VETIVER SYSTEM

FOR ENVIRONMENTAL PROTECTION

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INTRODUCTION

- The Vetiver System (VS) is based on the use of vetiver grass *(Vetiveria zizanioides L.)* for a wide range of applications. VS was first developed by the World Bank for soil and water conservation and now being used in over 100 countries.

- In Australia the Vetiver System is based on the use of Monto Vetiver which is sterile, non invasive, it flowers but set no seeds hence no weed potential.

- R&D conducted by the author showed that Monto vetiver is tolerant to the most adverse conditions, high levels of pesticides and herbicides and also to a wide range of heavy metal toxicities. Therefore VS has been successfully used for environmental protection purposes in Australia, Asia, Africa and Europe.

- Monto Vetiver was derived from south India, therefore genetically identical to most cultivars grown around the world, including the cultivar from South Africa.

UNIQUE PHYSIOLOGICAL CHARACTERISTICS

Tolerant to:

- **Drought an flood**
- **Acidity, alkalinity, salinity and sodicity**
- **Heavy metals**
- **Various soil types and conditions**

Saline threshold level is at EC_e=8 dsm^{-1}, and vetiver can survive at 47.5 dsm^{-1} under dryland salinity conditions

Salt tolerance level of Vetiver grass as compared with some crop and pasture species grown in Australia.

Species	Soil EC_{se} (dSm^{-1})	
	Saline Threshold	50% Yield Reduction
Bermuda Grass *(Cynodon dactylon)*	**6.9**	**14.7**
Rhodes Grass (C.V. Pioneer) *(Chloris guyana)*	**7.0**	**22.5**
Tall Wheat Grass *(Thynopyron elongatum)*	**7.5**	**19.4**
Cotton *(Gossypium hirsutum)*	**7.7**	**17.3**
Barley *(Hordeum vulgare)*	**8.0**	**18.0**
Vetiver grass *(Vetiveria zizanioides)*	**8.0**	**20.0**

Vetiver growing among mangrove seedlings on a tidal creek near Brisbane

In Fiji vetiver growing next to a coastal mangrove swamp

EXTRAORDINARY PHYSIOLOGIAL CHARACTERISTICS

Tolerant to adverse soil conditions:

- **High acidity, pH 3.0-12.5**
  - **Aluminium and Manganese toxicities.**

Highly erodible acid sulfate soil in coastal Queensland

One year after planting

Threshold levels of heavy metals to vetiver growth as compared with other species

Heavy Metals	Threshold levels in soil ($mgKg^{-1}$)		Threshold levels in plant ($mgKg^{-1}$)	
	Vetiver	Other plants	Vetiver	Other plants
Arsenic	100-250	2.0	21-72	1-10
Cadmium	20-60	1.5	45-48	5-20
Copper	50-10	Not available	13-15	15
Chromium	200-600	Not available	5-18	0.02-0.20
Lead	>1 500	Not available	>78	Not available
Mercury	> 6	Not available	>0.12	Not available
Nickel	100	7-10	347	10-30
Selenium	>74	2-14	>11	Not available
Zinc	>750	Not available	880	Not available

EXTRAORDINARY PHYSIOLOGIAL CHARACTERISTICS

- **High percentage removal of N and P from polluted water**

- **High percentage removal of N, P, COD and Chloride from landfill leachate**

N and P removal: **With high capacity of removing N and P in polluted water, vetiver cleaned up blue green algae in 4 days**

Sewage effluent infested with Blue-Green algae due to high Nitrate (100mg/L) and high Phosphate (10mg/L)

Same effluent after 4 days after treating with vetiver, reducing N level to 6mg/L (94%) and P to 1mg/L (90%)

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Vetiver roots thrive in high N and P sewage effluent under hydroponics conditions

Reduction of Pollutants from Domestic Effluent under Hydroponics Treatment

	Total N (mg/L)	Total P (mg/L)	COD	E. coli (org/100 mL)	EC (dS/m)
Initial	**66.0**	**12.4**	**252**	**>1600**	**963**
Day 14	**20.3**	**6.5**	**93**	**50**	**634**
Reduction %	**76**	**59**	**63**	**97**	**34**
Reduction per bin	**8 002 (mg)**	**1 165 (mg)**	**-**	**-**	**-**

Removal rates of pollutants from polluted water in China (*Zheng et al. 1 997*)

Pollutants		River 1*	River 2**	Tap water
Total N	Concentration (mg/L)	13.8	10.5	0.1
	Removal %	71.0	58.1	
Total P	Concentration (mg/L)	0.94	1.03	ND
	Removal %	99.3	93.7	

*After 3 weeks

** After 2 weeks

ND Not detectable

Removal rates of pollutants from landfill leachate (*Xia et al. 2000*)

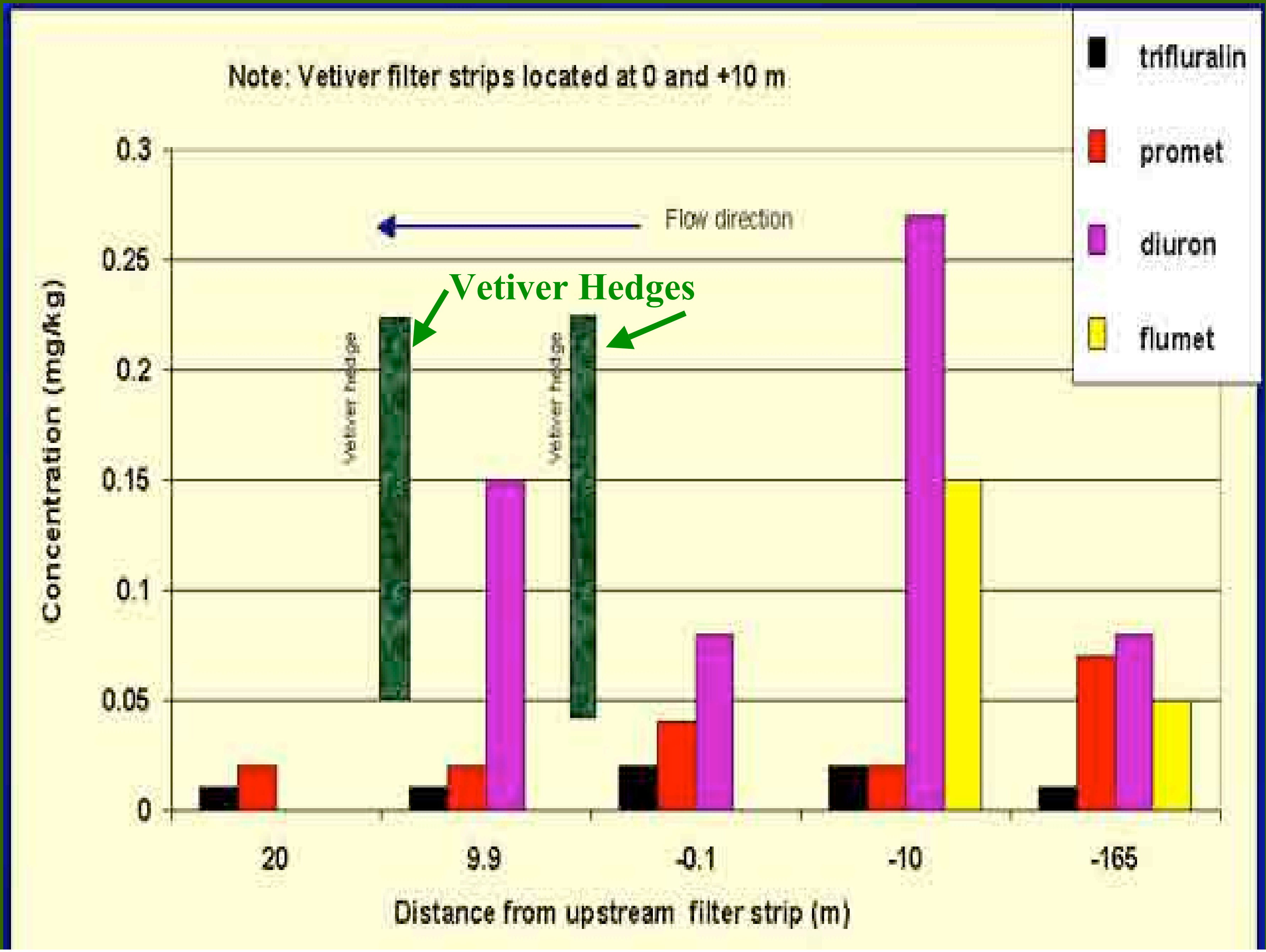
Pollutants		High concentration leachate	Low concentration leachate
COD	Reduction %	69.0	61.9
Carbonate +Bicarbonate	Reduction %	80.6	59.0
Total N	Reduction %	79.4	71.10
	Removal (mg/pot))	232.1	255.4
Total P	Reduction %	70.0	65.0
	Removal (mg/pot)	7.63	4.66
Chloride	Reduction %	21.5	7.9
	Removal (mg/pot)	321.9	207.8

HYDRAULIC CHARACTERISTICS

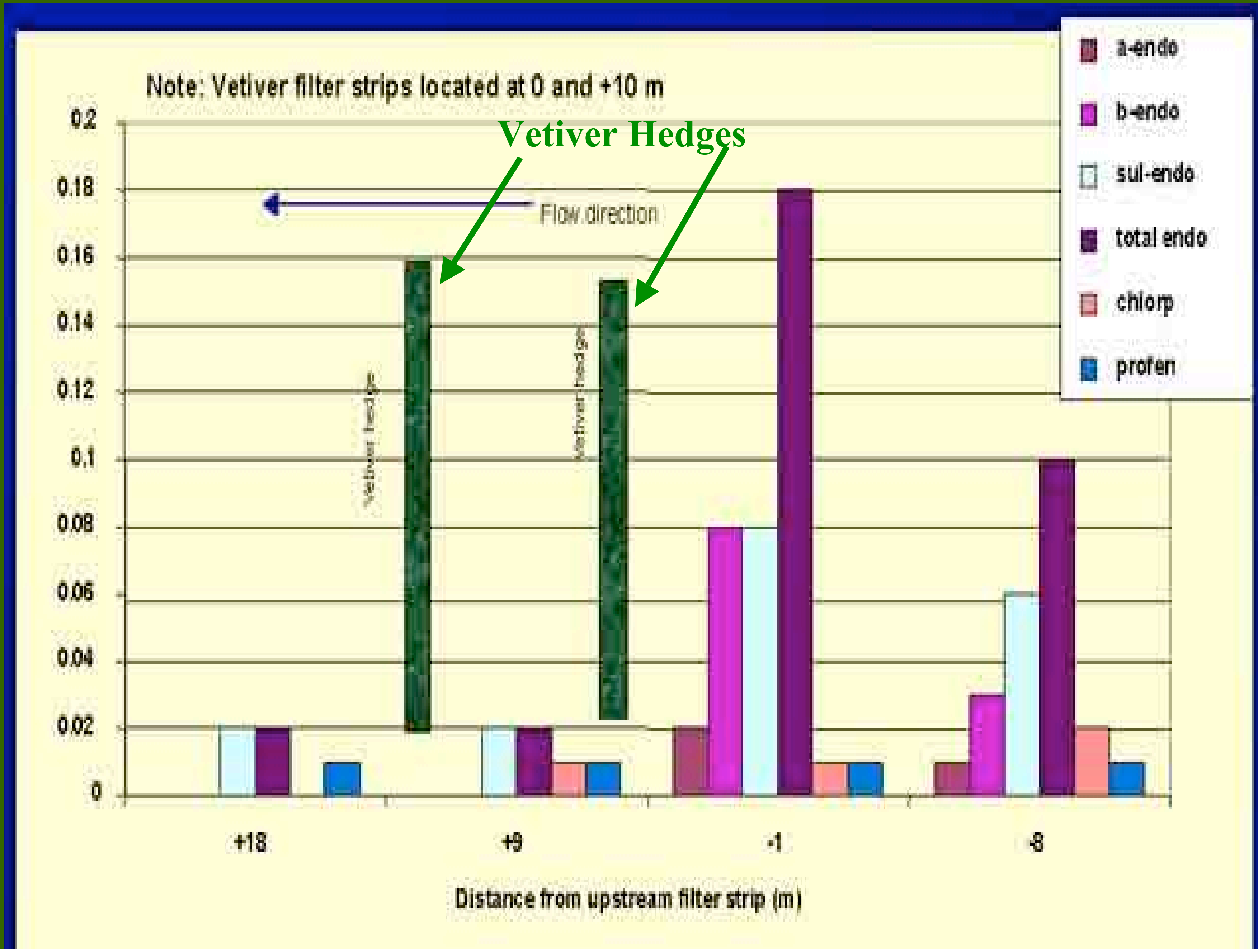
- **Reducing flow velocity**
  - **Trapping sediment containing nutrients, herbicides and pesticides**

Large silt fan trapped by this hedge on a sugarcane farm

Trapping herbicides on cotton farms in central Queensland



Trapping pesticides on cotton farms in central Queensland



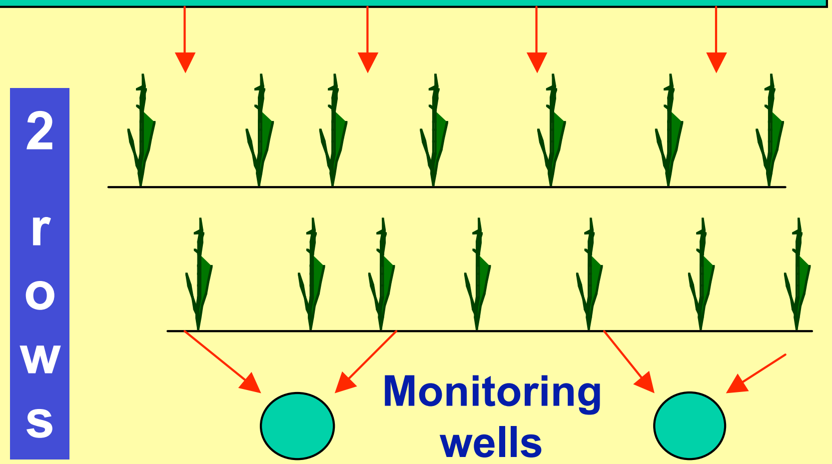
APPLICATION OF THE VETIVER SYSTEM FOR DOMESTIC EFFLUENT DISPOSAL

- **Sewage effluent seepage from septic systems**

Vetiver was most effective in absorbing effluent discharge from a toilet block at Beelarong Community demonstration centre in Brisbane.

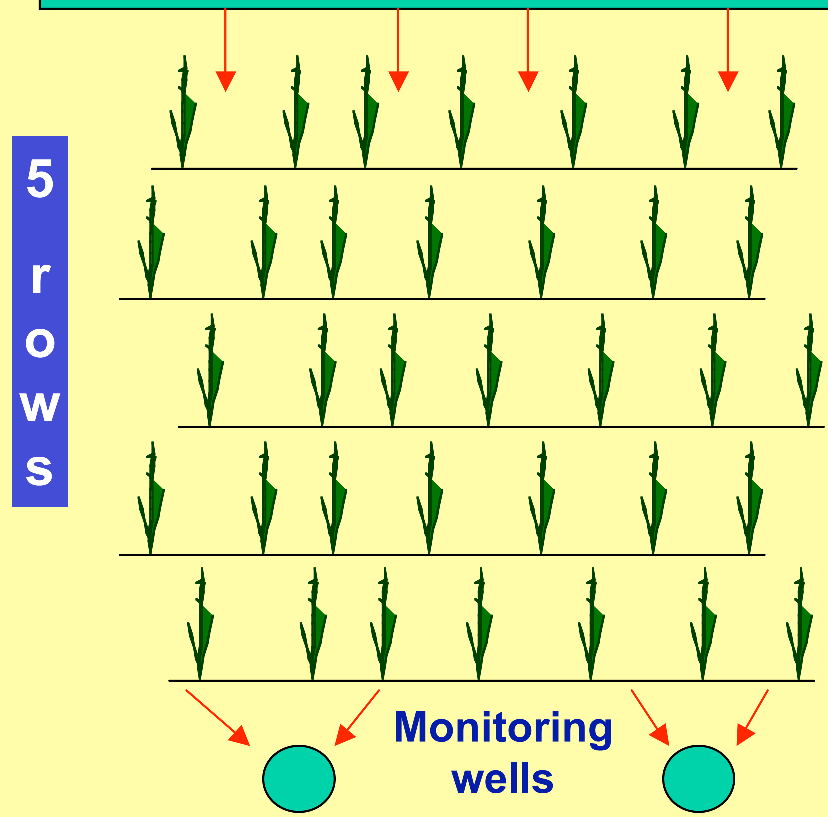
Effectiveness of vetiver in reducing N level in domestic blackwater

Entry: **Total N level at 95.2mg/L**



Exit: **Total N level at 16mg/L or a reduction of 83%**

Entry: **Total N level at 95.2mg/L**



Exit: **Total N level at 1.2mg/L or a reduction of 99%**

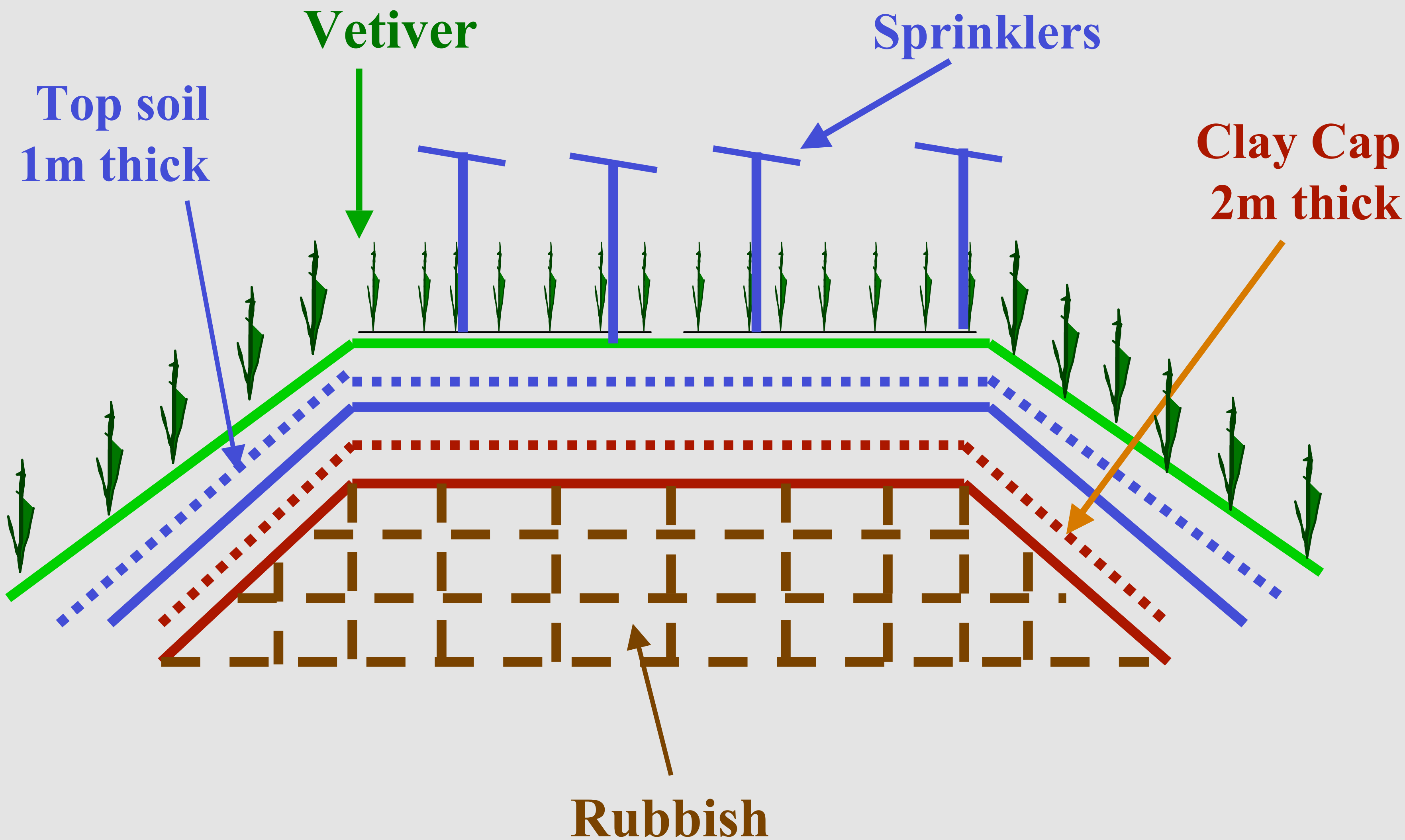
Effectiveness of Vetiver in Removing N and P from Blackwater Effluent

	Total Nitrogen (mg/L)	Total Nitrate (mg/L)	Total Phosphorus (mg/L)
Original Levels	95.2	92.8	1.3
After 2 vetiver rows	16.0	16.7	0.24
Reduction (%)	**83**	**82**	**82**
After 5 vetiver rows	1.2	0.7	0.20
Reduction (%)	**99**	**99**	**85**

APPLICATION OF THE VETIVER SYSTEM FOR LANDFILL LEACHATE TREATMENT

(Land irrigation)

- **Tweed Shire, NSW**



Diagrammatic cross section of the mound at Stotts Creek Landfill, Muwillumbah

Space planting

Irrigated with leachate after planting each day

One year after planting

Fourteen months after planting

VETIVER SYSTEM

FOR

INFRASTRUTUTURE PROTECTION

UNIQUE MORPHOLOGICAL CHARACTERISTICS

- **Erect and stiff stems, which slow flow velocity**
- **Forming thick hedges when planted close together, which can divert flows and trap sediments**

Forming a thick hedge when planted in row

Strong current flattened the native grass but not vetiver on this waterway

UNIQUE MORPHOLOGICAL CHARACTERISTICS

- **Deep, extensive and penetrating root system**

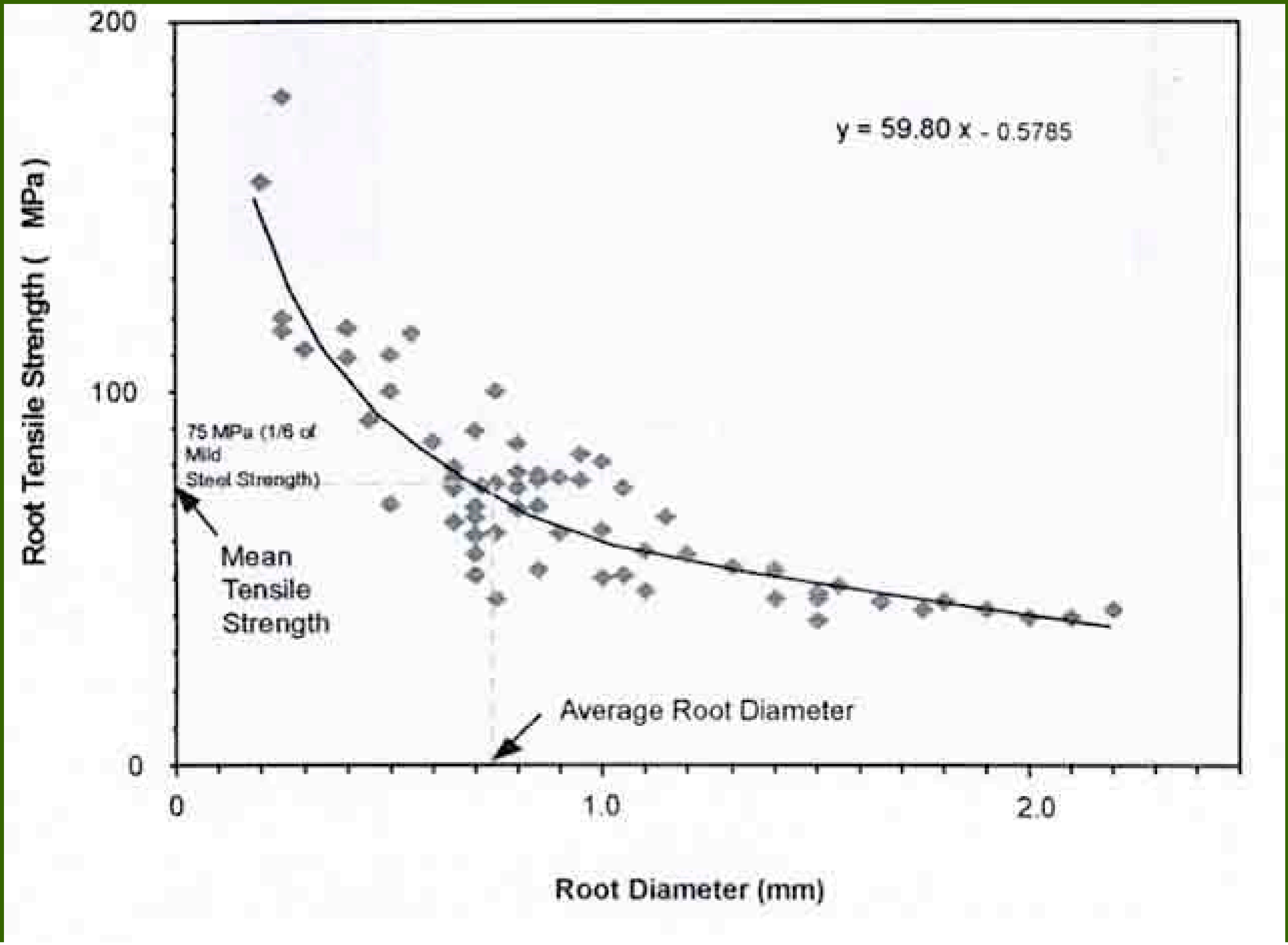
China: One year old with 3.3m deep root system
(These roots have a tensile strength equivalent to 1/6 mild steel reinforcement)

Thailand: One year old, 3.3m long

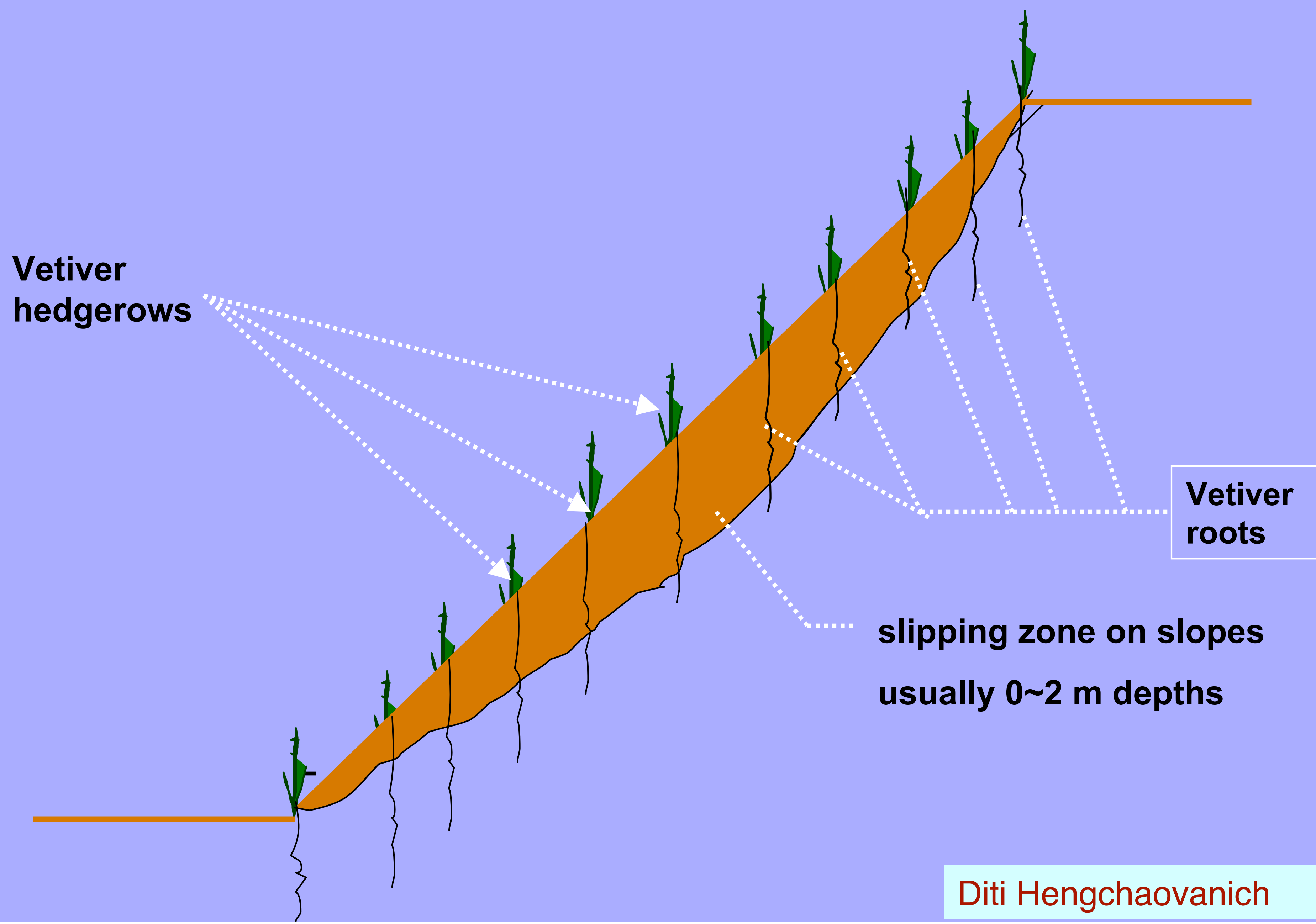
Vietnam: The different root systems between vetiver grass and native vetiver

Root size distribution and tensile strength

These roots have a tensile strength equivalent to 1/6 mild steel reinforcemen

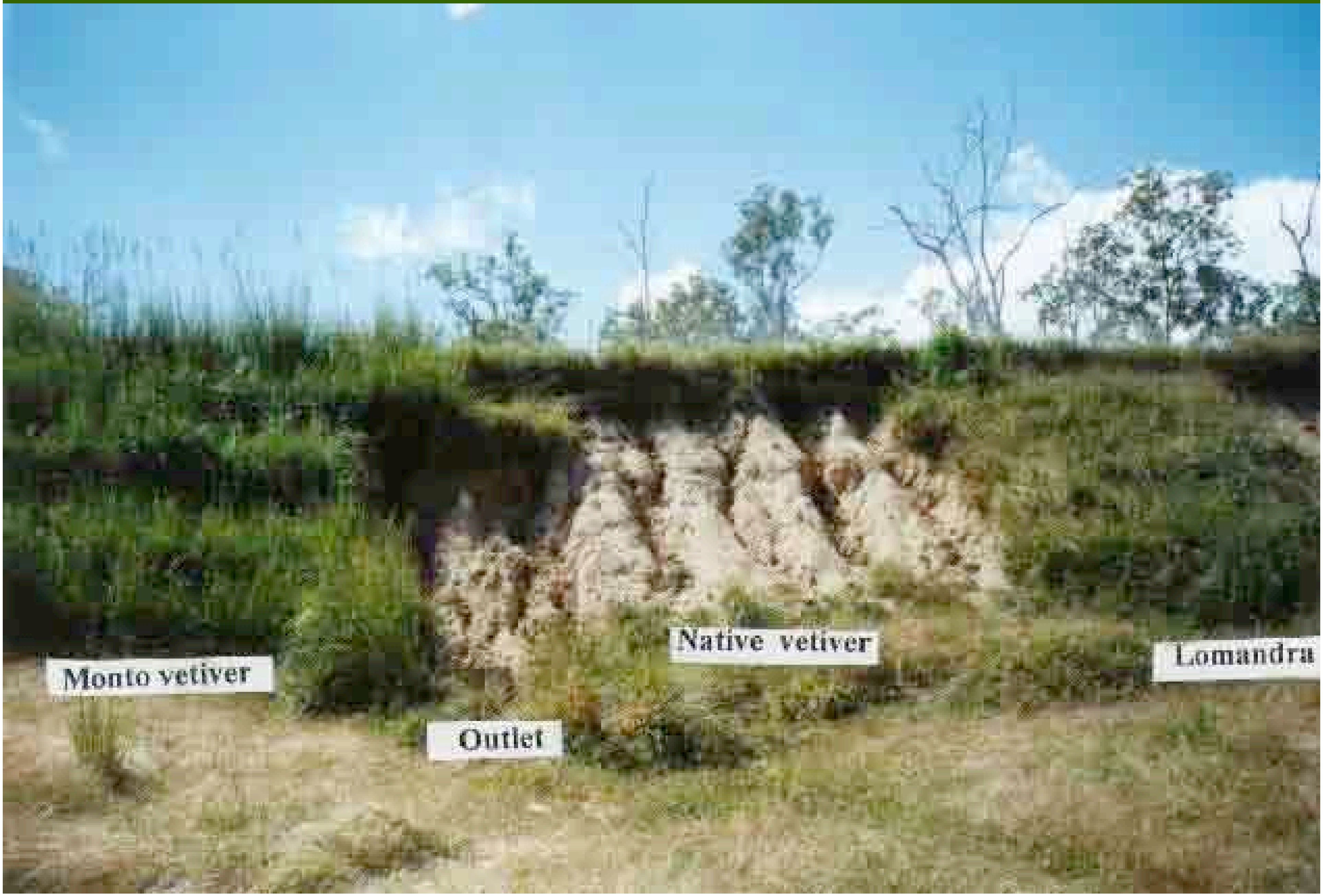


Soil stabilisation mechanism by vetiver



Diti Hengchaovanich

Australia: After 400mm of rain in 10 days in northern Queensland




Monto vetiver
Lomandra
Native vetiver
Monto vetiver
Lomandra
Native vetiver

New batter, severely eroded within weeks in the wet season

Three months after planting

Completely stabilised seven months after planting

Hydromulching three months after planting

Three weeks after planting

Eight months after planting

Highly tolerant to fire: One month after a severe wildfire

Two months after fire

Bridge abutment: Ten weeks after planting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Malaysia: East West highway

East West highway

Vietnam: Ho Chi Minh Highway


The best trial, where the first sod was planted by the President. It is lucky because it is internally stable, though still having problem at its toe.


Vetiver
No vetiver

China: Fancy cement-concrete works, imagine the cost

Beautiful when new, but…

But do not always stay up when old or typhoon affected

CONCLUSIONS

- Vetiver hedge can be rapidly established in arid conditions and poor soils with little if any nutrients.
- Once established vetiver hedges are maintenance free and withstand arid and dry season conditions including bush fires.
- Provides protection to steep cuts and fill batters resulting in substantial savings in earthwork costs.
- Encourages sheet flow and reduced water run-off velocities resulting in natural vegetation re-growth and prevention of erosion.
- Eliminates undermining of hard rock structures
- Effective alternative to hard rock check dams
- Effective prevention of gully erosion
- Very cost effective, with savings ranging from 73% for culvert protection to 64% for table drain and is miscellaneous protection works and 60% for road shoulder protection.
- In highly erodible soils, the most important advantage of vetiver technology over conventional structures is that rock structures themselves are not stable and require constant maintenance to protect the road works which will add to the overall operating costs of infrastructure in the long term.

Thank You