EMBEDDING VETIVER GRASS TECHNOLOGY INTO FARM SYSTEMS AT VARIOUS SCALES UNDER “TROPICAL” and “SEMI-ARID” CONDITIONS

Over 20,000 farmers planted vetiver hedgerows in the Mettu area of western Ethiopia resulting in significant reduction in soil loss, increased and sustainable crop yields, and reduced conservation maintenance costs.

Yield increase 30-50%
Soil Loss reduction 18T/ha to 3T/ha/yr
Rainfall runoff reduction 70%
Adjacent wetlands recharged
Pest control
Forage
Thatch

6,000 plants/linear km

Sloping land (30%)

2020

Perennial flow spring water

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.

DICK GRIMSHAW & JIM SMYLE -- TVNI

THE BEST SMALL FARM VETIVER SWC PROJECT THAT I KNOW OF.
WHY EMBED VETIVER??

#1 -- INCREASE SOIL MOISTURE

- REDUCE SOIL LOSS
- INCREASE SOIL ORGANIC MATTER
- IMPROVE SOIL HEALTH
- INCREASE NET FARM INCOME

GET IT RIGHT ON THE FARM -- THEN

DOWN STREAM --- ALL SPECIES (INCLUDING HUMANS) WILL BENEFIT FROM REDUCED SEDIMENT, REDUCED CHEMICALS, CLEANER AND MORE WATER
LOSS OF SOIL AND WATER ON SLOPING LANDS

A FARM THAT LOSES SOIL IS LOSING WATER!!

SOIL LOSS -- 20-100 TONS/ha/year

WATER LOSS EQUIV to ¼ ANNUAL RAIN

THESE STANDAD RUN OFF PLOTS DO NOT ALWAYS REFLECT WHAT HAPPENS AT LARGER SCALE UNDER EXTREME RAINFALL EVENTS

RILLING STARTS AT ABOUT 2M VI

AS VELOCITY INCREASES RILLS JOIN TO BECOME SMALL GULLIES

LESOTHO -- EROSION AGGRAVATED BY RUN OFF FROM GRADED CONTOUR TERRACES

SHEET, RILL & GULLY EROSION
EXTREME SOIL EROSION ON FARMS AND RAINFALL CAUSED BY COMMUNITY/PUBLIC INFRASTRUCTURE

OFTEN CAUSED BY RAINFALL RUNOFF FROM ADJACENT ROADS
LOSS OF SOIL AND RAINFALL OCCURS ON FLAT LANDS

<1% SLOPE – EXTREME EROSION AND SEDIMENT MOVEMENT FROM LEFT, DEPOSITED RIGHT OF RED LINE

SOME SAY THAT FLAT LAND DOES NOT NEED PROTECTION!!

TREE DOES NOT STOP EROSION

GULLY FORMATION ON FLAT VERTISOLS

RESULTING FLOOD WATER FROM FLAT LAND
Hard Engineered SWC Technologies

- Are expensive to construct
- Are expensive to maintain
- Often fail, especially in extreme rainfall events
- Take up space
- Divert precious rainfall off crop fields
- Create gullies due to lack of waterway area
- Have no add on benefits

Failed conventional unmaintained graded bunds

Graded terraces and small waterways can result in gullying

Failed conventional unmaintained graded bunds
VETIVER GRASS - SOFT – SMART SWC – A NATURE BASED SOLUTION

- LOW MAINTENANCE AND CONSTRUCTION COSTS
- RARELY EXHIBIT FAILURE
- MINIMUM SPACE REQUIREMENT
- DO NOT DIVERT RAINFALL RUNOFF
- HEAL GULLIES
- HAVE MANY ADD ON BENEFITS

ERODED SEDIMENT & WATER IS SPREAD EVENLY BEHIND HEDGEROW – RUNOFF VELOCITY REDUCED TO NEAR ZERO AT HEDGEROW

30 cm in one year

Hedge - cross section
CLIMATE SMART FARMING USING NATURE BASED SOLUTIONS

VETIVER GRASS TECHNOLOGY SIX BASIC MODES OF APPLICATION

1. AS A SWC SYSTEM FOR TOTAL FARM PROTECTION WITHIN WHICH OTHER CULTURAL/MANAGEMENT PRACTICES CAN BE APPLIED.

2. AS AN ADHOC HEDGE INSERTION TO EXISTING CROP MANAGEMENT PRACTICES FOR SWC

3. VETIVER PLANT(S) INSERTIONS IN VARIOUS CONFIGURATIONS TO ENHANCE CROP PERFORMANCE BASED ON A SPECIFIC VETIVER CHARACTERISTIC

4. BIOENGINEERING APPLICATIONS TO SUPPORT FARM INFRASTRUCTURE AND GENERAL ENHANCEMENT OF FARM ECOSYSTEM

5. MITIGATE NON CROP POLLUTION ASSOCIATED WITH FARM ACTIVITIES

6. SPECIFIC NON CROP RELATED VETIVER BUSINESS ACTIVITIES
1. A SWC SYSTEM FOR THE **TOTAL FARM PROTECTION** WITHIN WHICH OTHER CULTURAL/MANAGEMENT PRACTICES CAN BE APPLIED.

**A LONG LIVING * VETIVER HEDGE CAN:***

1. **REDUCE RAINFALL LOSSES** (RUNOFF REDUCTION UP TO 70%)
2. **SPREADS WATER RUNOFF** BEHIND THE HEDGE
3. **INCREASE SOIL MOISTURE** TO ENHANCE PLANT GROWTH AND IN TIMES OF **DROUGHT** INCREASES CROP TIME TO WILTING
4. **IMPROVE INFILTRATION** AT AND BETWEEN HEDGEROWS
5. **INCREASE GROUND WATER RECHARGE**, ENHANCE WATER TABLES AND REHABILITATE FARM RELATED WETLANDS
6. **REDUCE EROSION** AND SOIL (BY UP TO 90%).
7. **CREATE NATURAL TERRACES** > SLOPE DECREASES > EROSION DECREASES
8. **PROVIDE A PERMANENT KEY LINE** FOR CONTOUR CULTIVATION AND CROP MANAGEMENT PRACTICES
9. **REHABILITATE DEGRADED** FARM LAND
10. **UNDER EXTREME RAINFALL EVENTS** PERFORM **SIGNIFICANTLY BETTER THAN ALTERNATIVE TECHNOLOGIES**

*Minimum of 20 + years if maintained*
VGT APPLICATION – TOTAL FARM PROTECTION - SWC – SLOPING LANDS

SOUTH AFRICA

ETHIOPIA

ETHIOPIA

CUBA
VGT APPLICATION - TOTAL FARM PROTECTION - SWC – SLOPING LANDS – FLAT LANDS

BLACK CRACKING AND ERODIBLE VERTISOLS

Hedgerows 100 meters apart on flat land

AUSTRALIA

ZIMBABWE
FOR LARGE SCALE PLANTINGS – MECHANICAL DEVICES

Left: machine planting; below: machine digging of nursery propagated plants.

AUSTRALIA
2. AS AN **ADHOC HEDGE INSERTION** TO EXISTING CROP MANAGEMENT PRACTICES FOR SWC
ADHOC HEDGE INSERTION FOR FARM PROTECTION

VETIVER HEDGES CAN FIT ANYWHERE WITH NO NEGATIVE EFFECT DOWN SLOPE

MADAGASCAR

MALAWI

SOUTHAFRICA - DRAINAGE LINE PROTECTION

APRIL 12 2021

THE VETIVER NETWORK INTERNATIONAL
VGT -- ADHOC HEDGE INSERTION FOR FARM PROTECTION

INCREASES SOIL MOISTURE

CHINA – WIND BREAK

INDONESIA – REPLACES SLASH AND BURN

DROP AND CUT MULCH

MULCH

VEIETNAM VETIVER FARMERS GROUP

Tho Ngo

APRIL 12 2021

THE VETIVER NETWORK INTERNATIONAL
Dune invasion of banana plantation
(Les Niayes, Senegal)

Left: Before. Note condition of banana

Dune stabilized with one vetiver hedge.
MANY FARMS HAVE DEGRADED LAND – CAN BE REHABBED WITH VETIVER

LAND REHAB – BEFORE AND AFTER (ABOUT 6-8 years)

APRIL 12 2021
THE VETIVER NETWORK INTERNATIONAL
3. VETIVER PLANT(S) INSERTIONS IN VARIOUS CONFIGURATIONS TO ENHANCE CROP PERFORMANCE BASED ON A SPECIFIC VETIVER CHARACTERISTIC(S) AND FARM NEEDS

- MULCH: SOM – SOC - SOIL MOISTURE – SOIL TEMPERATURE
- SOIL NUTRIENT RECYCLING - - SOIL HEALTH – ARBUSCULAR MYCORRIZA
- IMPROVED SOIL MICRO FLORA/FAUNA
- SYMBIOTIC PLANTING WITH INDIVIDUAL PLANT
- HABITAT FOR BENEFICIAL INSECTS & FAUNA
- PEST CONTROL – STEM BORER RICE and MAIZE +++
- TOXIC CHEM REMOVAL - ARBUSCULAR MYCORRIZA - 90% STORED IN ROOTS
- BARRIER TO EXTERNAL TOXIC SOIL CHEMICALS ( ++ ORGANIC FARMING CERT?)
- ENHANCES BIODIVERSITY – PARTICULARLY IN “WINTER MONTHS” WHEN LAND IS BARE
- FORAGE
WITH AND WITH OUT VETIVER – NUTRIENT and MOISTURE ENHANCEMENT

A TAMARIND TREE

Below: Tree of the same age, without help from vetiver.

Above: One year old Tamarind, circled with vetiver (Chiang Rai Research Station, Thailand. Arbuscular mycorrhizal activity, associated with vetiver roots, results in better soil nutrient translocation at depth. The latter combined with improved soil moisture and more soil micro-fauna activity results in better tree growth.

Planted in association with vetiver:
• Arbuscular mycorrhiza cycles NPK
• Improved soil moisture
• Greater micro fauna activity
• Possible reduced pests (nematodes)
• Soil temperature reduction

with vetiver – planted at the same time as above – fruited two months earlier – improved soil moisture

without vetiver – no banana fruit

14 month with Vetiver

14 month without vetiver
IN-SITU MULCH – INCREASED: SOIL ORGANIC MATTER & SOIL MOISTURE.
- REDUCED: SOIL EROSION, SOIL TEMPERATURES, PEST DAMAGE


BENEFICIAL INSECTS LIKE PARASITOIDAL WASPS NEST IN VETIVER
DESTROY SAP SUCKING INSECTS
VGT – IMPROVED SOIL MOISTURE, PEST CONTROL

PAPAYA

SPAIN – GRAPE SPRING BUDDING - SYMBIOSIS

CUT AND DROP MULCH

PEPPER

VEGETABLES THAILAND
VETIVER CAN BE THE PRIMARY LAYER AND INITIAL “DRIVER” OF FOOD FORESTS

INSITU MULCH

VANYA FARMS INDIA

FOOD FOREST _ VETIVER CRITICAL ELEMENT

IMPROVED SOIL ORGANIC MATTER

THE VETIVER NETWORK INTERNATIONAL

VETIVER SYMBIOSIS

BIRD’S NEST

START OF A FOOD FOREST
VETIVER CAN CONTROL SOME PESTS

DEAD END TRAP CROP:
- STEM BORER OF MAIZE AND SORGHUM (*Chilo partellus*)
- STEM BORER OF RICE – Pink (*Sesamia inferens*) and Striped stem borer (*Chilo suppressalis*)
- STEM BORER OF SUGAR CANE?
  Anecodatal
- FALL ARMYWORM – attracts but not preferential over maize

HOSTS BENEFICIAL INSECTS:
- PARASITIC WASPS
- LADY BIRDS
- SPIDERS

OTHER PESTS
- VETIVER DETERS APPEARS TO DETER NEMATODES AND TERMITES
- WHITE FLY ON BRASSICAS

GENERAL OBSERVATION – CROPS / VEGETABLES IN THE VICINITY OF VETIVER NEARLY ALWAYS LOOK “CLEAN” DO NOT NEED A CONTINUOUS HEDGE (3x25 m)

APRIL 12 2021
Vetiver feed values compared to other forage grasses

<table>
<thead>
<tr>
<th>Analytes</th>
<th>Units</th>
<th>Vetiver grass</th>
<th></th>
<th>Rhodes</th>
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<th>Kikuyu</th>
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<tr>
<td></td>
<td></td>
<td>Young</td>
<td>Mature</td>
<td>Old</td>
<td>Mature</td>
<td>Mature</td>
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<tr>
<td>Energy (Ruminant)</td>
<td>kCal/kg</td>
<td>522</td>
<td>706</td>
<td>969</td>
<td>563</td>
<td>391</td>
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<tr>
<td>Digestibility</td>
<td>%</td>
<td>51</td>
<td>50</td>
<td>-</td>
<td>44</td>
<td>47</td>
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<tr>
<td>Protein</td>
<td>%</td>
<td>13.1</td>
<td>7.93</td>
<td>6.66</td>
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<tr>
<td>Fat</td>
<td>%</td>
<td>3.05</td>
<td>1.30</td>
<td>1.40</td>
<td>1.11</td>
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<tr>
<td>Calcium</td>
<td>%</td>
<td>0.33</td>
<td>0.24</td>
<td>0.31</td>
<td>0.35</td>
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<tr>
<td>Magnesium</td>
<td>%</td>
<td>0.19</td>
<td>0.13</td>
<td>0.16</td>
<td>0.13</td>
<td>0.19</td>
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<tr>
<td>Sodium</td>
<td>%</td>
<td>0.12</td>
<td>0.16</td>
<td>0.14</td>
<td>0.16</td>
<td>0.11</td>
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<tr>
<td>Potassium</td>
<td>%</td>
<td>1.51</td>
<td>1.36</td>
<td>1.48</td>
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<tr>
<td>Phosphorus</td>
<td>%</td>
<td>0.12</td>
<td>0.06</td>
<td>0.10</td>
<td>0.11</td>
<td>0.43</td>
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<tr>
<td>Iron</td>
<td>mg/kg</td>
<td>186</td>
<td>99</td>
<td>81.40</td>
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<td>Copper</td>
<td>mg/kg</td>
<td>16.5</td>
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<td>10.90</td>
<td>7.23</td>
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<tr>
<td>Manganese</td>
<td>mg/kg</td>
<td>637</td>
<td>532</td>
<td>348</td>
<td>326</td>
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<tr>
<td>Zinc</td>
<td>mg/kg</td>
<td>26.5</td>
<td>17.5</td>
<td>27.80</td>
<td>40.3</td>
<td>34.1</td>
</tr>
</tbody>
</table>

VETIVER AS FORAGE

NEEDS TO BE PROPERLY MANAGED THROUGH REGULAR CUTTING OR GRAZING

DROUGHT TOLERANT MAINTENANCE FODDER
STREAM BANK BUFFERS REDUCES POLLUTANTS MOVING DOWN STREAM

FARM/FIELD VETIVER BOUNDARY HEDGES ALSO STOPS POLLUTION FROM NEIGHBORS ENTERING LAND
VETIVER REMOVES **TOXIC AGRO CHEMICALS** FROM WATER MOVING OFF FARM FIELDS

EVERY VETIVER PLANT CAN TAKE UP EXCESS N&P, PESTICIDES, & HEAVY METALS

PLANTING VETIVER HEDGEROWS ON FIELD BOUNDARIES, DRAIN BANKS, AND STREAM BANKS, WILL HELP MAINTAIN “ORGANIC” CERTIFICATION

Above: Drain associated hedgerows are effective in trapping sediment. **Right:** reduction in herbicide concentration when drainage water passes through vetiver filter hedges.

**MULCHING WITH VETIVER IMPROVES SOIL ORGANIC MATTER AND SOIL HEALTH**
4 - BIOENGINEERING APPLICATIONS TO SUPPORT FARM INFRASTRUCTURE AND GENERAL ENHANCEMENT OF FARM ECOSYSTEM

- FARM PONDS
- BUILDING SITES
- DAM WALLS & SPILLWAYS
- ROAD SIDE
- GULLY REHAB
- CANAL BANKS
- RIVER BANKS
- DRAINS
5 - MITIGATE NON CROP POLLUTION ASSOCIATED WITH FARM/DOMESTIC ACTIVITIES

- **Phyto Transpiration Tertiary Latrine Effluent**
- **Pit Latrine, Stabilization, Leahate Treatment**
- **Above Ground Horizontal Grey Water Treatment**
- **Farm Trash Dump**
- **Farm Trash Dump After Vetiver Treatment**
- **Treatment of Piggery Waste Lagoon**

The Vetiver Network International
6 - SPECIFIC NON CROP RELATED VETIVER BUSINESS ACTIVITIES

• OFF FARM SALES OF VETIVER PLANTS
  BIOENGINEERING APPLICATIONS
• CONTRACTOR FOR OFF FARM APPLICATIONS
• VETIVER DESIGN CONSULTANT
• THATCH and THATCHING CONTRACTS
• FORAGE
• BIOMASS FOR ENERGY
• VETIVER OIL PRODUCTION AND SALES
• HANDICRAFTS FROM VETIVER LEAVES AND ROOTS

The Antahova family in the Mangarivotra Village proudly displayed their Vetiver nursery where they reached their target of 110,000 plants.
Getting the Message Out

- Community Driven
- Comprehensive Messaging About VS As A Whole
- Publications/Pamphlets/Social Media
- Training Of Trainers
- Training Of Farmers
- Key “Mother” Nursery (The Medium Is The Message)
Minimum Support Required

• Start up nurseries: Small localized household/community nurseries....central supply opportunity?
• Networks (e.g., WhatsApp-type that allow connection of “champions” with farmers)
• NGOs — to facilitate access to financing, link across communities, integrate into their ongoing NRM initiatives, support capacity development (TOT, training, F2F extension, learning visits, central nursery), organization at higher scales.
• Productive relationship with existing extension services....however good or bad they are
Minimum Support Required

- National platform (e.g., Sustainable Land Use Forum in Ethiopia) to provide support & linkages between institutions and policy makers and communities/end user support systems.
- Technical competency is a **must**. All technical or promotional staff must know what they are talking about.
- Involve Universities/Research Inst. to validate technology (esp., benefit/cost, impacts, systematize experiences, develop technical standards), fine tune & advance innovations developed by users.
- Supportive government policy – at minimum for “soft” solutions, then specifically for VGT in public procurement (requires standards to be fully integrated)
## Embedding VGT Across Scales

<table>
<thead>
<tr>
<th>Unit</th>
<th>Primary Stakeholders / Target Groups</th>
<th>VGT Objectives &amp; Focus</th>
</tr>
</thead>
</table>
| **Field**  
| Micro-watershed | Farmer (-s) | → Soil/water cons., nat. disaster mitigation, climate risk, productivity, mulch, pests, fodder; micro-nursery  
| |  | → Participatory planning; BMPs; site design; demonstration; people’s science |
| **Farm**  
| Micro-watershed | Farming Household (HH) | → All above + infra. protection, H₂O quality, sanitation, handicrafts  
| |  | → Same as above |
| **Farmer Group (FG)**  
| Micro-watershed | Farming HH | → Lead farmers & demonstrations  
| | Community-Based Organizations (CBO) | → Training (F2F)  
| | C/V Leaders | → Group nursery propagation plan |
| **Community / Village**  
| (C/V)  
| Micro-watershed or Sub-watershed | Farming HH | → Training of Trainers (TOT)  
| | CBO | → Community/Village nursery propagation strategy  
| | C/V Leaders | → Promote business opportunities  
| | M/D Tech Staff |  |
| **Municipality / District**  
| (M/D)  
| Sub-watershed or Watershed | Farmer & CBO | → Technical guides – manuals, pamphlets, etc. in local languages  
| | C/V Leaders | → Micro-hub – knowledge, networking, planting material, outreach, promotion  
| | M/D & R/P Tech Staff |  
| | Local Authorities |  
| | Micro-Credit Inst |  |
| **Region / Province (R/P)**  
| Watershed or Sub-basin | Farmer & CBO | → Social media (e.g., FB groups, INaturalist)  
| | C/V Reps | → Enabling/supportive policy (e.g., inclusion in public and NGO/ODA programs, eligible for incentive payments)  
| | M/D & R/P Tech Staff | → Organized field visits for target groups  
| | R/P Authorities | → Focal point (links micro-hubs, facilitates coordination between key stakeholders)  
| | Academics, Researchers, NGOs | → Workshops & training events; outreach & promotion  
| | Micro-Credit Inst | → Enabling/supportive policy (participate in policy formulation to incorporate VGT)  
| |  | → Organized field visits for national decision-makers & delegations from outside |

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**Country**  
River basin, multiple watersheds

| Farmer Orgs | NGOs | Nat’l Authorities | Univ. & Research Inst. | ODA |
Embedding VGT Under Tropical & Arid Conitions

→ Adaptability: 500 mm/yr upwards
→ Higher cost to propagate in lower rainfall (ETB 0.17 vs ETB 0.10 per seedling)
→ Drier conditions: Recommend containerized seedlings & closer spacing (8 cm) to get hedge closure in 1 year
→ Wetter conditions: Bare rooted, 4 tillers/slip at 10 cm spacing to get hedge closure in 1 year
→ Drier conditions demand good organization & timing...wetter, too, but more forgiving