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**

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

30 cm in 1 year

Hedge - cross section

Hedge - longitudinal section

“A LOOK-SEE AT VETIVER”

P.K.Yoon
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


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
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

Rural road protection – Solomon Islands

Alain Ndona

Urban gully rehab - community
Congo

Urban gully rehab - contracted

Before

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

Building site protection
20,000 vetiver plants

Stabilization of runway
3 m vetiver plants grown by small nurseries

MYANMAR

SOLOMON ISLANDS

Robinson Vanoh

Thein Maw
LAND SLIDE REHABILITATION

Brazil - Before 2008 – After 2012

Madagascar - Extreme erosion and landslides Before and after vetiver application
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

- 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

- 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

• 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)

Paul Truong

BOONAH SEWAGE TREATMENT

<table>
<thead>
<tr>
<th>Results</th>
<th>BOD (mg/L)</th>
<th>COD (mg/L)</th>
<th>Conductivity (µS/cm)</th>
<th>pH</th>
<th>Suspend. solid (mg/L)</th>
<th>NH3 (mg/L)</th>
<th>Total N (mg/L)</th>
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<tr>
<td>Inlet</td>
<td>341</td>
<td>738</td>
<td>1550</td>
<td>8.0</td>
<td>515</td>
<td>71</td>
<td>96</td>
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<tr>
<td>Outlet</td>
<td>23</td>
<td>10</td>
<td>350</td>
<td>8.0</td>
<td>80</td>
<td>4.6</td>
<td>7.6</td>
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</tbody>
</table>
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
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
Improved orchard tree and vegetable crop growth – soil nutrient (mycorrhizal) and moisture transfer, soil conservation, pest control

Mulching black peppers

SWC and mulching coffee

Improved quality and output

Vietnam Vetiver Farmers Group - Embedding vetiver into the farm system

Tho Ngo
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
  o Vetiver performed as well/better than “hard” systems, at ¼ the capital
    cost and 1/10 recurrent cost
  o 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.
## VGT Timeline

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

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### Number of Technical Publications/References in Technical Publication by Thematic Area

<table>
<thead>
<tr>
<th>Source</th>
<th>Essential Oil</th>
<th>Agriculture Productivity</th>
<th>Socially Sound Development/Environmental Management</th>
<th>Bioengineering/Infrastructure</th>
<th>Climate Change / Natural Disasters</th>
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<td>7</td>
<td>6</td>
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</tbody>
</table>
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:
  o Intentional structured learning approaches that value “learning from the field”
  o 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.