

# SOCIO-ECONOMIC BENEFITS OF THE VETIVER SYSTEM TECHNOLOGY IN MINING AREAS IN DEVELOPING COUNTRIES



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# INTRODUCTION

- 1. Vetiver grass**
- 2. Vetiver System Technology (VST) and Applications**
- 3. Benefits of VST in mining areas in developing countries**
- 4. Case studies of benefits of VST in Africa, Asia and Latin America**

# 1- Vetiver grass

**Morphological attributes:** Stiff and erect stems up to 2m tall and over 2.5m with flower head



Forming a thick hedge when planted in row



Young plant stiff enough to trap large gravel

## EXTENSIVE AND DEEP ROOT

**China:** One year old with 3.3m deep root system

**Australia:** One year old, 1.3m and root bound

(These roots have a tensile strength equivalent to 1/6 mild steel reinforcement)



CHINA



BRISBANE

# 1- Vetiver grass

## Physiological attributes

- **Vetiver grass is both a xerophyte and a hydrophyte and, once established, is not affected by droughts or floods.**
- **Adaptability to a wide range of soil and climatic conditions,**
  - **Can be established in sodic, acidic, alkaline and saline soils,**
  - **Tolerant to drought due to deep and extensive root system,**
  - **Mature plants are tolerant to extreme heat (50°C) and frost (-14°C).**
- **Vetiver can withstand burning, slashing and moderate tractor traffic**
- **Resistant to infestation from most pests, diseases and nematodes.**
- **Vetiver grass is extremely long-lived, have been observed to persist for over 50 years**

# Adaptability Range of Vetiver Grass in Australia and other Countries

Adverse Soil Conditions	Australia	Other Countries
Acidity	pH 3.3	pH 4.2 (with high level soluble aluminium)
Aluminium level (Al Sat. %)	Between 68% - 87%	80%-87%
Manganese level	> 578 mgkg <sup>-1</sup>	
Alkalinity (highly sodic)	pH 9.5	pH 12.5
Salinity (50% yield reduction)	17.5 mScm <sup>-1</sup>	
Salinity (survived)	47.5 mScm <sup>-1</sup>	
Sodicity	33% (exchange Na)	
Magnesicity	2 400 mgkg <sup>-1</sup> (Mg)	
<b>Heavy Metals</b>		
Arsenic	100 - 250 mgkg <sup>-1</sup>	
Cadmium	20 mgkg <sup>-1</sup>	
Copper	35 - 50 mgkg <sup>-1</sup>	
Chromium	200 - 600 mgkg <sup>-1</sup>	
Nickel	50 - 100 mgkg <sup>-1</sup>	
Mercury	> 6 mgkg <sup>-1</sup>	
Lead	> 1 500 mgkg <sup>-1</sup>	
Selenium	> 74 mgkg <sup>-1</sup>	
Zinc.	>750 mgkg <sup>-1</sup>	

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

Heavy Metals	Threshold levels in soil (mgKg <sup>-1</sup> )		Threshold levels in plant (mgKg <sup>-1</sup> )	
	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

## 2- Vetiver System Technology & Applications

The VST is based on the application of Vetiver grass and its unique and extraordinary attributes

The major applications of VST are:

1. Soils and water conservation in farm land
2. Infrastructure protection by Bioengineering
3. Environmental protection by Phytoremediation
  - Wastewater treatment: Sewage effluent, landfill leachate and industrial wastewater
  - Mine rehabilitation and industrial contaminated land
4. Poverty alleviation

*Globally over 100 countries are using VST for at least one of these applications ([www.vetiver.org](http://www.vetiver.org))*

# VST Application: Soils and water conservation in farm land



**Flood erosion and sedimentation control on the Darling Downs flood plain, Queensland**



**Soil erosion and sedimentation control on sugar cane field in North Queensland**





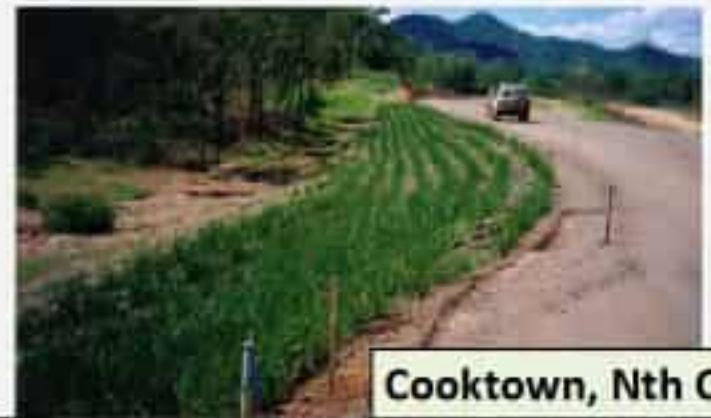
# VST Application: Infrastructure protection by Bioengineering



Road Batters



Dam wall Guangzhou, China



Dam wall, Alcoa, Gove, NT



# VST Application: Wastewater treatment - Sewage and leachate



**Sewage effluent, Ephemeral Wetland, Qld**



**Teys Abattoir, Beenleigh, Qld**

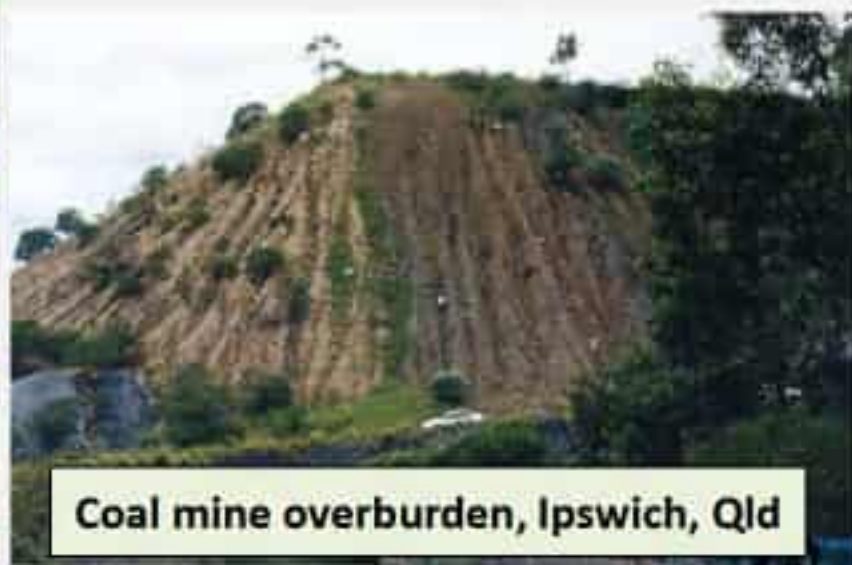
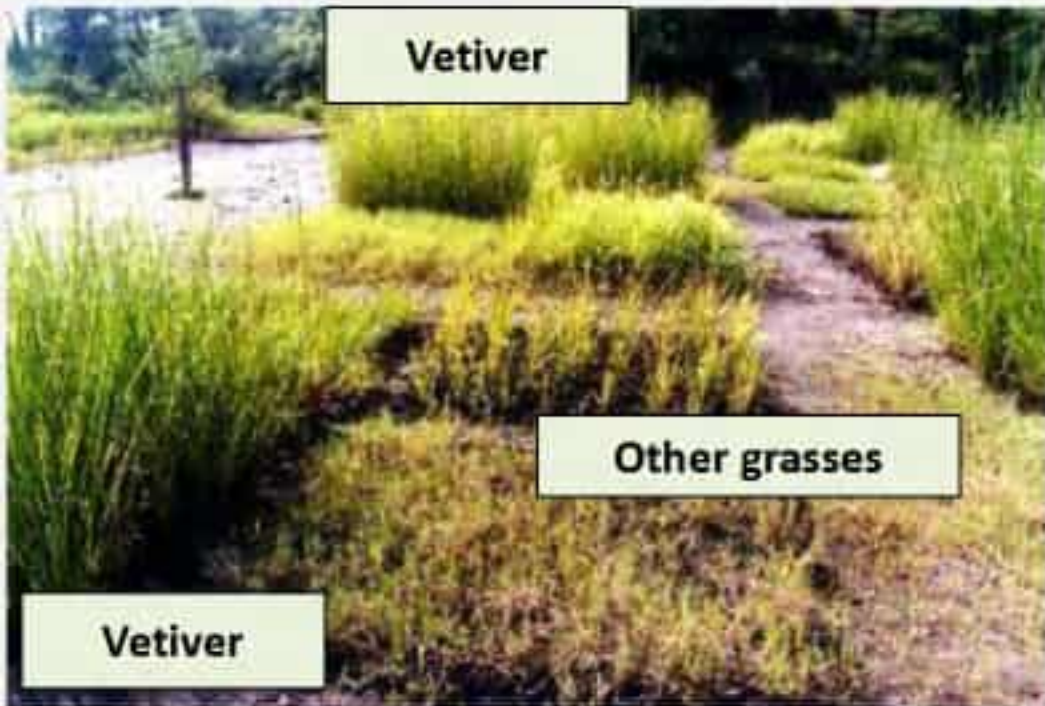


**Landfill leachate, Tweeds, NSW**



**Sewage effluent, Boonah, Qld**

# VST Application : Mine rehabilitation - Overburden



# VST Application: Mine rehabilitation – Tailings

Coal Tailings, Emerald, Qld



Vetiver had the best growth among the 5 species used in central Qld

Redmud, Alcoa, Gove, NT



Bermuda grass grows on higher ground which is less caustic

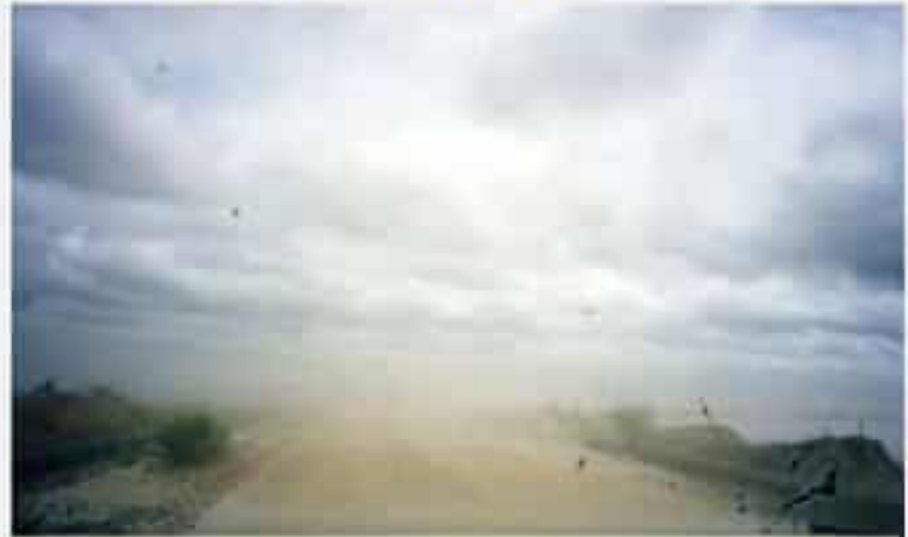
Good establishment and growth with some lime and fertilisers

pH	2.7
SO <sub>4</sub>	8500mg/kg
S	3.75%
As	970mg/kg
Ba	710 *
Cu	230 *
Pb	290 *
Sr	350 *
Zn	560mg/kg

Old gold Tailings, Kidston, Qld



# Fresh gold Tailings, Kidston, Qld

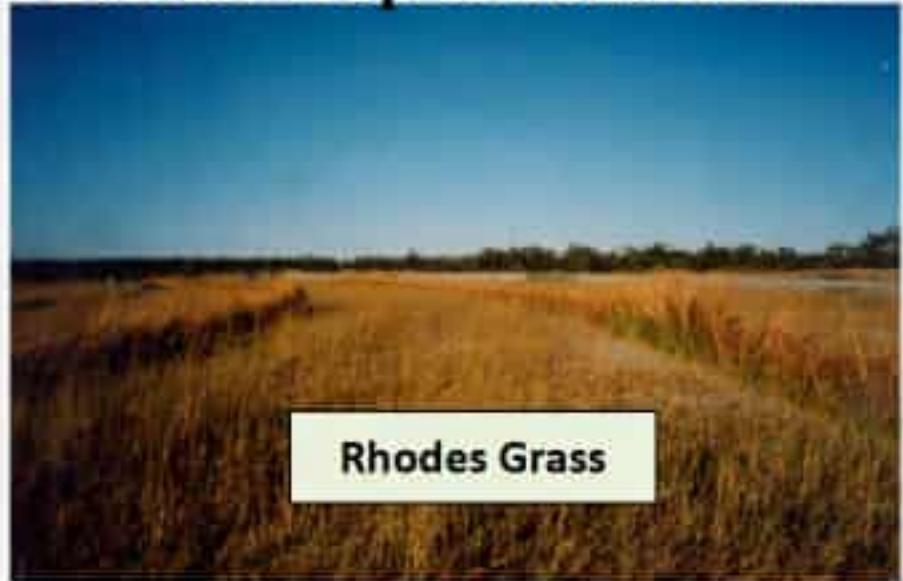
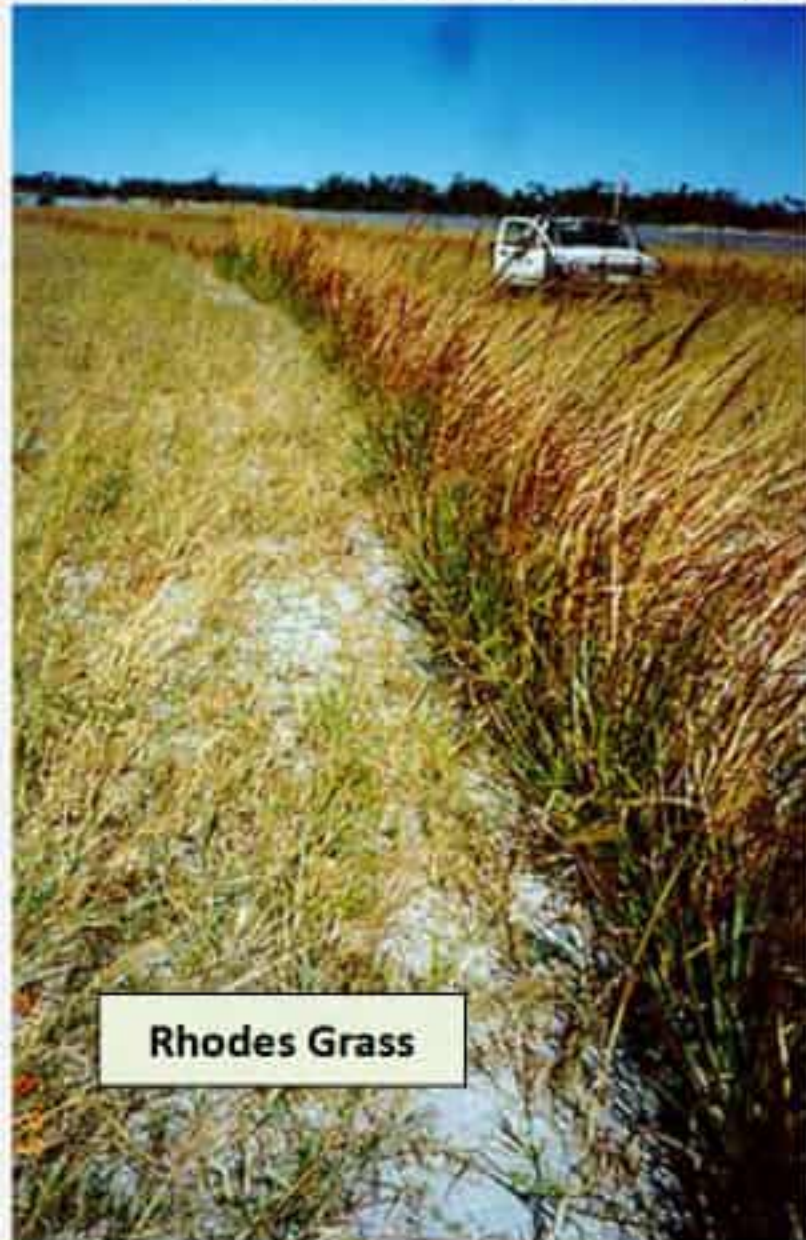


The dust is highly contaminated with heavy metals such as Arsenic, Copper etc.

Millet cover crop to control wind erosion



**The flexible Vetiver hedges provided a low cost wind barrier,  
provided excellent protection for crop establishment**



# VST Application: Poverty alleviation



Rural employment

Madagascar



Vietnam



Food crop protection

Indonesia



Venezuela



Handicraft production

Thailand



China

## 4. Benefits of VST in Mining Areas in Developing Countries



**Rural employment: Plant production in Madagascar and Vietnam**







**Rural employment: Handicraft production in Venezuela**



## **4. Case Studies of Benefits of VST in Africa, Latin America and Asia**

- 1. MADAGASCAR: Local employment, professional training and income**
- 2. VENEZUELA: Local employment, professional training and income**
- 3. VIETNAM: Local employment and income**
- 4. WEST AFRICA: Local employment, professional training and income**

# CASE STUDY 1: Madagascar Demographics



- 4<sup>th</sup> biggest Island in the world with a population around 20 Million.
- 80% of population live below the poverty line.
- Only 54% of population in urban areas & 4% in rural areas have access to potable water.
- Life expectancy is 52 years with 46% literacy.
- Infant Mortality is 89 per 1,000
- Economic isolation for many communities resulted from the collapse of the regional & national road network system with 80% of roads impassable for up to 10 months per year.
- Massive environmental degradation (biodiversity).

**The Project:** Erosion and sediment control of highly erodible sand dunes on service road at Rio Tinto Ilminite mine at Fort Dauphin

**Before**



**After**



# The Project

- Started in 2006 with 15 communities and expanded to 32 communities by 2008
- Involved 133 families over the project period.
- 4,000,000 Vetiver plants were propagated & supplied.
- 40 hectares were stabilised and revegetated with commercial and locally harvested native grass seed species used in mixture
- Vetiver was inter-planted with native dune vegetation
- *This community based "Vetiver propagation program" has generated approximately (US\$250,000) collectively to the respective communities within the construction period.*



Nursery establishment training



Family nursery



Project implementation

## Nursery establishment training



### Obtaining Vetiver for home nurseries



Well established nurseries and new houses built from nursery production and employment income

# Employment and Technical Training



**Indigenous people at Fort Dauphin**



**Project implementation**



# CASE STUDY 2: VENEZUELA — Poverty Alleviation and Rural Employment

## The Project: Open cut Bauxite mine at Los Pijiguaos





**Fill slope**



**Cut slope**



**VST for erosion and sedimentation control at Los Pijiguaos Bauxite mine**

**Drainage channel**



**Dam wall**



# **VENEZUELA: Poverty Alleviation and Rural Employment by Handicraft Production**



**Introduction**



**Training**



**Growing Vetiver**



**Harvesting**

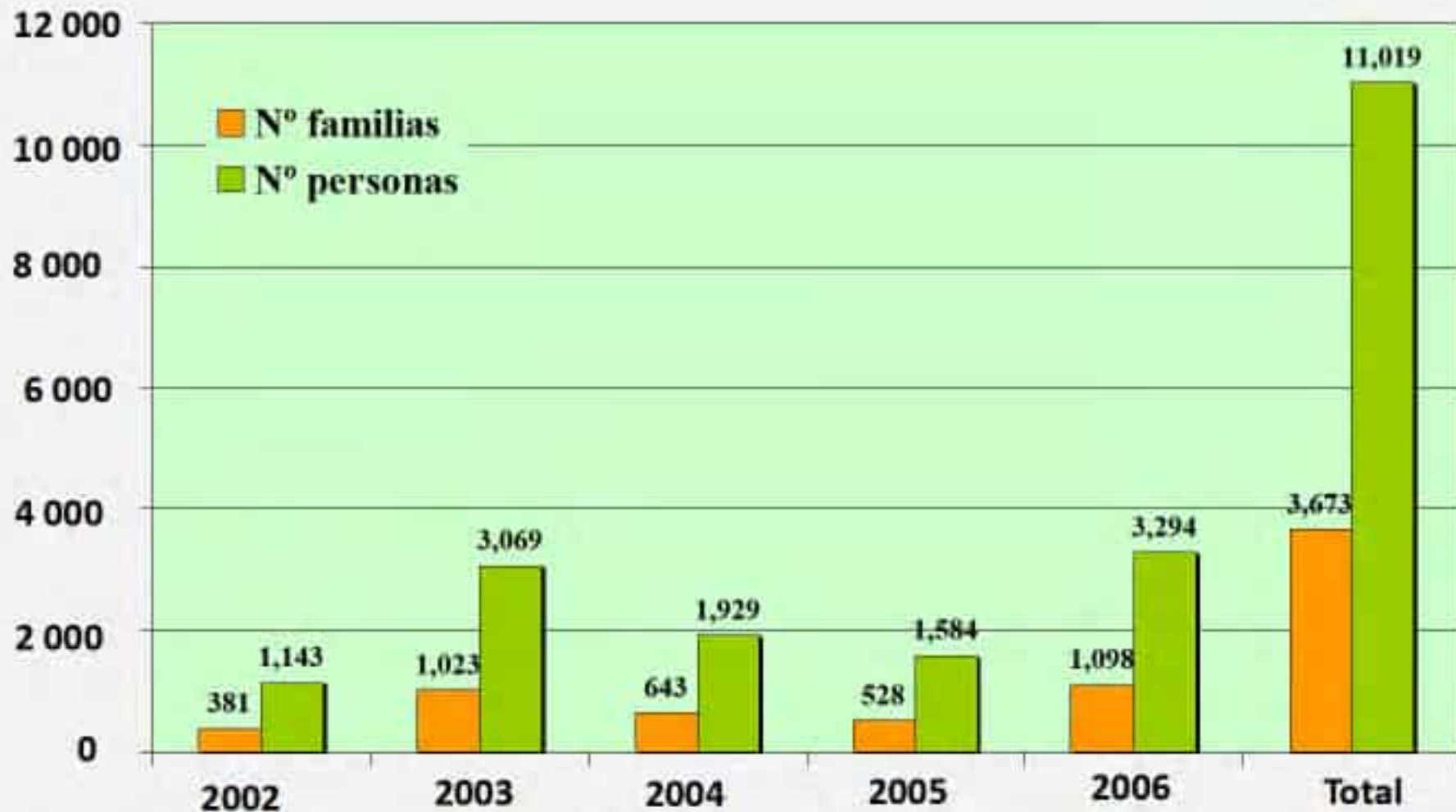


**Handicraft Production**



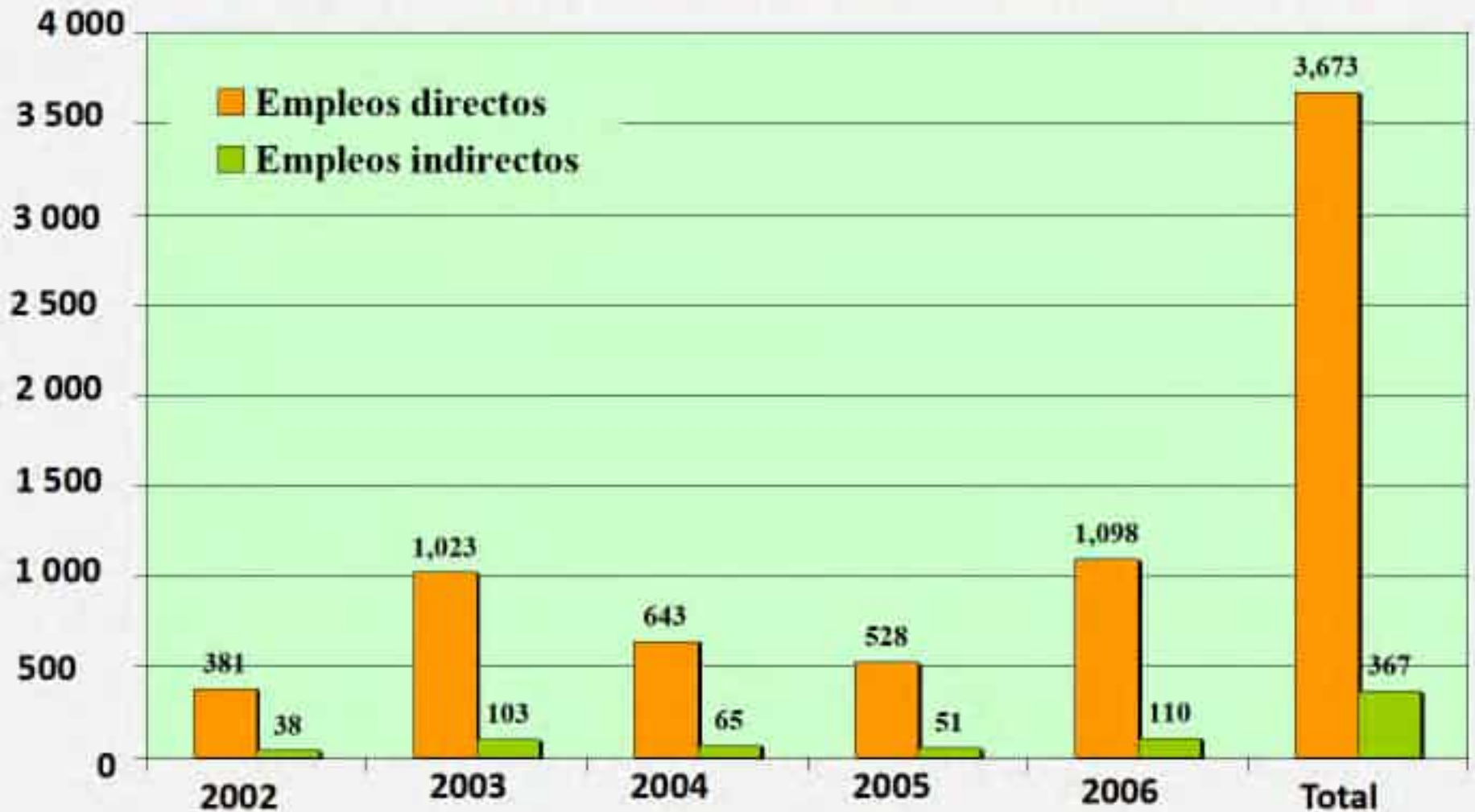
**Marketing**

## Number of family and people involved from 2002-2006 (3,673 families and 11,019 local people)



# Number of direct and indirect people employed from 2002-2006

**(3,673 direct and 367 indirect people employed)**



# **CASE STUDY 3: VIETNAM - Infrastructure Protection**

## **The Project: The Ho Chi Minh Highway**



**Before and after VST application on the 3 000km Highway from the Chinese border to the gulf of Thailand.**



# Community nurseries along the Highway



# Local employment during implementation phase



# CASE STUDY 4: VIETNAM - Infrastructure Protection

## The Project: Flood mitigation in the Mekong Delta

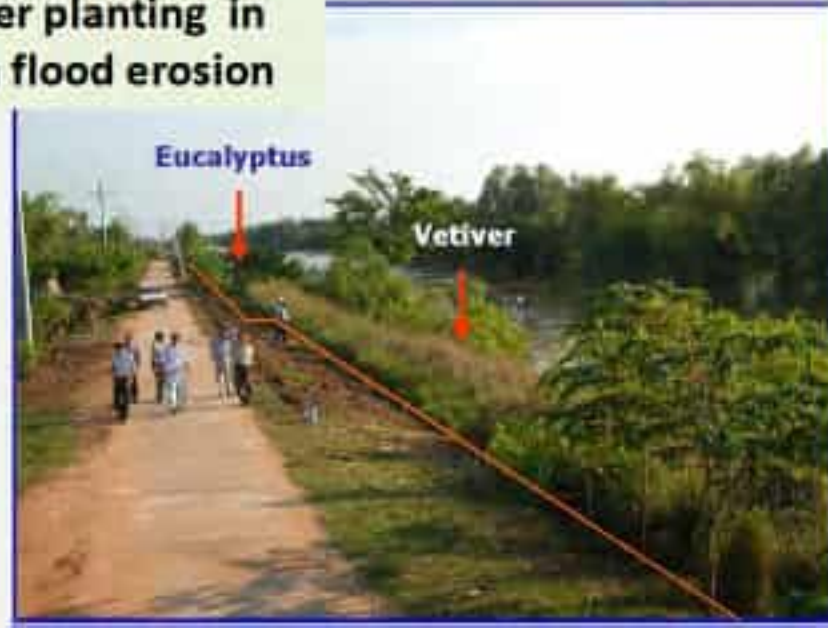
Flood water causing severe erosion on dikes



Vetiver planting on outer wall of the dikes



Effectiveness of vetiver planting in protecting dikes from flood erosion





# Community nurseries and local employment



## CASE STUDY 5: Some major mining projects in Africa

Rio Tinto Bauxite mine at Simandou, Guinea, West Africa





**Excessive Erosion caused by surface water runoff**





**Before & After VST application for slope stabilisation –  
Reasonable cover attained on slopes**



540 ha of tropical jungle situated on the Equator removed in one operation, resulting in a civil and environmental disaster

Phase 1: 20 ha side slopes rehabilitated with VST

## GSEZ Nkok, Gabon, West Africa



### Work Undertaken

- 30,000m vetiver grass hedge rows
- Bio-Jute – 10,000 m<sup>2</sup>
- Silt fences - 3,600 m<sup>1</sup>
- Sand Bags – 2,500 m<sup>1</sup>
- Hydroseeding -200,000 m<sup>2</sup>

### Climatic Conditions

Annual rainfall +  
3700mm

2 Rainy seasons –  
September to  
December & May to

 July



# Ambatovy Access Road Project, Moramanga, Madagascar



# Installing Erosion Control Structures, VST & Hydroseeding



**All vetiver plants and labor are sourced from local communities**



**Malomanye Village On-Site Training in Soil Conservation Techniques**





*Thank You*