (Suriyo and Vongkasem, 2002)**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4.2 Soil Fertility Improvement

❖ **Land under continuous cultivation tends to lose its fertility, especially with no application for fertilizer**

❖ **Improper cultivation may also result in soil structure deterioration, thus reducing yielding capacity when used for crop production.**

❖ **Improvement of soil fertility can be done through the use of vetiver in:**

❖ **Symbiotic association with soil microorganisms**

❖ **Recycling nutrients from deep soil profiles**

❖ **Reducing the loss of nutrients**

4.3 Moisture Conservation

- Vetiver hedges spread out concentrated water flows, thus acting as a form of “irrigation” to plants that otherwise might not get their fair share of water
- Vetiver hedgerows significantly reduce rainfall runoff and therefore enhances groundwater that can be used for domestic water and irrigation purposes
- When grown in fruit-tree orchards in their initial stage of development, or in alternate rows with other trees, vetiver can conserve moisture for the area

4.3 Moisture Conservation (Con't.)

For moisture conservation purpose, vetiver can be planted:

- **In rows in parallel with fruit trees or rubber plants at an interval of 1 m., and use vetiver cut leaves to cover the tree base to conserve soil moisture and to increase soil fertility, and**
- **In a half circle facing upward along the slope around each tree at the radius of 1.5-2.0 m from the base of the tree**

Effect of Vetiver Planting on Soil Moisture Content

- **Na Nagara (1966) reported that on steep slope land, there was an increase of 35% of moisture in the soil underneath the trees with vetiver**
- **Comparing the soils where vetiver was cut and leave as mulch, and the area 1 m away have higher moisture that the one without vetiver leaves**


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4.4 Soil Organic Matter Improvement

4.4.1 Mulch

4.4.2 Compost

4.4.1 Mulch

- Vetiver mulch is durable and long lasting
- It provides shade to plot, and keeps weed under control
- It is applied to vegetable and field crop plots, at base of fruit tree, etc.

4.4.2 Compost

- **Vetiver leaves and culms decompose completely to become soft, disintegrated**
- **Vetiver compost contains major elements such as N, P, K, Ca, Mg, etc. with a pH of 7.0**
- **Vetiver compost provides humic acid that enhances soil fertility**

4.5 Pest Control

4.5.1 As a repeller.

4.5.2 As a trap crop.

4.5.3 As an insecticide.

4.5.4 As a nematicide.

4.5.5 Integrated Pest Management

4.5.1 As a Repeller

- Karen hill-tribers in northern Thailand place bundles of vetiver roots at the bottom of the clothe basket or in the closet to repel insect
- Some other who grow vetiver for multiplication observed the land used to grow vetiver earlier infested with termites had practically no more infestation
- Applying vegetable plots with vetiver compost and a medicinal plant results in reduction of flea beetle
- This may be because vetiver has a compound that can repel insect

4.5.2 As a Trap Crop

4.5.2.1 Insect Trap.

4.5.2.2 Weed-seed trap.

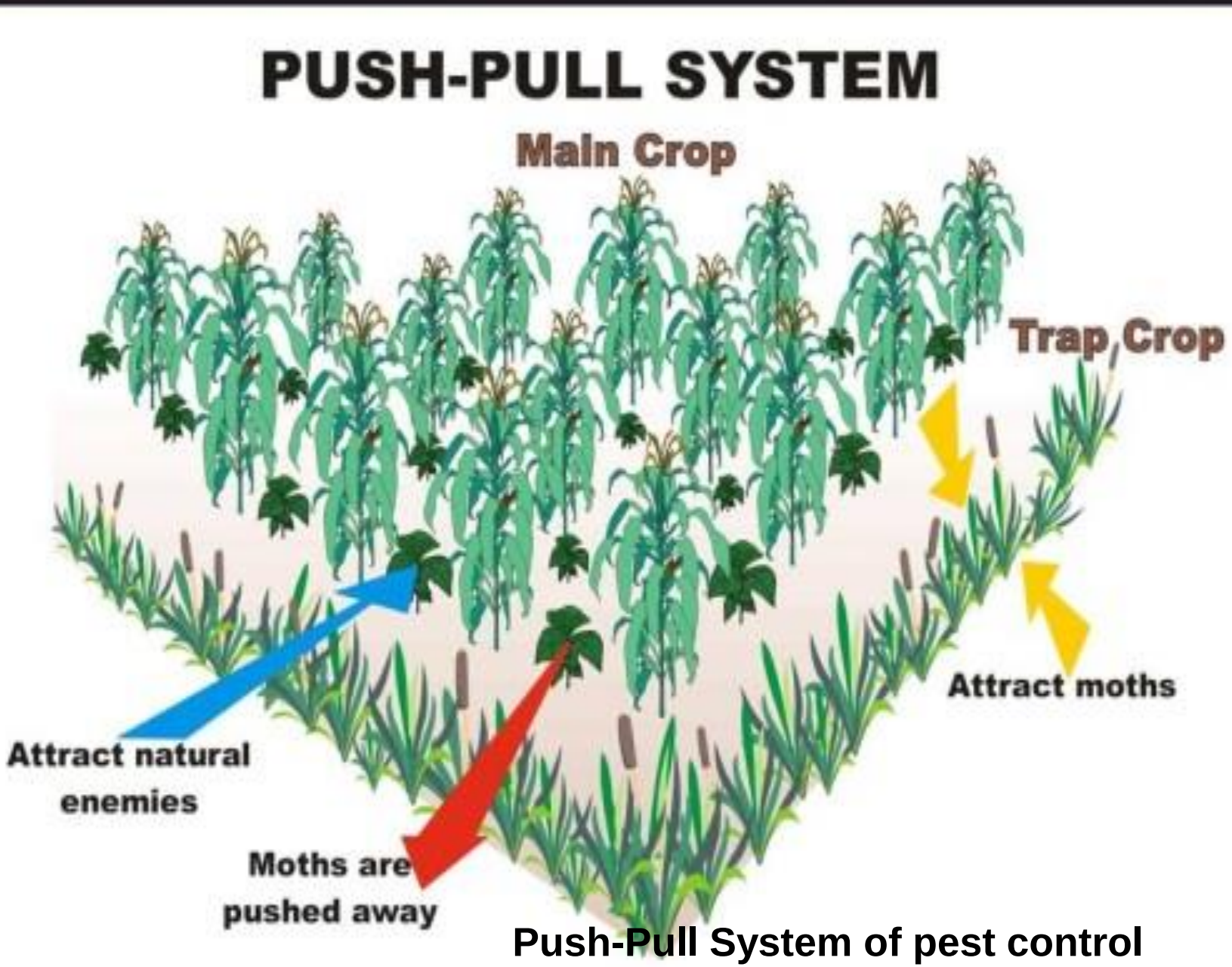
4.5.2.3 Pesticide trap.

4.5.2.1 Insect Trap

- **Levy (1994) observed that the vetiver plant grown in close proximity to the sugarcane could inhibit the attack upon the sugarcane of certain insects such as the cane borer. He proposed that it may be due to the effect of insect trapping.**
- **Javier Frances in San Salvador observed that the stem borers rather lay their eggs on the vetiver than on the sugarcane plant. The sugarcane plant seems to be healthy with very little attack of the stem borers compared with sugarcane plants in other fields that do not have vetiver along the side.**

4.5.2.1 Insect Trap (Con't.)

- **Work by Van den Berg et al. of South Africa showed that vetiver acts as a trap crop for stem borer.**
- **Vetiver hedgerows reduce the amount of stem borer damage to maize and other cereal crops as stem borers lay their eggs preferably on vetiver leaves.**
- **Due to the hairs on the underside of vetiver leaves the larvae cannot burrow into the vetiver stem and fall off and die.**
- **Vetiver leaves are also accommodate insect predators that over winter on the plant, that then attack other insects on the maize plants in the spring.**



Push-Pull System of pest control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4.5.2.2 Weed-seed Trap

- Vetiver hedges have proven to be very effective to filter, slow and spread fast incoming overland flow
- An added bonus is that incoming weed seed is trapped behind the vetiver hedge, enabling farmers to eradicate it by non-chemical means

4.5.2.3 Pesticide Trap

- Vetiver can be used to trap runoff following pesticide and fertilizer applications
- Elevated concentrations of pesticides, herbicides and nutrients in runoff were reduced after the runoff had filtered through the vetiver strip

4.5.3 As an Insecticide

- A farmer in Fang District, Chiang Mai, Thailand noted that vegetable flea beetle was reduced in number when applied with vetiver compost added with medicinal plants
- Vetiver has now been used to protect crop and orchard plant against insect infestation in many countries

4.5.4 As a nematicide

- Vetiver has been used to protect crop and orchard plant against nematode infestation in Australia, Senegal and Thailand
- In Ethiopia one farmer reported that when growing chilies between vetiver hedgerows he had an excellent crop, whereas adjacent farmer chili crops were badly damaged by nematode

4.5.5 Integrated Pest Management

- **Of the 79 species of insect found on the vetiver rows, only four attacked young vetiver leaves (Chen 1999)**
- **30 other species found in the vetiver rows are considered beneficial insects, as they are the all-important prey enemy of garden, field-crop and forest pests**
- **This indicates that an Integrated Pest Management scheme is put into operation when vetiver is introduced to a new environment**
- **In Thailand, methanol extracts of ground stem and root were found to be very effective in preventing the germination of a number of both monocot- and dicot-weed species. These results indicate the potential of vetiver extract as a natural pre-emergent herbicide**

4.6 As Ornamental Plants

4.6.1 Landscaping.

4.6.2 Decorative hedge.

4.6.3 Decorative potted plants.

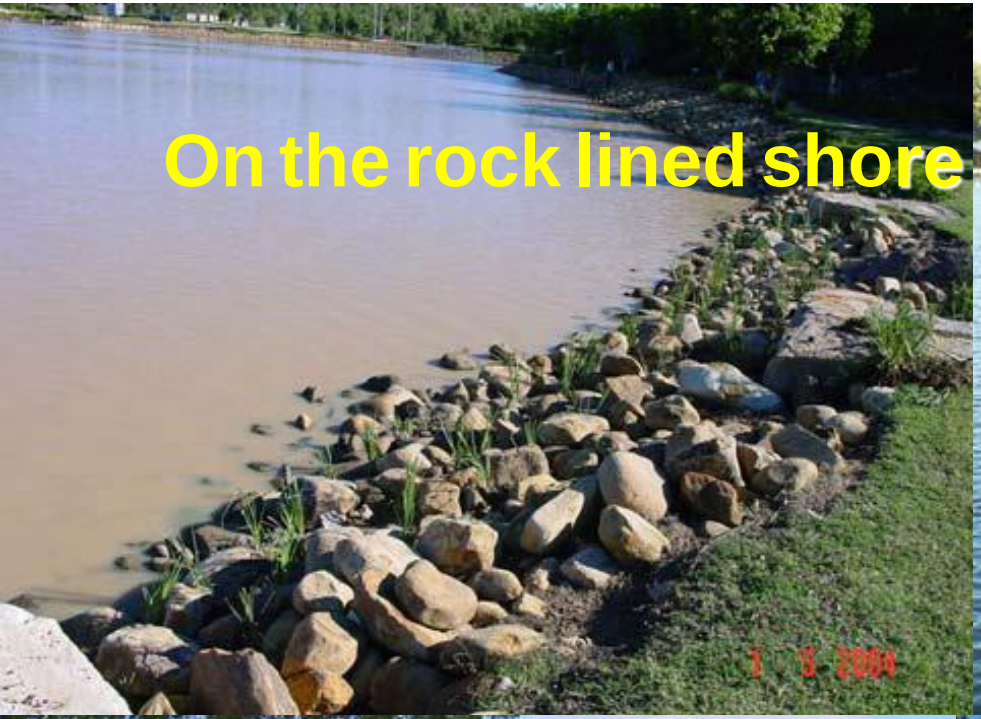
4.6.4 Vetiver bouquet.

4.6.1 Landscaping

- Vetiver is a beautiful plant for gardens, patios, decks, etc.

Planting close together in line, vetiver forms a dense, uniform, and attractive hedge

Forms beautiful barrier to unsightly view


On the rock lined shore line in Australia


Planting along the lake shore purely
for ornamental purpose

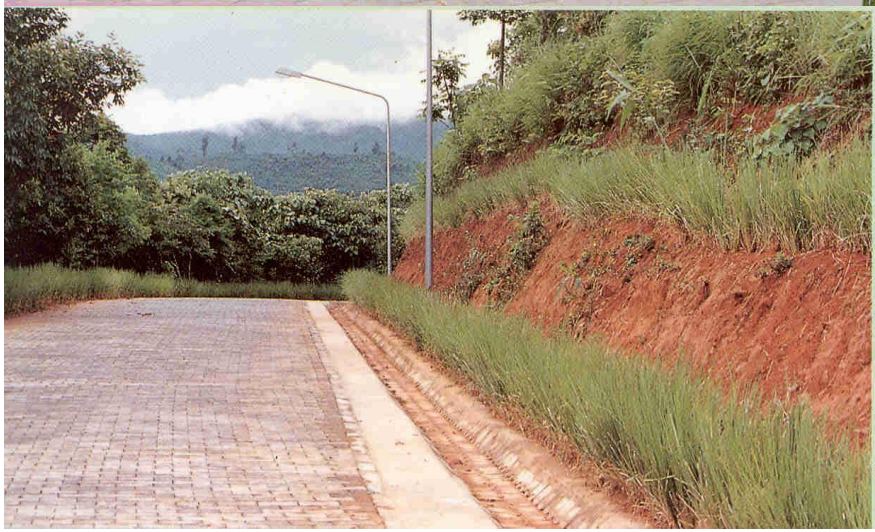
4.6.1 Landscaping (Con't.)

- In gardens, patios, decks, etc.
- As a decorative hedge
- Beautify landscape and protect the environment
- Pond and reservoir landscaping

4.6.1 Landscaping (Con't.)

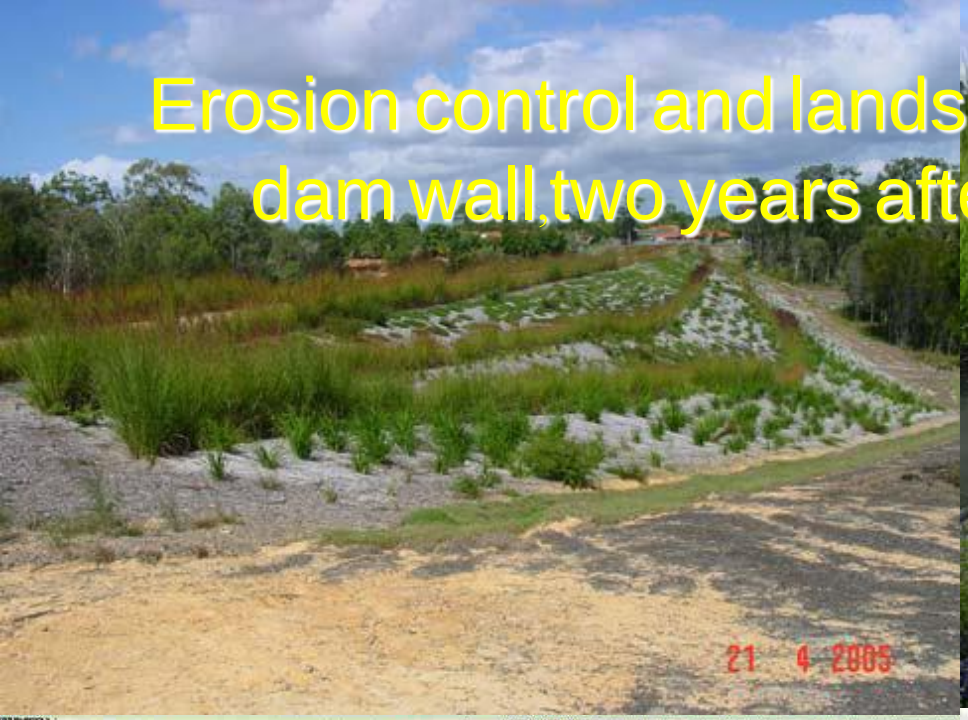
Beautify landscape and protect the environment

- **Vetiver hedges stabilize soil and beautify landscape in many countries, e.g. Australia, China, South Africa**
- **Also at the Doi Tung Development Project, Chiang Rai**

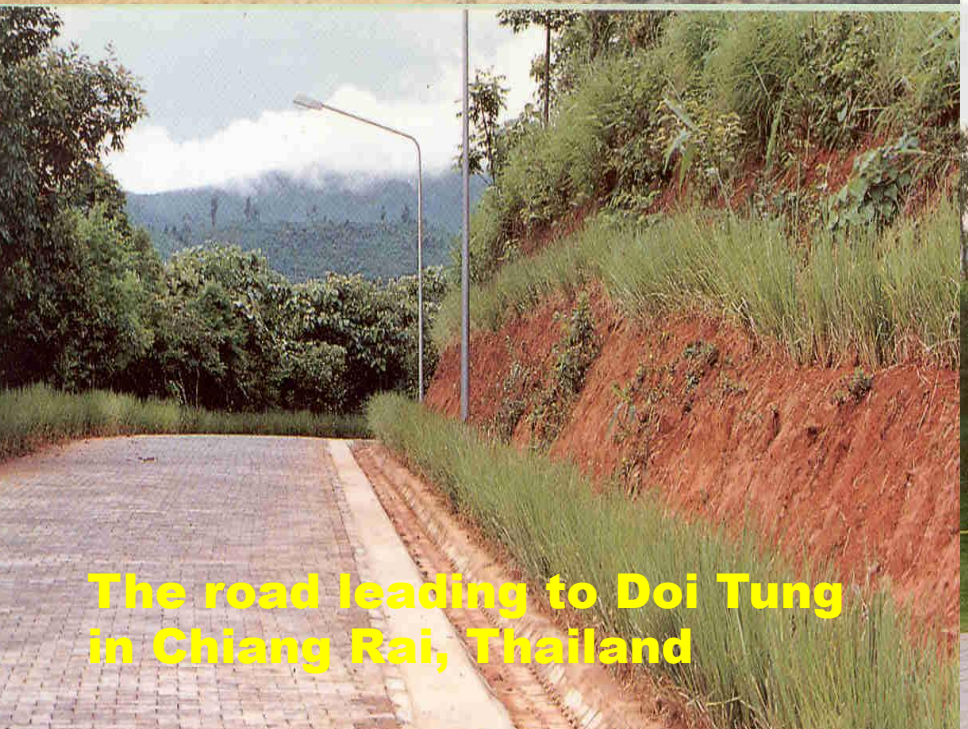


Vetiver used to stabilize sandy garden beds on a beach resort in Senegal

As potted plants and around a lotus pond in Vietnam



Erosion control and landscaping on a flood control dam wall,two years after planting in Australia



The road leading to Doi Tung in Chiang Rai, Thailand

Planting at the entrance of a small park
for ornamental purpose

Erosion control and landscaping in Australia

After establishment

Three years later

4.6.1 Landscaping (Con't.)

Reservoir Landscaping:

- In China, vetiver grown on bare bank of the reservoir
- At KU Sakon Nakhon Campus, vetiver hedges beautify scenery of the reservoir with no erosion of lateritic soil

4.6.2 Decorative Hedge

- On round abouts at C'mara Municipal de Portim'o, Portugal
- These hedges hide from view the traffic that is passing on the opposite site of the round abouts

Road & Pond Boundary

Vetiver hedges along roads and ponds make a nice boundary, much more pleasing to the eyes than concrete panels and other artificial objects.

Vetiver decorated in front of the office

4.6.3 Decorative Potted Plant

- Forms a nice bush with green foliages, some upright, some drooping
- Decorate platform, stage
- Grown in large clay pots

4.6.3 Decorative Potted Plant (Con't.)

- ❖ Forms a nice bush with green foliages, some upright, some drooping
- ❖ Decorate platform, stage, etc.
- ॐ In Thailand, decorated on stage of ICV-2
- ॐ In Senegal, grown in large clay pots for sale
- ॐ In Vietnam, to decorate outside an office

ICV-2 stage decorated with potted vetiver

4.6.4 Vetiver Bouquet

Bundle of cut vetiver leaves and flowers can be used as material of a bouquet, or decorative plant in containers for display.

4.7 As Field Boundaries

- **As field boundaries: In West Africa, vetiver is used as a border for roads, gardens and cultivated fields to prevent the extension of Dub grass**
- **As sub-divisions, or separation between sections of garden plots: Many Thai farmers use vetiver to separate their fields and vegetable plots**

4.8 As Agricultural By-products

- **Utilization of cut leaves as agricultural by-products:**

  4.8.1 As forage.

  4.8.2 As mulch.

  4.8.3 As mushroom medium.

4.8.1 As Forage

- **When planted as hedgerows along the contour line of a sloping land, vetiver produce significant yield of forage for livestock as a by-product.**
- **If planted as a stand-alone forage crop, it can produce very large quantities of biomass.**
- **Forage value of freshly cut vetiver leaves is comparable to other grasses.**
- **It contains insignificant amounts of toxic substances; thus not harmful to animals.**
- **It is the only grass that provides feed during drought period.**
- **Native vetiver burnt in spring to produce forage for Fulani livestock in Africa.**

4.8.2 As Mulch

Utilization of cut leaves as mulch:

- **Improves soil moisture**
- **Reduces erosion**
- **Adds soil organic matter**
- **Reduces weed control operation**

4.8.3 As Mushroom Medium

- Vetiver leaves and culms contain chemical compounds such as cellulose, hemicellulose, lignin, crude protein, minerals -- optimum for mushroom growth
- Oyster, shiitake and straw mushrooms can be grown on vetiver medium

5. Discussion

5.1 Simple and low cost technology.

5.2 Low maintenance costs.

5.3 Sustainable.

5.4 Ecological *vs* economical benefits.

5.1 Simple and Low Cost Technology

- **Vetiver is one of the most simple plants and employs a low-cost technology.**
- **Planting vetiver is relatively cheap as compared to other plants such as trees and ornamental plants.**

5.2 Low Maintenance Cost

- Vetiver requires low maintenance cost
- It is only required to cut the leaves down every three months, to leave the cut leaves to cover the soil to reduce evaporation, and to add nutrients to the soil after decay.

5.3 Sustainable

- Most other plants grown for land use or in agricultural production are difficult to sustain
- Cultivated crops, for example, require fertilizer application, spraying with fungicides and insecticides
- Vetiver is easier to sustain itself

5.4 Ecological *vs* Economic Benefits

- Ecological benefit in preventing soil erosion, etc.
- Economic benefit in reducing the cost of stabilization of highway slopes and embankments
- Ecological potential in environmental protection
- These benefits not recognized by small-scale farmers as they have to sacrifice their small land
- A challenge to extension workers to convince them


That’s All .. Folk