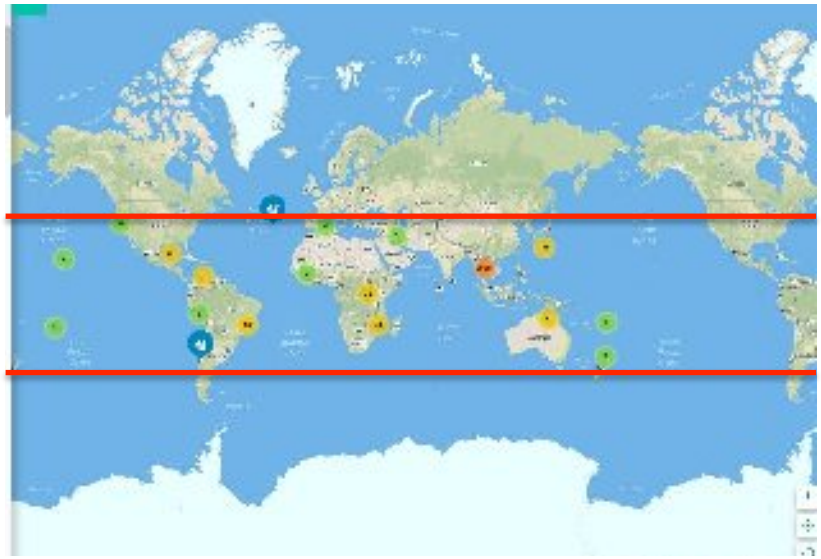
SOME SIMPLE TECHNOLOGIES CAN OFTEN MEET THE NEED AT MINIMUM COSTS

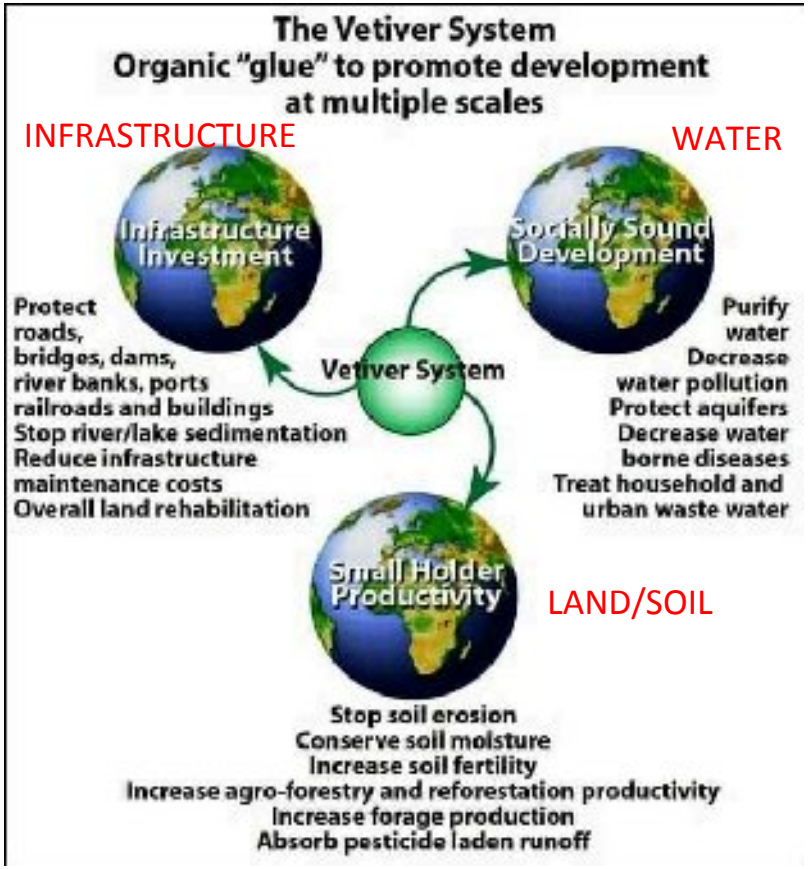
Mosquito nets –
two billion nets
have reduced malaria by 68% (WHO)

VETIVER GRASS
Billons planted

"It can take a generation or more to introduce a technical innovation…. can social media shorten that?

The story of the development and global dissemination of Vetiver Grass Technology (VGT) as a tool for climate change adaptation, and community resilience."





TECHNOLOGY DEVELOPED & EXTENDED
BY A GLOBAL COMMUNITY OF USERS & SCIENTISTS WORKING TOGETHER

including three special people
JOHN GREENFIELD (AGRICULTURIST) PAUL TRUONG (SCIENTIST),
KING BHUMIBOL THE GREAT OF THAILAND (SAW THE NEED, SUPPORTED, ACTED & LED!)

ECO-RESTORATION

- VIDEO FARMERS FRIEND

CLIMATE CHANGE ACCELERATES LAND AND WATER RELATED PROBLEMS

PROBLEMS	VETIVER GRASS TECHNOLOGY CAN MITIGATE
SOIL EROSION	Reduces soil loss 70 to 90%
SLOPE STABILITY/EROSION	Increase shear strength of soil by 40% + erosion control
SOIL HEALTH	Removes and filters excess N, P and ag chems
SOIL FERTILITY	Increases crop yields by 10-50% . Increases SOM significantly
SOIL MOISTURE/DROUGHT	Soil moisture improvement up to 40% - extends time to wilting pt.
RUNOFF VELOCITY/FLOODING	Reduces runoff by 30-70% especially from extreme rainfall events
AGRIC CHEMICAL BUILD UP	Hosts key beneficial insects - acts as "dead end" trap crop
CONTAMINATED LAND (MINE)	Tolerant to: Al, As, Cd, Cu, Cr, Hg, Pb, Se, Zn
DEGRADING UPLANDS	Improves soil moisture -- pioneer plant for other species
DEGRADING WETLANDS	groundwater recharge of adjacent wetlands
NET SOIL CARBON LOSS	Net Gain of SOC when used as mulch = 1-2 ton/ha/annum?????
WATER QUALITY	Can bring N,P,CODs, BODs levels to EPA standards
GROUND WATER	Recharge up to 20% of rainfall runoff + water quality improve

VETIVER GRASS – THE PLANT

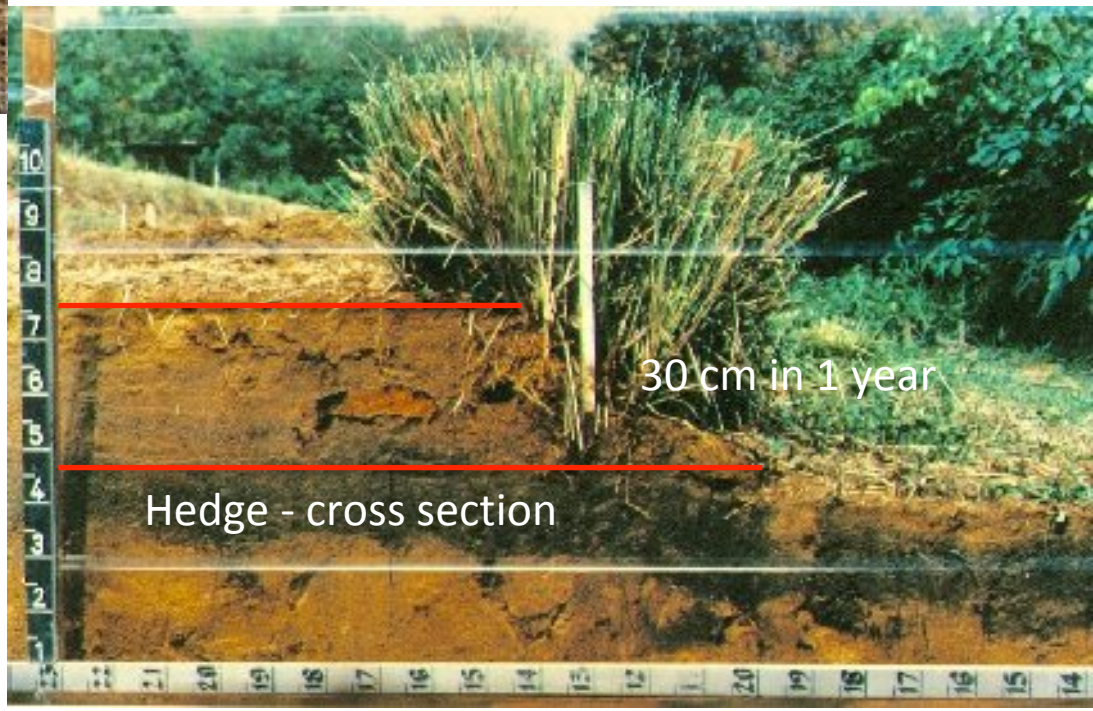
- ***Chrysopogon zizanioides*** ***native to India. C. nigritanus native to Africa (nearly as good).***
- ***Unique fast growing perennial aromatic plant***
- ***Extremely complex plant with high location adaptability and longevity***
- ***Drought tolerant – survives prolonged submergence – saline tolerant***
- ***Versatile non-invasive plant with many different applications***
- ***Special Morphological Features***
  - ***Erect and Stiff Stems***
  - ***Extensive, deep and penetrating roots***
  - ***Forms thick and dense hedges that can spread and filter rainfall runoff***

VETIVER GRASS TECHNOLOGY (VGT BASIC FUNCTION)

MOST OFTEN PLANTED AS A

NARROW NON-INVASIVE HEDGE BARRIER ACROSS THE SLOPE SPREADING RAINFALL RUNOFF TRAPPING ERODED SOIL

P.K.Yoon



"A LOOK-SEE AT VETIVER"

VETIVER IS **NOT** PROPAGATED FROM SEED

but by division, in-vitrio, layering, bare rooted/containerized

Smallholder nursery - Madagascar

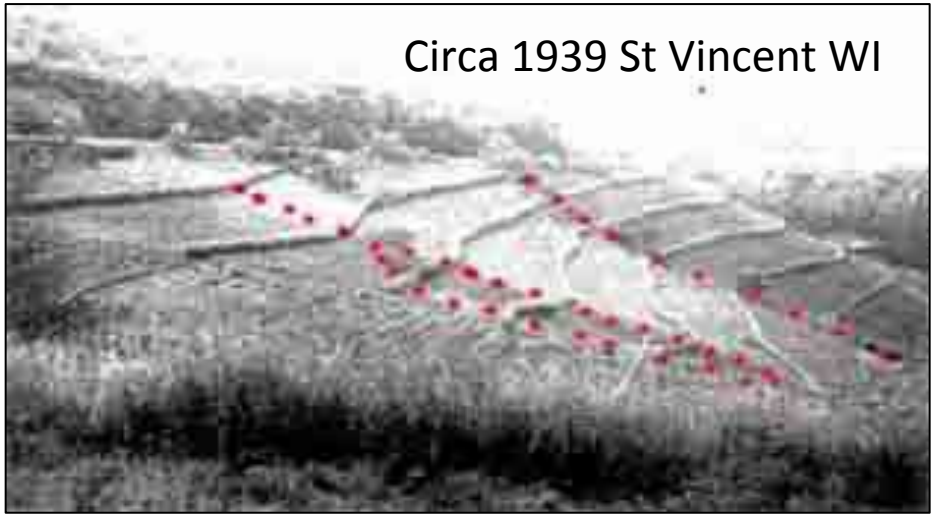
Plant material preparation - India

20 ha nursery in China

Feng Ziyuan

HISTORY - VETIVER – 3000 BC to 1960s

Pre 1930s Traditional/commercial uses -- field demarcation (India, Nigeria), forage, aromatic oil for perfume industry, medicinal uses, erosion control, pan-tropical distribution.

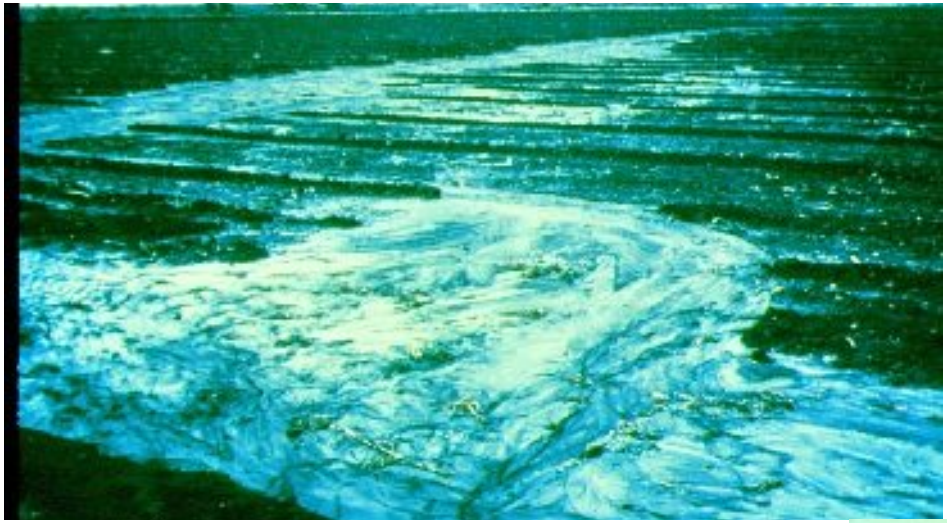


1930 – 1960s **British** colonial service "toolkit". Vetiver hedgerows for soil conservation (West Indies, Uganda, Fiji, Tanzania, Mauritius…)

Post WW II - Shift to engineered conservation structures (*TVA Effect*)
Vegetative & cultural methods "forgotten"

---- Consequences: $$$$ | disposal of water | soil health ignored

PHASE 1 - THE START - World Bank – India – On Farm Soil and Water Conservation



THE PROBLEM

Four WB watershed management projects (1980s), mainly located on black vertisols that cracked and swelled and highly erodible (70 million ha) – hard engineering technology failed and soil/crop moisture deficiencies

1984. Bank staff (John Greenfield) introduce Vetiver Grass hedgerows as alternative to "hard" conservation systems. Indian research (4 key stations) & field experience from 1985 to 1993 show viability and benefits

1984 – World Bank and Vetiver – NATURE'S WAY

John Greenfield

Stream bank/riparian protection

Gully Rehabilitation

FIJI - 30 YEAR IMPACT OF A VETIVER HEDGE (1956-1984)

THE “START” IN INDIA

INDIA from 1985 Introduction to Watershed Management Projects

PHASE 2 - WORLD BANK - 1987- 1994
Extending to other countries – Mainly Asia

FOCUS – AGRICULTURE SOIL AND WATER CONSERVATION

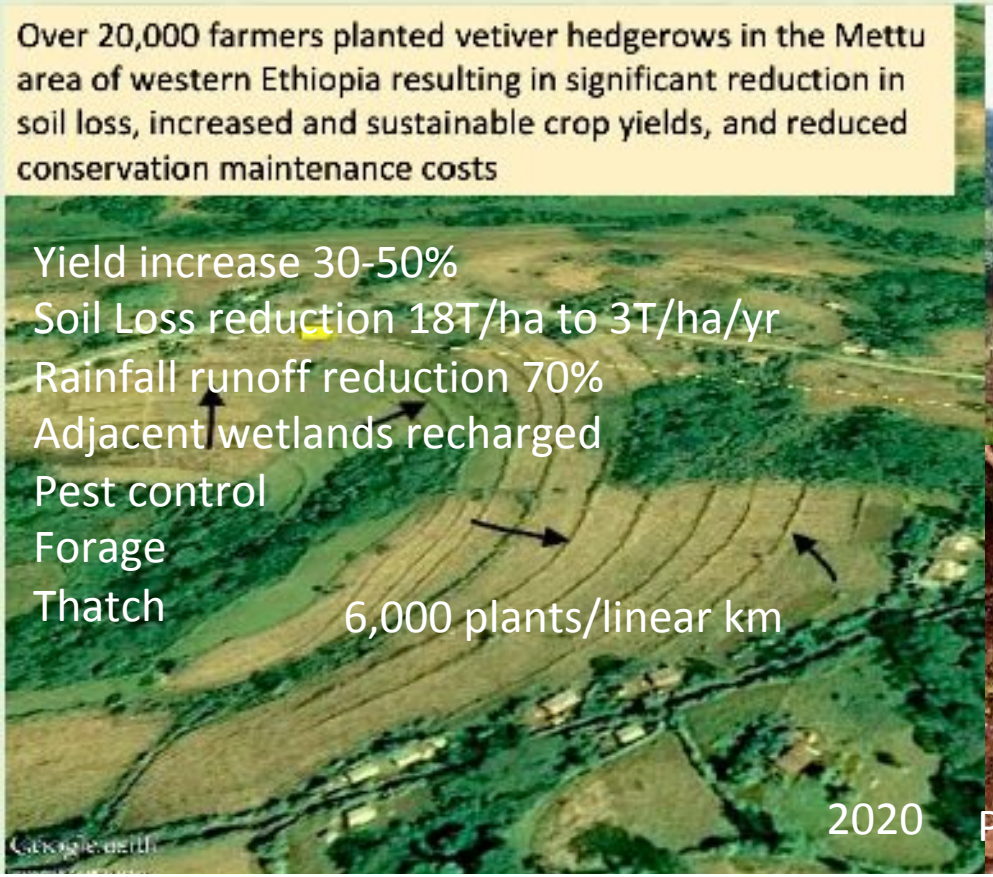
Driver = Asia Agricultural Technical Division (ASTAG)

- DISSEMINATION through mainly Bank projects and processes: **India** (*Greenfield*), **Malaysia** *(Yoon)*, **Thailand** *(King)*, **China** *(WB Red Soils Project/ China Academy of Science)*, **Australia** *(Truong, Queensland Department of Primary Industries)*, **Ethiopia** *(Smyle)*, **Bangladesh & Tanzania** *(DANIDA)*, **Venezuela** *(Rodriguez/Luque),* **Central America** *(WB/Smyle***) Philippines** (*WB/ Gunasekera*).
- Newsletter" & cash awards for R&D;
- Vetiver research continues and expands – India, Australia, Malaysia, Thailand China
- Greenfield's farmer handbook: "*Vetiver Grass A Hedge Against Erosion (1987)"*
- US National Research Council: scientific audit (Drs. Borlaug, Lal, & Popenoe) published "*Vetiver Grass – A Thin Green Line Against Erosion*" (1993).

AGRICULTURE - SOIL AND WATER CONSEVATION

ON FARM SOIL AND WATER CONSERVATION, **PLUS** FORAGE, PEST CONTROL, SOM, LAND REHABILITATION, REMOVAL OF AG CHEMICALS, CO2 SEQUESTERING

SLOPING LANDS



Debela Dinka

Some of these hedgerows were planted in 1990 – organized by an NGO with support of a $10,000 grant from the Vetiver Network. At least 30,000 ha protected. Expansion - Farmer to Farmer and continues.

FLAT LAND -- EROSION & FLOOD DAMAGE REDUCTION

SERIOUS AND DIFFICULT TO MITIGATE - VERTISOLS

VERTISOL – BLACK CRACKING SOIL > 1% SLOPE – HUGE SOIL LOSS UNDER EXTREME RAINFALL EVENTS

ECO RESTORATION
FIRST REDUCE RAINFALL LOSS - THEN PLANT THE TREES

“Red Desert” restoration − Guangdong Province, China

PHASE 3 - THE VETIVER NETWORK 1995-2000

NEW MAJOR APPLICATION – BIOENGINEERING FOR ENGINEERED SLOPES and EXTREME SITES

THE VETIVER NETWORK established as a non-profit (1995)

- $100K award from Monsanto & $400K DANIDA grant
- Established regional & country networks; small grants ($10,000) for vetiver initiatives, technical workshops & research
- Publishing "hard copy" newsletters
- International Vetiver Conferences supported by Chaipattana Foundation of Thailand,
- Regional & country conferences/workshops
- 1997 - Established web site

- Bio-engineering application *(Hengchoavanich),* spreads Malaysia/Thailand/China/Vietnam/Latin America/Africa/ Philippines (private sector companies)
- Research in many countries including: Australia, India, China, Thailand, Nigeria, Ethiopia, Vietnam
- DNA analysis (2000) confirms genetic family of non-invasive cultivars pre-dominant; DNA bar coding (2019) developed to allow certification of germplasm

King of Thailand
Queen Mother of Thailand

BIO-ENGINEERING - SOIL BASED STRUCTURE STABILIZATION

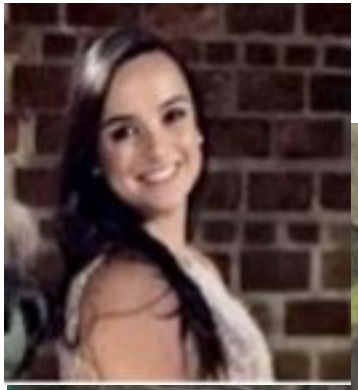
ROADS, RAILWAYS, BRIDGES, CANALS, DRAINS, GULLYS, RIVERS, BUILDING SITES

Urban gully rehab - community

Congo

Urban gully rehab - contracted

BRAZIL COASTAL PROTECTION



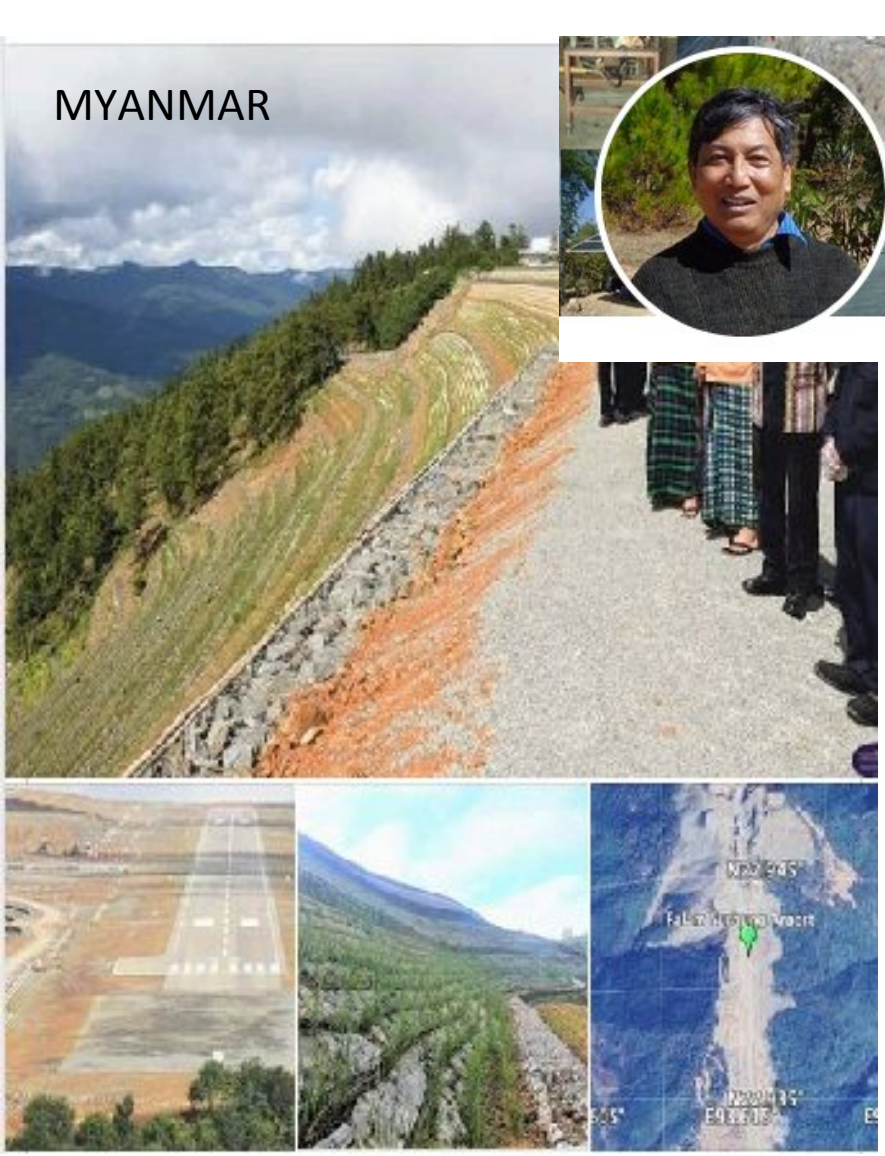
Paula Leão Pereira

Ho Chi Minh Highway (2,000 km) Vietnam

VETIVER NOT ONLY STABILIZES THE SLOPE BUT ACTS AS A PIONEER PLANT FOR NATIVE SPP

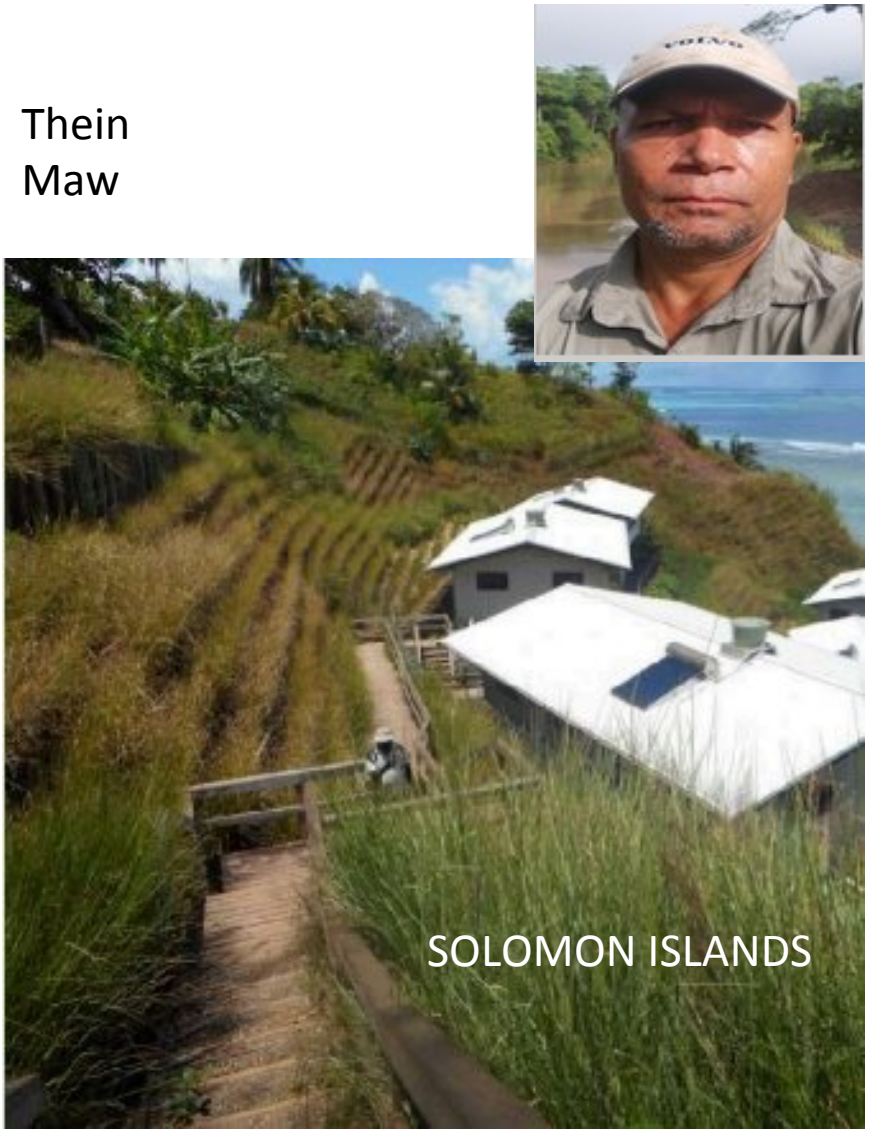
STEEP SLOPE STABILIZATION

Robinson Vanoh



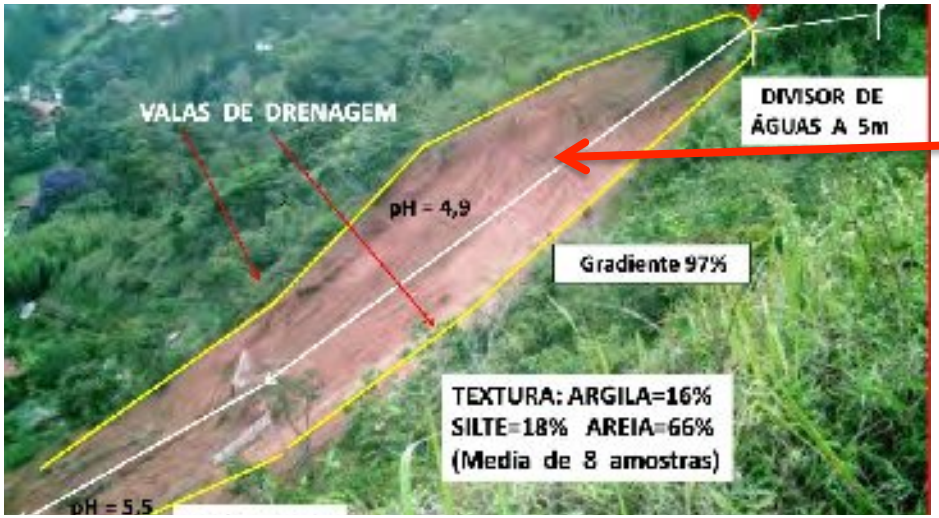
Stabilization of runway
3 m vetiver plants grown by small nurseries

Thein Maw



Building site protection
20,000 vetiver plants

LAND SLIDE REHABILTATION



Brazil - Before 2008 – After 2012 Paulo Rogerio

Madagascar - Extreme erosion and landslides Before and after vetiver application

PHASE 4 - GLOBAL EXPANSION - from 2000 -2020

NEW MAJOR APPLICATION -- PHYTOREMEDIATION

- Phytoremediation applications developed (Australian/Chinese/Thai/Ethiopia research)
- Computer modeling (Truong) for small scale treatment of polluted water
- Pest control applications – Maize stem borer (2012), rice stem borer (2018)
- Social applications like handicrafts, thatching, community eco-restoration

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- TVNI website becomes important, global knowledge hub (2020 - 600,000 visits, 1.8 million pages)
- Certification of competent VGT operators
- Vetiver Tracking app (2019) developed by Thais − now switching to iNaturalist -- bigger and better/easier platform

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- Increasing involvement of private sector on all continents: bioengineering, phytoremediation, disturbed land reclamation, plant production, poverty related programs − China - Indonesia.
- NGO involvement, social groups, land care groups, networks, and more
- TVNI facebook page (2015) encourages other users to create Internet presence (41 FB pages in 2021 w/ ~20,750 members), blogs, Whats app groups, webpages.
- **Ascendency of vetiver orientated social media groups**

PHYLOSOPHY --- **"LET 1000 FLOWERS BLOOM"**

PHYTO UTILIZATION – CONSUMING EFFLUENT – ELIMINATING DISPOSAL COSTS

Eric Wiediger

- VIDEO - LEACHATE

PHYTO REMEDIATION

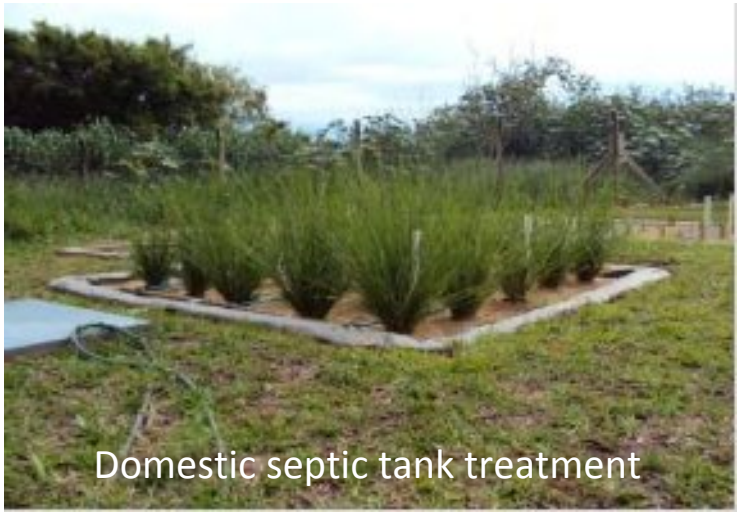
(REMOVAL OF N, P, HEAVY METALS, CHEMICALS)
WASTE WATER TREATMENT, SEWAGE TREATMENT, LANDFILL EFFLUENT TREATMENT, DECONTAMINATION OF SOIL (AGRIC CHEMICALS, MINING, INDUSTRIAL SITES)

Effluent quality before and after the vetiver treatment

Results	BOD mg/L	COD mg/L	Conductivity us/cm	pH	Suspend. solid mg/L	NH3 mg/L	Total N mg/L
Inlet	341	738	1550	8.0	515	71	96
Outlet	23	10	350	8.0	80	4.6	7.6

VETIVER VERSATILITY – MITIGATION OF CONTAMINATED WATER

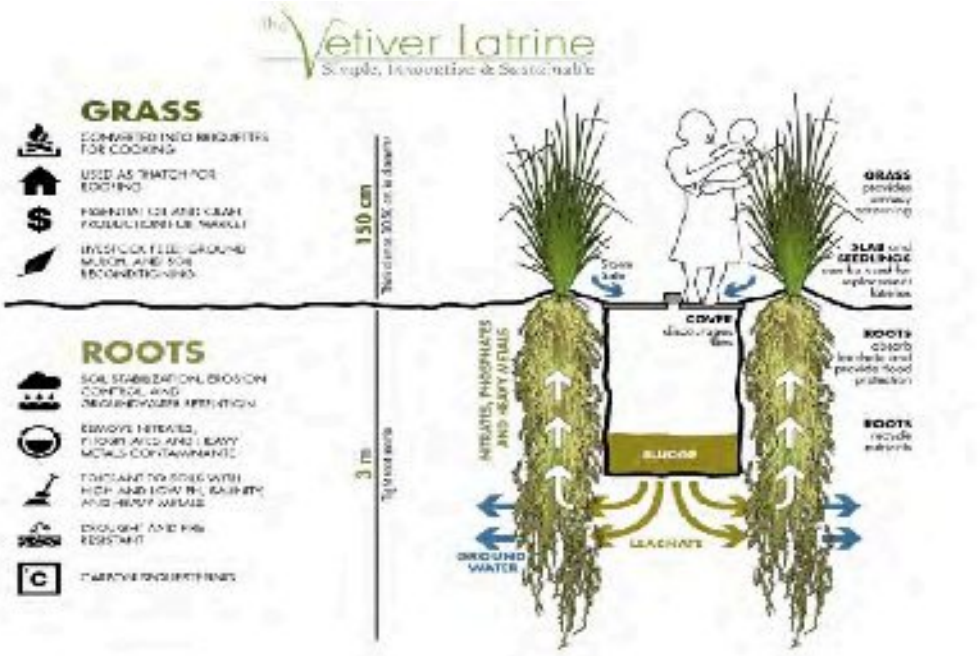
Banda Aceh Rehab – Indonesia - Domestic septic tank tertiary treatment



Piggery effluent lagoons in China and Vietnam using floating vetiver pontoons

Floating treatment of tertiary sewage effluent - China

VETIVER GRASS LATRINE



Oswaldo Luque

Ghana

Venezuela

China

Vetiver Handicrafts

VETIVER BUSINESS OPPORTUNITIES

- Plant material supply – low to med skills
- Contract applications and/or consulting services for:
  - ❑ environmental remediation contaminated soils/water – hi skills
  - ❑ infrastructure, slope, riverbank stabilization – med to hi skills
  - ❑ mine rehabilitation – med to hi skills
  - ❑ wastewater treatment – med to hi skills
  - ❑ disturbed land reclamation – low to med skills
- Quality thatching – low to med skills
- Handicrafts – low to medium (artisan) skills
- Aromatic oil production – low to med skills
- Biomass production & sales for forage/energy – low to med skills

China: hydro-electric scheme

VGT STATUS 2021

- **In VGT we have a multipurpose technology with cross sector application that is particularly suitable for rural communities with limited resources**
- Proven and cost-effective
- Acceptable to most users
- High potential tool for many global challenges:
  - Climate resilient infrastructure / Climate smart agriculture - water/ land infrastructure protection
  - Nature-based solutions: water security, water pollution, food security, human health, & disaster risk management
  - Soil health/regenerative agriculture
  - Remediation of contaminated water & soil
  - Carbon capture
  - Poverty reduction – sustainable productivity and health benefits
- Governments are starting to take notice of VGT as they align their policies with green solutions.
- Social media platforms offer a way to disseminate info at community level

Ethiopia – commercial farm

VIETNAM VETIVER FARMERS GROUP - Embedding vetiver into the farm system

Mulching black peppers

SWC and mulching coffee

Improved quality and output

Improved orchard tree and vegetable crop growth – soil nutrient (mycorrhizal) and moisture transfer, soil conservation, pest control

The Need and the Response

THE NEED

- For low cost and effective technologies with potential for rapid upscaling & autonomous adaptation by communities & the poor

THE RESPONSE

- VGT positioned for rapid upscaling:
  - Plant material widely available and easily propagated, in over 100 countries
  - Effective at micro and large scale
  - Acceptable to broad range of stakeholders (farmers, NGOs, communities, private entrepreneurs, govt. institutions)
  - Resource people available for support and training trainers and leaders of technical staff in all regions, and can be used as consultants to help design development projects.

Cambodia

Getting to Scale
Experience Gained & Lessons Learned

- **Social media effective** at reaching motivated end-users
- **Motivated end-users deepen innovation** & development, create positive feedback loops
- **Proof of concept** -- innovation & development do not require $$$$ or institutional investment…if innovation relatively simple and easy to grasp
- **Self-scaling amongst motivated** end-users…a demand response…but scaling slow & modest in scale – could be accelerated with better national policies.
- **Getting beyond "modest" requires institutional platforms** (local, national, international)
- Effective **backward learning linkages weak/missing**…how/from who do institutions learn?

If Such a Good Idea, How Come…

Ethiopia Case

- VGT for on-farm SWC **adopted widely** in Illubabor Province
- **Farmer preference** clear
- Ethiopian researchers' published findings demonstrate
  - **Vetiver performed as well/better** than "hard" systems, at ¼ the capital cost and $^{1}/_{10}$ recurrent cost
  - **Additional important benefits** that terraces do not provide…multiple benefits importance often not considered by designers/policy makers.
- Government aware but continued to support expensive structures
- World Bank & other aid agencies **continued to support/finance hard structures** at expense of farmer preference.

If Such a Good Idea, How Come…

VGT Timeline

- *Traditional Use / Colonial Ag Service*
- *World Bank & Soil & Moisture Conservation*
- *TVNI Analog & Early Digital*
- *TVNI Phase II Digital & Rise of Social Media*

Number of Technical Publications/References in Technical Publication by Thematic Area					
Source	Essential Oil	Agriculture Productivity	Socially Sound Development/ Environmental Management	Bioengineering/ Infrastructure	Climate Change / Natural Disasters
	Pre-1985				
Academic & Technical[1]	302	222	4	0	0
Int'l Research & Technical Assistance Agencies[2]	0	0	0	0	0
Multilateral Development Agencies[3]	0	0	0	0	0
	1985 to 1993				
Academic & Technical	105	255	36	80	41
Int'l Research & Technical Assistance Agencies	0	1	0	0	0
Multilateral Development Agencies	0	0	0	0	0
	1994 to 2003				
Academic & Technical	313	1,710	211	508	208
Int'l Research & Technical Assistance Agencies	16	98	5	1	0
Multilateral Development Agencies	0	7	4	2	0
	2004 to 2013				
Academic & Technical	1,120	4,860	1,800	1,620	985
Int'l Research & Technical Assistance Agencies	5	127	2	0	3
Multilateral Development Agencies	2	18	5	3	0
	2014 to 2021				
Academic & Technical	2,040	7,860	4,250	2,340	1,960
Int'l Research & Technical Assistance Agencies	4	76	3	0	3
Multilateral Development Agencies	2	4	7	6	4

If Such a Good Idea, How Come…

- Applications that can be "privately profitable" (e.g., bioengineering, phytoremediation) are doing fine…but >> potential where gov't policy/agency norms support soft alternatives & adopt design standards (e.g., Philippines)
- Applications that primarily deliver "public goods" are not doing fine…lack institutional platforms to mobilize

What Is The Objective?

- Resilient communities
- Sustainable livelihoods
- Climate smart agriculture
- Nature-based solutions
- Building Back Better
- Landscape scale management
- Sustainable land management
- Regenerative agriculture
- Sustainable agriculture
- Watershed management
- Natural disaster mitigation
- Climate change adaptation
- Climate resilient infrastructure
- Soil health
- Food security
- Empowering communities
- Environmental health
- …and more

How Do We Get There?

Better understanding & track record at:

- Macro- e.g., policy, strategy, regulation, markets, institutions, & other enabling conditions..
- Program/project-scales – e.g., planning, capacity building, value-chains, productive infrastructure, PPP, support systems, crop insurance, weather forecasting, governance, organization, social inclusion, IOT in production systems, clean food, business development services, better adapted varieties & production system, & many others.

How Do We Get There?

BUT…at community/household/resource manager-level?

- Agency perspective: **limited offering & capacity for outreach & innovation**…& too often "innovation" defined by sophisticated peer reviewers
- From end-user perspective – yes, **but hyper-local**
- Rainfed smallholders & their farming communities falling out of the market-based, poverty reduction agenda
- **Very few specific tools that communities self-manage & sustain w/o expensive, limited, supporting bureaucratic & technical infrastructure…**

How Do We Get There?

- Define “innovation” from perspective of end users
- Increase capacity for innovation by actively looking for & recognizing innovation when you see it
- Create backward linkages thru:
  - Intentional structured learning approaches that value “learning from the field”
  - Incentivize & reward effective bottom-up learning into institutional platforms (local => regional => national => international TA & finance)

How Do We Get There?

Study success:

In the past two years a series of very interesting **innovations** have been generated, tested, and put into practice by **Vietnamese** farmers…all self-motivated in result of **effective social media** interaction...demonstrating both how the pace of **innovation can be accelerated** & how that, in turn, can reach to & **spread to a global** (in this case, vetiver) community.

How can the existing institutional architecture – national & international – actually capitalize on local learning, experience, innovation? Is that even a question being asked?

RAPID UP-SCALING

- **Recognition -**Technology, its community & business opportunities
- **Policies -** Promote/support natural solutions (vs hard infrastructure) across sectors (ag/infra/water/env/ health)
- **Programs** -Systematic promotion/dissemination:
  - Training −Training of trainors, techs, communities (govt./NGO/ CBO/private sector)
  - Financial instruments (adaptation funds, climate smart credit, etc.), to local govt. & communities
  - Micro-hubs community groups with strong leader/moderator to promote the technology to meet local needs.
- **Positive and creative initiatives -** role of development agencies (e.g., WB)
- **INFORMATION − PUBLICATIONS − COMMUNICATIONS** and a lot of it!
- **Technical competence & quality control -** competent & experienced resource persons to support designs, & monitor/advise on program execution of programs.