A dense barrier of napier around the maize plot ; Spacing of napier plants should be 75 cm between rows and 50 cm between plants within a row. (ICIPE)

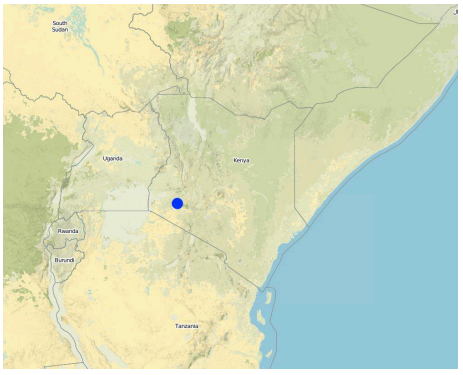
Push-Pull Integrated Pest and Soil Fertility Management (Kenya)

DESCRIPTION

"Push-Pull" is a technology to efficiently control pests and progressively improves soil fertility.

In the Lake Victoria region - like in many other parts of sub-Saharan Africa – stemborer pests, striga weeds and poor soil fertility are the main constraints to efficient production of cereals. In combination they often lead to complete crop failure. The "Push-Pull" technology efficiently controls the pests and progressively improves soil fertility. It involves intercropping maize with a repellent plant, such as desmodium ("push"); an attractant trap plant, such as napier grass (Pennisetum purpureum) is planted as a border crop around this intercrop ("pull"). The stemborer moths are attracted to volatile compounds emitted by the napier grass which at the same time serves as a haven for the borers' natural enemies. When moths lay eggs on napier grass a sticky substance secreted by the grass physically traps the moths' larvae. Napier is also an important carbohydrate-rich fodder grass. Desmodium, a perennial cover crop, produces repellent volatile chemicals that push away the moths, and the plant effectively suppresses striga weeds through its root exudates. Furthermore, desmodium fixes nitrogen, conserves soil moisture, enhances arthropod abundance and diversity and improves soil organic matter, thereby making cereal cropping systems more resilient and adaptable to climate change. Being a low-growing plant it does not interfere with the crops' growth. Push-pull simultaneously improves cereal productivity; enables production of year-round quality fodder - thereby allowing for integration with livestock husbandry; diversifies income streams and enables smallholders to enter into the cash economy. It also improves soil fertility; protects fragile soils from erosion and enables a minimum tillage system. The technology is appropriate to resource-poor smallholder farmers as it is based on locally available plants, affordable external inputs, and fits well with traditional mixed cropping systems practiced in SSA.

LOCATION



Location: Lake Victoria region, Kenya

No. of Technology sites analysed:

Geo-reference of selected sites
- 35.34, -0.64

Spread of the Technology:

In a permanently protected area?:

Date of implementation: 10-50 years ago

Type of introduction
- [ ] through land users' innovation
- [ ] as part of a traditional system (> 50 years)
- [x] during experiments/ research
- [ ] through projects/ external interventions

Desmodium is drilled in between maize rows at 75 cm row to row distance (ICIPE)

Overview of a push-pull plot (maximum size: 50 m x 50 m) (ICIPE)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [ ] improve production
- [ ] reduce, prevent, restore land degradation
- [ ] conserve ecosystem
- [ ] protect a watershed/ downstream areas – in combination with other Technologies
- [ ] preserve/ improve biodiversity
- [ ] reduce risk of disasters
- [x] adapt to climate change/ extremes and its impacts
- [ ] mitigate climate change and its impacts
- [x] create beneficial economic impact
- [ ] create beneficial social impact

Land use

Cropland

- Annual cropping: fodder crops - grasses, cereals - maize
- Perennial (non-woody) cropping: medicinal, aromatic, pesticidal plants - perennial

Is intercropping practiced? Yes

Water supply

- [x] rainfed
- [ ] mixed rainfed-irrigated
- [ ] full irrigation

Purpose related to land degradation

- [x] prevent land degradation
- [x] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [ ] adapt to land degradation
- [ ] not applicable

Degradation addressed

chemical soil deterioration - Cn: fertility decline and reduced organic matter content (not caused by erosion)

biological degradation - Bh: loss of habitats, Bp: increase of pests/ diseases, loss of predators

SLM group

- integrated soil fertility management
- improved plant varieties/ animal breeds

SLM measures

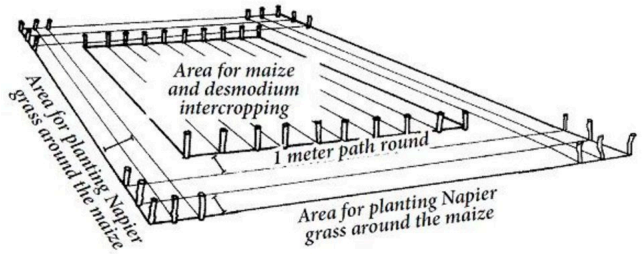
agronomic measures - A1: Vegetation/ soil cover

vegetative measures - V2: Grasses and perennial herbaceous plants

TECHNICAL DRAWING

Technical specifications

Layout of push-pull plot with1 m spacing between napier border and maize field



Author: ICIPE

Technical knowledge required for field staff / advisors: moderate

Technical knowledge required for land users: low

Main technical functions: increase in organic matter, increase in nutrient availability (supply, recycling,...), promotion of vegetation species and varieties (quality, eg palatable fodder), pest control

Mixed cropping / intercropping
Material/ species: Desmodium as a perennial intercrop
Remarks: Desmodium is drilled in between maize rows at 75 cm row to row distance

Contour planting / strip cropping
Material/ species: napier grass (Pennisetum purpureum)
Remarks: Spacing of napier plants should be 75 cm between rows and 50 cm between plants within a row

Aligned: -along boundary
Vegetative material: G : grass
Spacing between rows / strips / blocks (m): 75.00
Vertical interval within rows / strips / blocks (m): 50.00

Aligned: -linear
Vegetative material: C : perennial crops
Spacing between rows / strips / blocks (m): 75.00

Perennial crops species: Desmodium

Grass species: Napier grass (Pennisetum purpureum)

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated:
- Currency used for cost calculation: **USD**
- Exchange rate (to USD): 1 USD = n.a
- Average wage cost of hired labour per day: 1.2

Most important factors affecting the costs

Input prices (in US$): 1 Person-day = 1.2 US$. 1 napier root split / cane = 0.14 US$.; 1 kg desmodium seeds = 18.9 US$.; 1 kg superphosphate fertilizer = 0.68US$

Establishment activities

1. Plant 3 consecutive rows of napier grass (Bana variety) around the plot: make planting holes, apply fertilizer (or manure), place 3-node canes or root splits, cover with soil (before rains) (Timing/ frequency: None)
2. Land preparation for desmodium: plough and harrow the land (to get fine soil), make furrows between the rows where the maize will be planted (using strong pointed stick; before rains) (Timing/ frequency: None)
3. Mix desmodium seed with super phosphate fertilizer (ratio 1:2), or alternatively with fine soil. Sow into the furrows and cover with soil (onset of rains) (Timing/ frequency: None)
4. Plant maize./ Weeding of maize, desmodium and Napier grass (Timing/ frequency: 3 and 5-6 weeks after planting maize)
5. Manage napier grass: 1st harvest after 3 months (plants are 1-1,5 m high), leave stem height of 10 cm for quick regrow, start with inner row (Timing/ frequency: 1st harvest after 3 months)

Establishment inputs and costs

Specify input	Unit	Quantity	Costs per Unit (USD)	Total costs per input (USD)	% of costs borne by land users
Labour					
Plant 3 consecutive rows of napier grass	Persons/day	8.0	1.25	10.0	
Plant material					
Napier	pieces	1200.0	0.1666666	200.0	
Desmodium seeds	kg	0.5	18.9	9.45	
Fertilizers and biocides					
Fertilizer	kg	47.0	0.6808	32.0	
Total costs for establishment of the Technology				**251.45**	
Total costs for establishment of the Technology in USD				*251.45*	

Maintenance activities

1. Land preparation for maize: carefully dig/plough between desmodium lines not to disturb / uproot the desmodium (it is a perennial crop!) (Timing/ frequency: None)
2. Plant maize (Timing/ frequency: None)
3. Trim the desmodium so that it does not overgrow in between the maize plants (Timing/ frequency: after 3 and 6 weeks)
4. Repeat activities 5.-7. listed under establishment (Timing/ frequency: None)

Maintenance inputs and costs

Specify input	Unit	Quantity	Costs per Unit (USD)	Total costs per input (USD)	% of costs borne by land users
Labour					
Land preparation for maize	Persons/day	6.0	1.166666	7.0	100.0
Fertilizers and biocides					
Fertilizer for maiz	kg	47.0	0.6808	32.0	100.0
Total costs for maintenance of the Technology				**39.0**	
Total costs for maintenance of the Technology in USD				*39.0*	

NATURAL ENVIRONMENT

Average annual rainfall
- [ ] < 250 mm
- [ ] 251-500 mm
- [ ] 501-750 mm
- [x] 751-1,000 mm
- [ ] 1,001-1,500 mm
- [ ] 1,501-2,000 mm
- [ ] 2,001-3,000 mm
- [ ] 3,001-4,000 mm
- [ ] > 4,000 mm

Agro-climatic zone
- [ ] humid
- [x] sub-humid
- [ ] semi-arid
- [ ] arid

Specifications on climate
Thermal climate class: tropics

Mainly sub-humid; bi-modal rainfall pattern, with main rainy season March-May; short rainy season Oct.-Nov.

Slope
- [ ] flat (0-2%)
- [x] gentle (3-5%)
- [x] moderate (6-10%)
- [ ] rolling (11-15%)
- [ ] hilly (16-30%)
- [ ] steep (31-60%)
- [ ] very steep (>60%)

Landforms
- [ ] plateau/plains
- [ ] ridges
- [ ] mountain slopes
- [ ] hill slopes
- [x] footslopes
- [x] valley floors

Altitude
- [ ] 0-100 m a.s.l.
- [ ] 101-500 m a.s.l.
- [ ] 501-1,000 m a.s.l.
- [x] 1,001-1,500 m a.s.l.
- [ ] 1,501-2,000 m a.s.l.
- [ ] 2,001-2,500 m a.s.l.
- [ ] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

Technology is applied in
- [ ] convex situations
- [ ] concave situations
- [ ] not relevant

Soil depth
- [ ] very shallow (0-20 cm)
- [x] shallow (21-50 cm)
- [x] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [ ] coarse/ light (sandy)
- [x] medium (loamy, silty)
- [x] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [ ] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Topsoil organic matter content
- [ ] high (>3%)
- [ ] medium (1-3%)
- [x] low (<1%)

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [ ] 5-50 m
- [ ] > 50 m

Availability of surface water
- [ ] excess
- [ ] good
- [ ] medium
- [ ] poor/ none

Water quality (untreated)
- [ ] good drinking water
- [ ] poor drinking water (treatment required)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Is salinity a problem?
- [ ] Yes
- [ ] No

Occurrence of flooding
- [ ] Yes
- [ ] No

Species diversity
- [ ] high
- [ ] medium
- [ ] low

Habitat diversity
- [ ] high
- [ ] medium
- [ ] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [x] subsistence (self-supply)
- [x] mixed (subsistence/ commercial)
- [ ] commercial/ market

Off-farm income
- [ ] less than 10% of all income
- [ ] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [x] very poor
- [x] poor
- [ ] average
- [ ] rich
- [ ] very rich

Level of mechanization
- [x] manual work
- [x] animal traction
- [ ] mechanized/ motorized

Sedentary or nomadic
- [ ] Sedentary
- [ ] Semi-nomadic
- [ ] Nomadic

Individuals or groups
- [x] individual/ household
- [ ] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [ ] women
- [ ] men

Age
- [ ] children
- [ ] youth
- [ ] middle-aged
- [ ] elderly

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [x] 1-2 ha

Scale
- [x] small-scale
- [ ] medium-scale
- [ ] large-scale

Land ownership
- [ ] state
- [ ] company
- [x] communal/ village

Land use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased

- 2-5 ha
- 5-15 ha
- 15-50 ha
- 50-100 ha
- 100-500 ha
- 500-1,000 ha
- 1,000-10,000 ha
- > 10,000 ha

- group
- ✓ individual, not titled
- individual, titled

- individual

Water use rights

- open access (unorganized)
- communal (organized)
- leased
- individual

Access to services and infrastructure

IMPACTS

Socio-economic impacts

Crop production

decreased — ✓ — increased

Maize yields increase by 25-50% where stemborer is the only problem and by 300% in areas affected by stemborer and striga weed

fodder production

decreased — ✓ — increased

All-year round quality fodder for cattle (napier grass and desmodium)

expenses on agricultural inputs

increased — ✓ — decreased

Reduced fertilizer inputs thanks to nitrogen-fixing by desmodium

farm income

decreased — ✓ — increased

Selling cereal grains, desmodium seed, napier grass (if not fed to own livestock), and milk

workload

increased — ✓ — decreased

Weeding is minimized

Socio-cultural impacts

Social capital generated through common learning and implementing agricultural “best practices”

reduced — ✓ — improved

Ecological impacts

soil moisture

decreased — ✓ — increased

Cover crop, live mulch

soil cover

reduced — ✓ — improved

Cover crop, live mulch

soil loss

increased — ✓ — decreased

Soil protected from erosion through desmodium (cover crop) and napier grass (barrier)

nutrient cycling/ recharge

decreased — ✓ — increased

soil organic matter/ below ground C

decreased — ✓ — increased

wind velocity

increased — ✓ — decreased

Reduced wind impacts due to napier barriers

Off-site impacts

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns: very negative — ✓ — very positive

Long-term returns: very negative — ✓ — very positive

Benefits compared with maintenance costs

Short-term returns: very negative — ✓ — very positive

Long-term returns: very negative — ✓ — very positive

CLIMATE CHANGE

-

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- single cases/ experimental
- 1-10%

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- ✓ 0-10%
- 11-50%

- 11-50%
- > 50%
- 51-90%
- 91-100%

Has the Technology been modified recently to adapt to changing conditions?

- Yes
- No

To which changing conditions?

- climatic change/ extremes
- changing markets
- labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

Strengths: compiler's or other key resource person's view

- Improves cereal productivity
- Enables production of year-round quality fodder - thereby allowing for integration with livestock husbandry
- Diversifies income streams and enables smallholders to enter into the cash economy
- Improves soil fertility; protects fragile soils from erosion and enables a minimum tillage system
- The technology is appropriate to resource-poor smallholder farmers as it is based on locally available plants, affordable external inputs, and fits well with traditional mixed cropping systems practiced in SSA.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- Napier grass is an aggressive plant that spreads through rhizomes under the ground regular control and weeding.
- The older napier stems and leaves are less palatable for livestock regularly cut young, tender leaves and stems.
- Minor adjustment of the smallholder farming system to introduce desmodium in traditional maize-bean intercrops desmodium (fodder crop) and beans (food crop, important protein source) can both be intercropped with maize. In areas where striga weed is not a problem, farmers can plant desmodium after every 3 or 5 rows of maize, and use the other rows for beans. Stemborers will still be repelled

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

REFERENCES

Compiler
Unknown User

Editors

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Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_958/

Linked SLM data
n.a.

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- Biovision Foundation (Biovision Foundation) - Switzerland
- International Centre of Insect Physiology & Ecology (ICIPE) - Kenya

Project
- n.a.

Key references

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Links to relevant information which is available online

- None: None
- None: None