Sustainable Land Management (SLM)

A compilation of SLM technologies and approaches in Kenya

2024

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WOCAT World Overview of Conservation Approaches and Technologies

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List of acronyms

BMZ	Federal Ministry for Economic Cooperation and Development, Germany
CDE	Centre for Development and Environment
CIAT	International Centre for Tropical Agriculture
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
ProSoil	Global Programme "Soil Protection and Rehabilitation for Food Security"
SLM	Sustainable Land Management
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
WOCAT	World Overview of Conservation Approaches and Technologies

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Definitions

Sustainable land management (SLM) is the use of land resources, including soils, water, animals, and plants, to produce goods to meet changing human needs while ensuring the long-term productive potential of these resources and the maintenance of their environmental functions.

An SLM technology refers to a physical practice on the land that controls land degradation and enhances productivity and/or other ecosystem services. It consists of one or more measures, such as agronomic, vegetative, structure, and management measures.

An SLM approach defines the ways and means to implement one or more SLM technologies. It includes technical and material support as well as the involvement and roles of different stakeholders. It can refer to a project/programme or activities initiated by land users.

Source: WOCAT[1]

[1] WOCAT, "Glossary," https://www.wocat.net/en/glossary/.

Acknowledgments

We wish to acknowledge the invaluable contributions of all the farmers who are implementing sustainable land management (SLM) technologies and approaches, spreading knowledge of SLM, contributing to sustainable soil use and the rehabilitation of degraded soils.

The Alliance of Bioversity International and the International Center for Tropical Agriculture (CIAT), as a Consortium Partner of the World Overview of Conservation Approaches and Technologies (WOCAT), led this compilation and data collection. This data derives from the soil rehabilitation technologies and approaches implemented by the Global Programme "Soil Protection and Rehabilitation for Food Security" (ProSoil), implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. ProSoil is part of the special "Transformation of Agricultural and Food Systems" initiative commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ). It is co-funded by the European Union and the Bill & Melinda Gates Foundation.

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Tabitha Nekesa developed this compilation under the technical leadership of Stephanie Jaquet. Maps were created by Zhanguo Bai from the International Soil Reference and Information Centre (ISRIC) and Beatrice Wanjiku from the Alliance of Bioversity International and CIAT; special thanks go to Sherry Adisa for her excellent infographics and layout.

About

Germany's Federal Ministry for Economic Cooperation and Development (BMZ) has significantly invested in sustainable land and soil management (hereafter, SLM) and climate change adaptation efforts, exploring co-benefits with carbon sequestration in Africa and India. The Global Programme "Soil Protection and Rehabilitation for Food Security" (ProSoil) is part of BMZ's special initiative "Transformation of Agricultural and Food Systems", implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, and a Consortium Partner of the World Overview of Conservation Approaches and Technologies (WOCAT). ProSoil supports smallholder farmers in Benin, Burkina Faso, Ethiopia, India, Kenya, Madagascar and Tunisia through training and capacity building in sustainable land management (SLM). The programme promotes the adoption of climate-smart, agroecological practices in its partner countries to protect land from erosion and restore and maintain soil fertility. ProSoil collaborates with local governments, and public and private sectors in the advancement of sustainable food and agricultural systems. The European Union (EU) is co-funding the programme's work in the field of agroecology in Kenya, Ethiopia, Madagascar and Benin. Another co-funder is the Bill & Melinda Gates Foundation.

The World Overview of Conservation Approaches and Technologies (WOCAT – www.wocat.net) is a global network on SLM that promotes documenting, sharing, and using knowledge to support adaptation, innovation, and decision-making in SLM. WOCAT supports governments and their development partners in effectively using knowledge management and decision-support tools and processes to prevent and reduce land degradation and restore degraded land. Following this, WOCAT and its partners developed standardised questionnaires for assessing and documenting SLM practices. Such practices include both approaches and technologies. Questionnaire data are included in the Global SLM Database, the primary recommended database by the United Nations Convention to Combat Desertification (UNCCD) for reporting on SLM best practices.

The Alliance of Bioversity International and CIAT provide research-based solutions to global challenges of climate change, biodiversity loss, environmental degradation, and malnutrition. The organisation, a steering committee member of the WOCAT network, supported WOCAT's work on documentation, sharing, mainstreaming, and scaling out SLM practices in ProSoil partner countries.

Foreword

Kenya, rich in biodiversity and agricultural significance, faces significant challenges due to land degradation, impacting soil health, productivity, community livelihoods, and food security. Agriculture, a vital sector contributing significantly to Kenya's economy, faces the dual challenge of meeting growing food demands while mitigating land degradation. With Kenya's population projected to reach 63.9 million by 2030, the need for increased agricultural productivity and stringent environmental conservation measures is imperative.

With its diverse agricultural landscapes and dynamic farming communities, Western Kenya lies at the heart of the ProSoil initiative. We recognise that our collective journey toward sustainable land management (SLM) is ongoing and that knowledge is a powerful catalyst for change. We aim to empower local farmers, extension workers, and decision-makers with practical insights to enhance agricultural sustainability and resilience by documenting and sharing various soil management technologies within these pages.

The Alliance of Bioversity International and CIAT lead the documentation of eleven SLM practices in Western Kenya, publishing data on these practices on the World Overview of Conservation Approaches and Technologies (WOCAT) global database to promote their adoption. The Ministry of Agriculture, Livestock, Fisheries, and Cooperatives (MoALFC) remains committed to promoting sustainable agricultural development with its development partners. We anticipate that the insights, experiences, and technologies shared herein will support ProSoil's success and inspire future initiatives and collaborations in the broader field of sustainable agriculture.

We extend our gratitude to GIZ, MoALFC, WOCAT, GFA, WHH, and the local community, all of whom contributed to successfully promoting soil protection and rehabilitation through the wealth of Indigenous knowledge and innovative SLM technologies. This document aims to guide us toward a future of sustainable soil and land management practices that contribute to community prosperity and the planet's health.

This document captures the stories, challenges, and triumphs of farmers in Bungoma, Kakamega, and Siaya counties, showcasing the resilience and adaptability of communities amid changing climates and agricultural landscapes. This blend of local wisdom and innovation highlights the local community's commitment to embracing sustainable and climate-smart approaches to soil and land management.

This compilation is Western Kenya's contribution to a worldwide problem; it is a living resource that Bungoma, Siaya, and Kakamega counties can use for years. It provides guidance for implementing successful SLM practices, facilitating informed decision-making, and fostering continuous learning and improvement.

May this document be a testament to the resilience and innovation embedded in Western Kenya's agricultural landscape, inspiring positive change and sustainable practices for future generations.

David Kersting
Project Manager
ProSoil Kenya

Context

Land degradation is the reduction or loss of land's productive capacity, from socio-economic to environmental functions, due to anthropogenic or biophysical drivers. Arid and semi-arid lands (ASALs) in Kenya occupy more than 80 per cent of the land, increasing vulnerability to land degradation. About 30–40 per cent of Kenya's ASALs are being eroded quickly, and 2 per cent have completely been eroded (Mganga et al., 2015). As the ASALs, the remaining humid and sub-humid lands (<20 per cent) are subject to land degradation due to unsustainable land use and natural factors. Human activities have degraded 12 per cent of Kenyan land, occupied by about 27 per cent of the country's population (Kizito et al., 2018). Climate change and variability exacerbate land degradation, while land degradation contributes to climate change.

Unsustainable land use practices	Forms of land degradation
• Overcultivation	• Soil erosion
• Overgrazing	• Soil fertility depletion
• Deforestation	• Soil acidification
• Natural vegetation removal	• Soil salinisation
• Excessive logging for timber and charcoal	

Figure 1: Land degradation summary in Kenya

Kenya's economy heavily relies on rainfed agriculture, natural resources, and tourism, making land degradation a threat to national-level economic growth and the well-being of its people. This degradation impacts food security and the livelihoods of communities. Siaya, Bungoma, and Kakamega counties mainly depend on agriculture for socio-economic development; however, they are characterised by high poverty levels and food insecurity. Linked to these issues are land degradation from unsustainable agricultural practices and land conversion to agricultural production. The following is a summary of the highly degraded areas of the counties, from Kizito et al. (2018):

Northeastern parts of Siaya County	Southern parts of Bungoma County	Southern, Central and Northwestern parts of Kakamega County
15 per cent of land is degraded	10 per cent of land is degraded	40 per cent of the land is degraded
20 per cent of the land is inhabited by humans and livestock	10 per cent of the land is inhabited by humans and livestock	50 per cent of the land is inhabited by humans and livestock

Figure 2: Summary of highly degraded areas of Siaya, Bungoma and Kakamega Counties

Adopting SLM practices in the counties and nationally will address land degradation. The SLM practices halt, reverse, or reduce land degradation, contributing to enhanced land productivity. Ripple effects include enhanced biodiversity, soil and water quality, food security, climate resilience, and economic growth.

Methodology

The WOCAT documentation process was carried out in four main stages:

1. **Selection of practices for documentation.** ProSoil Kenya has disseminated SLM practices across the Siaya, Bungoma and Kakamege counties. The 11 practices for documentation were selected based on their presence or absence in the WOCAT SLM database. The criteria considered whether the practice:
   - Responds to the country's priorities defined by the UNCCD PRAIS 4 report
   - Holds status as a priority for the government, GIZ, and ProSoil partners
   - Demonstrates adoption by farmers without external support
2. **Training on the questionnaire and validation of the practices to be documented.** A 3-day training course on WOCAT documentation organised by the Alliance-CIAT, the Centre for Development and Environment (CDE) of the University of Bern, Switzerland, in collaboration with the ProSoil by GIZ, was conducted in Kisumu. The workshop involved training on the WOCAT documentation framework and linkage to UNCCD best practices, training on the use of WOCAT questionnaires and database, and the selection of SLM practices implemented by ProSoil-Kenya and its partners for potential documentation on the WOCAT database.
3. **Data collection and addition to WOCAT's online Global SLM Database.** Data collection on SLM technologies and approaches was conducted through field visits in ProSoil implementation areas using WOCAT questionnaires. This task was carried out by a consultant in collaboration with the ProSoil team, SLM specialists, and farmers, with support from the Alliance-CIAT. The WOCAT questionnaire covers several modules, including general information on the SLM technology or approach, descriptions and classifications of SLM practices, technical specifications and implementation activities, inputs and costs, and the natural and human environment. Documentation of impacts, concluding statements, and references with accompanying links are included.
4. **Reviewing and publishing of SLM technologies and approaches.** ProSoil and the Alliance-CIAT teams undertook an initial review of the questionnaires. Technical editors, compilers, and the WOCAT secretariat conducted the final review for data completeness. After approval, the SLM technologies and approaches were published in WOCAT's global database.

SLM technology/approach documentation process

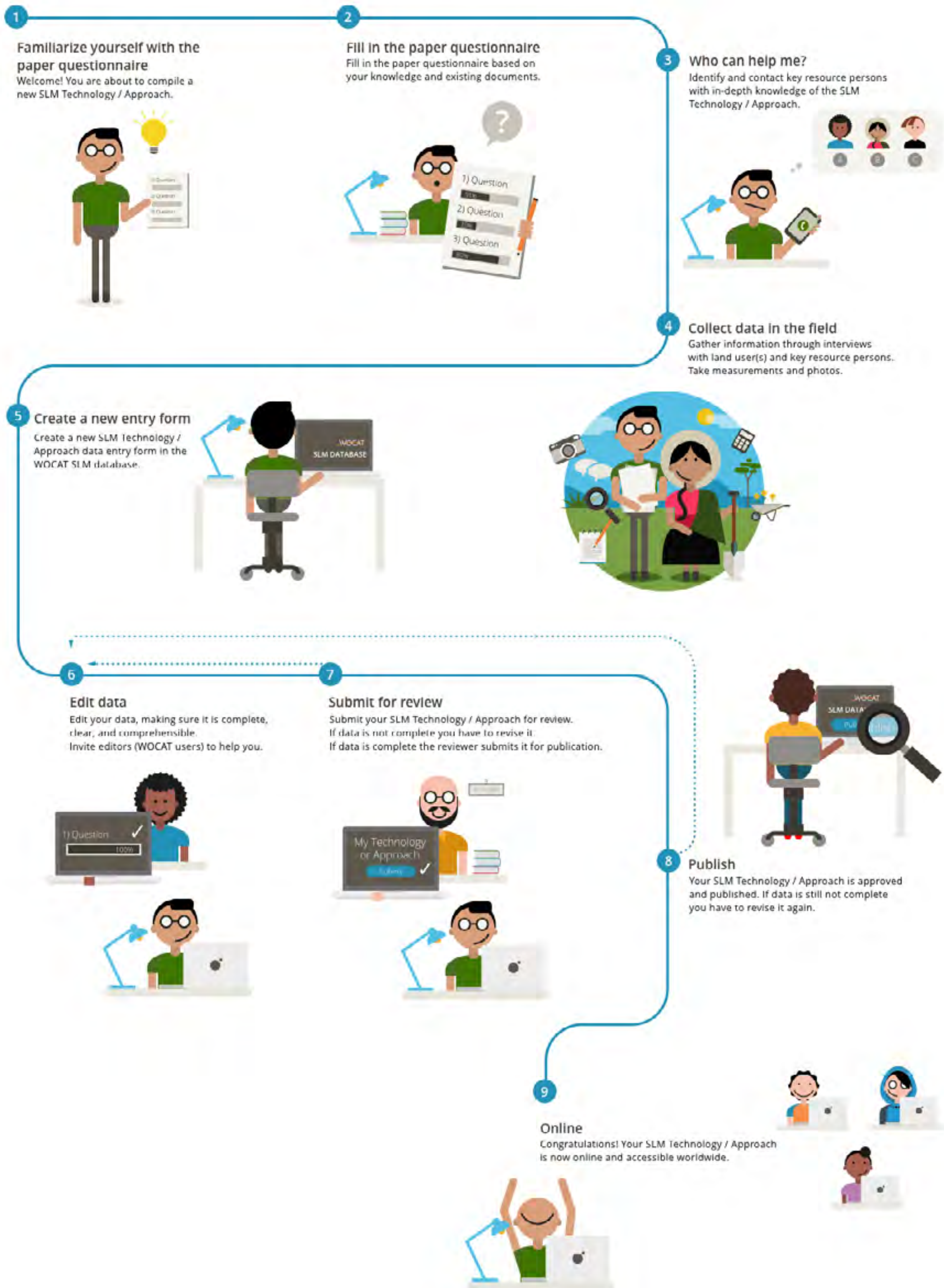


Figure 3: Steps of the WOCAT documentation process

Categories of SLM practices

Out of twelve selected SLM practices, eleven were published in the WOCAT database:

Soil fertility management

- SLM technology: Lime application to acid soils
- SLM technology: Compost for organic waste management and improved crop yields
- SLM technology: Vermicomposting - an effective liquid fertilizer and biopesticide

Agricultural and agroforestry practices and techniques

- SLM approach: Promotion of different trees for agroforestry
- SLM approach: Improving farmers' access to tools for conservation agriculture
- SLM technology: Push-pull pest control

Water and soil management and infrastructure

- SLM technology: Permanent soil cover
- SLM technology: Vegetative cross-slope barriers
- SLM technology: Retention ditches for soil and water conservation

Farmer research and extension

- SLM approach: Mucuna value-addition for female farmers
- SLM approach: Community resource persons in agricultural extension

Liming demonstration using a lime spreader. (Immaculate Juma)

Lime application to acid soils (Kenya)

DESCRIPTION

Lime application is a rapid way to treat soil acidity and improve productivity.

Liming is the application of soil conditioners, including marl, chalk, limestone, burnt lime, or hydrated lime to the soil to raise its pH; thus, reduce its acidity. Calcium (Ca) and magnesium (Mg)-rich materials are the most used – the Ca or Mg increase the base saturation in the soil hence neutralizing soil acidity that is often caused by the effects of acids from nitrogen (N) fertilizer, slurry, and high rainfall. Liming improves soil fertility by increasing the activity of beneficial earthworms and improving soil structure. It is a source of Ca, and by raising the pH of soils it increases uptake of plant nutrients.

The soil must be tested to determine its pH level. Lime should be applied to soils with pH levels below 5.0, but especially to soils with pH below 4.0 which are very acidic. High concentrations of acids decrease the availability of plant nutrients, especially phosphorous (P) and molybdenum (Mo) and increase the toxic effect of aluminium (Al) and manganese (Mn). In addition, acidity causes some plant nutrients to be leached below the plant rooting zone.

A farmer must wear protective clothing, including face masks, goggles, gumboots, gloves, and an apron before working with lime. The best time to apply agricultural lime to any piece of land is during the dry season. The lime must be covered with soil immediately after application to prevent loss through evaporation, since it is highly volatile. If lime has to be applied during the rainy season, the farmer must apply the lime just before it starts to rain so that the rainwater can leach the lime into the soil. Agricultural lime can be applied in three ways:

a) Broadcasting with a spreader. The land must be ploughed immediately to cover the lime and to prevent loss through evaporation.
b) Band method: Lime is applied between crops if it was not applied before land preparation. The lime must also be covered with soil immediately.
c) Spot method: Lime is applied at the base of the crop (similar to top dressing). Similarly, the lime must also be covered with soil immediately.

Farmers like agricultural lime because it improves soil structure and larger particles are formed in a process called flocculation. In addition, lime binds the larger particles of humus producing a good crumb structure. This improves soil drainage by creating more air spaces. Thus, the soil become easier to cultivate and plant root growth is facilitated. One acre (0.4 ha) of land with a pH of below 4.0 requires 300-350 kgs of lime; a pH of between 4.0 and 5.0, requires 200–250 kgs.

LOCATION

Location: Luuya Bwake Ward, Kabuchai Sub-county, Bungoma County in Western Kenya, Kenya

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 34.63473, 0.64343

Spread of the Technology: evenly spread over an area (approx. < 0.1 km2 (10 ha))

In a permanently protected area?: No

Date of implementation: 2022

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

Cation Exchange Capacity	mmol+/kg	[illegible]	[illegible]	
pH (water)	pH Value	5.3	6.0	7.2
Potassium (exch.)	mmol+/kg	2.7	1.5	3
Total Nitrogen	g/kg	1.2	1	2
Phosphorus (M3)	mg/kg	8.1	20	40
Aluminium (exch.)	mmol+/kg	7.2	10	40
Boron (exch.)	mmol+/kg	< 0	0.1	0.3
Boron (M3)	mg/kg	0.2	0.15	0.25
Copper (M3)	mg/kg	2.6	1	2
Iron (M3)	mg/kg	153	10	20
Zinc (M3)	mg/kg	1.6	2.5	4
Calcium (exch.)	mmol+/kg	19.2	15	20
Magnesium (exch.)	mmol+/kg	10.1	4.5	10
Total Sulphur	g/kg	0.1	0.3	0.5
Total Iron	g/kg		15	60

Soil test results (William Akwanyi)

Liming demonstration in a farm. (Immaculate Juma)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [x] improve production
- [x] reduce, prevent, restore land degradation
- [ ] conserve ecosystem
- [ ] protect a watershed/ downstream areas – in combination with other Technologies
- [x] preserve/ improve biodiversity
- [ ] reduce risk of disasters
- [ ] 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

Land use mixed within the same land unit: Yes - Agro-silvopastoralism

Cropland

- Annual cropping: cereals - maize, cereals - millet, legumes and pulses - beans, legumes and pulses - lentils, oilseed crops - groundnuts, root/tuber crops - sweet potatoes, yams, taro/cocoyam, other. Cropping system: Maize/sorghum/millet intercropped with legume
- Perennial (non-woody) cropping: banana/plantain/abaca, fodder crops - grasses
- Tree and shrub cropping: avocado, fruits, other, mango, mangosteen, guava, papaya

Number of growing seasons per year: 2
Is intercropping practiced? Yes
Is crop rotation practiced? Yes

Grazing land

- Cut-and-carry/ zero grazing
- Improved pastures

Animal type: cattle - dairy and beef (e.g. zebu), poultry
Is integrated crop-livestock management practiced? Yes
Products and services: economic security, investment prestige, eggs, manure as fertilizer/ energy production, meat, milk

Species	Count
cattle - dairy and beef (e.g. zebu)	3
poultry	10

Water supply

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

Purpose related to land degradation

- [ ] prevent land degradation
- [ ] reduce land degradation
- [x] 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), Ca: acidification, Cp: soil pollution

physical soil deterioration - Ps: subsidence of organic soils, settling of soil

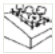
biological degradation - Bs: quality and species composition/ diversity decline, Bl: loss of soil life

SLM group

- integrated soil fertility management

SLM measures

agronomic measures - A2: Organic matter/ soil fertility, A3: Soil surface treatment



management measures - M4: Major change in timing of activities, M7: Others

TECHNICAL DRAWING

Technical specifications

A lime spreader

A bag of lime

Author: Justine Otsyula

Author: Justine Otsyula

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology area (size and area unit: **0.4 ha**)
- Currency used for cost calculation: **KES**
- Exchange rate (to USD): 1 USD = 124.21352 KES
- Average wage cost of hired labour per day: n.a

Most important factors affecting the costs

Rate of man-days and costs vary from one place to another, farmer to farmer, and with type of work. Costs for maintenance are subject to change with time. Exchange rate for February 2023, source: European Commission/ InfoEuro online at https://commission.europa.eu/funding-tenders/procedures-guidelines-tenders/information-contractors-and-beneficiaries/exchange-rate-inforeuro_en

Establishment activities

1. Soil testing (Timing/ frequency: In preparation for liming)
2. Lime acquisition (Timing/ frequency: In preparation for liming)
3. Acquisition of personal protective equipment clothing (PPE) (Timing/ frequency: In preparation for liming)
4. Lime application (Timing/ frequency: Before soil disturbance through ploughing/ before rains)
5. Ploughing/ covering lime (Timing/ frequency: After lime application)

Establishment inputs and costs (per 0.4 ha)

Specify input	Unit	Quantity	Costs per Unit (KES)	Total costs per input (KES)	% of costs borne by land users
Labour					
Lime application	Man-days	2.0	300.0	600.0	100.0
Ploughing/ covering lime	Man-days	15.0	300.0	4500.0	100.0
Equipment					
PPE	Set	1.0	3000.0	3000.0	100.0
Fertilizers and biocides					
Lime	50 kgs bag	20.0	300.0	6000.0	100.0
Other					
Soil testing	Sample	1.0	800.0	800.0	100.0
Total costs for establishment of the Technology				**14'900.0**	
Total costs for establishment of the Technology in USD				*119.95*	

Maintenance activities

1. Regular testing (Timing/ frequency: Every 3 years, after 6 months if all required lime was not applied)
2. Lime acquisition (Timing/ frequency: In preparation for liming)
3. Reapplication (Timing/ frequency: Dependent on soil test results)
4. Ploughing/ covering lime (Timing/ frequency: After lime application)

Maintenance inputs and costs (per 0.4 ha)

Specify input	Unit	Quantity	Costs per Unit (KES)	Total costs per input (KES)	% of costs borne by land users
Labour					

Lime application	Man- days	2.0	300.0	600.0	100.0
Ploughing/ covering lime	Man- days	15.0	300.0	4500.0	100.0
Equipment					
PPE	Set	1.0	3000.0	3000.0	100.0
Fertilizers and biocides					
Lime	50 Kg bags	3.0	300.0	900.0	100.0
Other					
Soil testing	Sample	1.0	800.0	800.0	100.0
Total costs for maintenance of the Technology				**9'800.0**	
Total costs for maintenance of the Technology in USD				*78.9*	

NATURAL ENVIRONMENT

Average annual rainfall
- [ ] < 250 mm
- [ ] 251-500 mm
- [ ] 501-750 mm
- [ ] 751-1,000 mm
- [x] 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
- [x] humid
- [ ] sub-humid
- [ ] semi-arid
- [ ] arid

Specifications on climate
Average annual rainfall in mm: 1200.0
Monthly rainfall variability is high with some months such as January recording less than 5 mm of total rainfall.
Name of the meteorological station: Bungoma Meteorological Station
The climate in the area favours most agricultural activities.

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

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

Altitude
- [ ] 0-100 m a.s.l.
- [ ] 101-500 m a.s.l.
- [ ] 501-1,000 m a.s.l.
- [ ] 1,001-1,500 m a.s.l.
- [x] 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
- [x] not relevant

Soil depth
- [ ] very shallow (0-20 cm)
- [ ] 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)
- [ ] fine/ heavy (clay)

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

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

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

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

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

Water quality refers to: both ground and surface water

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

Occurrence of flooding
- [ ] Yes
- [x] No

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

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

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

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

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

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

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

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

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

Gender
- [x] women
- [x] men

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

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

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

Land ownership
- [ ] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [x] individual, not titled
- [x] individual, titled

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

Water use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [x] individual

Access to services and infrastructure

	poor				good
health	poor		✓		good
education	poor			✓	good
technical assistance	poor			✓	good
employment (e.g. off-farm)	poor		✓		good
markets	poor		✓		good
energy	poor	✓			good
roads and transport	poor	✓			good
drinking water and sanitation	poor			✓	good
financial services	poor		✓		good

Comments
The above rating varies from one village to the other.

IMPACTS

Socio-economic impacts

Crop production	decreased						✓		increased

Quantity before SLM: 3
Quantity after SLM: 9

crop quality	decreased ✓ increased	Quantity refers to the number of 90 Kg bags of maize produced per acre.
fodder production	decreased ✓ increased	Not easy for the farmers to quantify.
fodder quality	decreased ✓ increased	Quantity before SLM: 6 Quantity after SLM: 10 Quality refers to the number of bunches/ loads of harvested napier grass.
risk of production failure	increased ✓ decreased	Not easy for the farmers to quantify.
land management	hindered ✓ simplified	Quantity before SLM: 50 Quantity after SLM: 40 Quantity refers to the percentage probability of the crop failing to do well.
expenses on agricultural inputs	increased ✓ decreased	Not easy for the farmers to quantify but the farmer says that it is easier to work on the soil since lime was applied.
farm income	decreased ✓ increased	Quantity before SLM: 3,500 Quantity after SLM: 6,000 The farmer used to buy 1 bag of 50 Kg DAP for the 1 acre. The test results recommended that she applies 2.5 bags of 50 Kg NPK. This increased the expenditure on fertilizer.
workload	increased ✓ decreased	Quantity before SLM: 6,000 Quantity after SLM: 15,000 She used to sell 2 bags of 50Kgs of maize at KES 3,000/- but after improved production she was able to sell 5 bags at the same price.
		Not easy to quantify but the work has slightly increased due to the need to apply lime.

Socio-cultural impacts

SLM/ land degradation knowledge	reduced ✓ improved	Quantity before SLM: 30 Quantity after SLM: 70 Quantity refers to the estimated percentage of knowledge in SLM/ land management.

Ecological impacts

acidity	increased ✓ reduced	Quantity before SLM: 5.3 Quantity after SLM: Not known The has not done a confirmatory test but it is clear that the pH has reduced due to the improved production.

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

Gradual climate change

annual temperature increase	not well at all ✓ very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology
- [x] single cases/ experimental
- [ ] 1-10%
- [ ] 11-50%
- [ ] > 50%

Of all those who have adopted the Technology, how many have done so without receiving material incentives?
- [ ] 0-10%
- [ ] 11-50%
- [ ] 51-90%
- [ ] 91-100%

Number of households and/ or area covered
About 30 households

Has the Technology been modified recently to adapt to changing conditions?
- [ ] Yes
- [x] 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
- Improves crop yields.
- Efficiency in use of fertilizers.

Strengths: compiler's or other key resource person's view
- Makes it easier to work on land.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome
- High cost of PPE. The farmer should budget for and plan to buy the PPE early before time of application.

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome
- Limitation in accessing soil testing facilities/ services. Create awareness about and link farmers to existing soil testing facilities/ services.

REFERENCES

Compiler
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Reviewer
William Critchley
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Date of documentation: March 19, 2023

Last update: July 10, 2023

Resource persons
Maryann Nanjala Wekesa - land user
JUSTINE OTSYULA - SLM specialist
Innocent Faith - SLM specialist

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6702/

Linked SLM data
Approaches: Community Resource Persons (CRP) in agricultural extension https://qcat.wocat.net/en/wocat/approaches/view/approaches_6688/

Documentation was faciliated by

Institution
- CIAT International Center for Tropical Agriculture (CIAT International Center for Tropical Agriculture) - Kenya
- Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)

Project
- Soil protection and rehabilitation for food security (ProSo(i)l)

Key references
- Liming effects on soil pH and crop yield depend on lime material type, application method and rate, and crop species: a global meta-analysis: Free download at https://www.researchgate.net/publication/327188728_Liming_effects_on_soil_pH_and_crop_yield_depend_on_lime_material_type_application_method_and_rate_and_crop_species_a_global_meta-analysis

Links to relevant information which is available online
- Soil Acidity and Liming: https://www.ctahr.hawaii.edu/oc/freepubs/pdf/pnm10.pdf
- Bungoma County Integrated Development Plan, 2018-2022: Free download at https://www.devolution.go.ke/wp-content/uploads/2020/02/Bungoma-CIDP-2018-2022.pdf

SLM technology: Compost for organic waste management and improved crop yields

A farmer demonstrating the third stage of compost-making (William Onura)

Compost for organic waste management and improved crop yields (Kenya)

Mbolea bora (Kiswahili)

DESCRIPTION

Composting with on-farm organic solid waste management improves the soil sustainably and raises crop yields.

Composting is a natural process of converting organic materials such as plant leaves, and food remains into a nutrient-rich soil-enhancing amendment called compost (if mainly from vegetative matter) or manure (if mainly from animal dung). It involves breaking organic matter down into humus/ compost by aerobic microorganisms - with by-products of water, heat, ammonia (NH3), and carbon dioxide (CO2). Humus is a dark and crumbly natural form of fertilizer applied to the soil to improve crop production. Composting is cost-effective since it can be made from locally available materials such as leaves, plant residues, food remains, cow dung, poultry droppings, animal urine, soil, etc. Composting is thus an on-farm solid waste management measure. When made correctly it can improve carbon sequestration in the soil (compost is carbon-rich) and prevent methane emissions (a greenhouse gas) since methane-producing microbes become inactive in aerobic conditions (in the presence of oxygen).

There are many ways of preparing compost. This method involves three key stages; mixing brown organic materials, such as twigs, and green materials, such as fresh leaves that are nitrogen-rich and moist. In the first stage, brown and green materials are layered, beginning with a 30 cm layer of twigs at the bottom, followed by a 30 cm layer of dry matter, such as maize straw chopped to a maximum of 7.5 cm. This is followed by a 30 cm layer of dry grass and dry leaves covered by a 7.5 cm – 15 cm layer of fresh cow dung. The fresh cow dung is covered by a 15 cm layer of fresh tithonia (an exotic plant) that is completely covered by a layer of ash and sprayed uniformly using 10 litres of animal urine and finally completely covered by a layer of soil or manure. All the above inputs except urine are sprayed with 10 – 20 litres of water. The pile is then completely covered with a black polythene sheet to help absorb heat, prevent the entry of rainwater, and prevent volatilization of nitrogen, i.e., the conversion of ammonium into ammonia gas, and left to decompose for 21 to 30 days.
The second stage involves mixing and transferring all the material except the twigs, to another space. The heap is again completely covered with a black polythene sheet to help absorb heat, prevent rainwater entry, and prevent nitrogen volatilization. It is again left to decompose for another 21 to 30 days. The third stage, like the second stage, involves completely mixing and transferring all the material from the second stage to another space and completely covering the heap with a black polythene sheet to help absorb heat and prevent the entry of rainwater. The contents are allowed to decompose for another 21 to 30 days, after which they are ready-to-use compost. The compost is stored under shade and covered with a black polythene sheet again to prevent nitrogen volatilization.

One heap of compost (first stage: 1.5 m by 1.5 m by 1.5 m) produces about 5 tonnes of ready-to-use compost. Composting takes about 90 days; hence, provided that all inputs are available, a farmer can produce compost 4 times each year from the same heaping point, i.e., about 20 tonnes. Normally, a 0.4-hectare farm requires about 20 tonnes of this compost. However, the amount varies from farm to farm depending on the conditions of the soil and the crop(s) to be grown. It is important that soil testing is done to determine the conditions of the soil to ensure that the compost is being used in the most effective manner.

Compost is carried to the farm on wheelbarrows and in buckets and is applied at the farm during planting time where a handful of compost is applied in the planting hole and mixed with soil before planting. It is again applied around the base of the crop and completely covered with soil. Preparation of compost in conservation agriculture situations could pose the problem of competition for plant material since plant material is used in conservation agriculture to cover the soil. To manage this, a farmer implementing both composting and conservation agriculture may have to acquire plant material for composting from other sources such as purchasing stover from other farmer who are not implementing conservation agriculture. In addition, the farmer could also use hedge trimmings as plant material for composting, especially if the farmer has a live fence.

LOCATION

Location: Elang'ata Village, Bulanda Sub-location, Imanga Location, Marama Central Ward, Butere Sub-county, Kakamega County in western Kenya, Kenya

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 34.48169, 0.2895

Spread of the Technology: applied at specific points/ concentrated on a small area

In a permanently protected area?: No

Date of implementation: 2018

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


The first stage in the process of making compost. (William Onura)


A farmer displaying ready-to-use compost (William Onura)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [x] improve production
- [x] 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
- [x] mitigate climate change and its impacts
- [x] create beneficial economic impact
- [ ] create beneficial social impact

Land use

Land use mixed within the same land unit: Yes - Agro-silvopastoralism

Cropland

- Annual cropping: cereals - maize, fodder crops - grasses, legumes and pulses - beans, root/tuber crops - cassava, vegetables - other. Cropping system: Maize/sorghum/millet intercropped with legume
- Perennial (non-woody) cropping: banana/plantain/abaca
- Tree and shrub cropping: avocado, fruits, other, mango, mangosteen, guava, papaya

Number of growing seasons per year: 2
Is intercropping practiced? Yes
Is crop rotation practiced? Yes

Grazing land

- Cut-and-carry/ zero grazing
- Improved pastures

Animal type: cattle - dairy, cattle - dairy and beef (e.g. zebu), poultry
Is integrated crop-livestock management practiced? Yes
Products and services: economic security, investment prestige, eggs, manure as fertilizer/ energy production, meat, milk

Species	Count
cattle - dairy	2
cattle - dairy and beef (e.g. zebu)	3
poultry	10

Water supply

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

Purpose related to land degradation

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

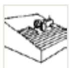
Degradation addressed

chemical soil deterioration - Cn: fertility decline and reduced organic matter content (not caused by erosion), Ca: acidification, Cp: soil pollution

SLM group

- integrated crop-livestock management
- integrated soil fertility management
- waste management/ waste water management

SLM measures

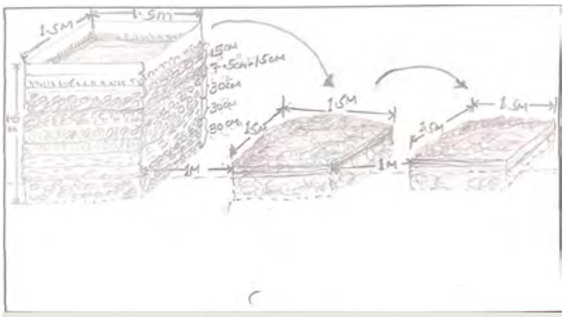


agronomic measures - A2: Organic matter/ soil fertility, A6: Residue management (A 6.3: collected)

TECHNICAL DRAWING

Technical specifications

Stage 1: about 30 cm deep under the ground, 1.5 m long by 1.5 m wide by 1.5 m high, including the 30 cm below the ground. Constructed using timber off-cuts (locally known as magogo) supported on posts at corners using nails. From bottom: 30 cm of twigs to extend some few inches above the ground to allow air circulation, 30 cm of dry matter e.g., maize straw chopped to 7.5 cm maximum, 30 cm dry grass and leaves, 7.5 cm - 15 cm layer of fresh cow dung, 15 cm layer of fresh tithonia, layer of ash, layer of soil or manure, black polythene sheet cover.
Stages 2 and 3: about 1-ft deep under the ground, 1.5 m long by 1.5 m wide, height depends on the volume of the material.
Allow space of no more than 1 m from one stage to the other for easy of mixing and transfer of materials from one stage to the next.



Author: William Onura

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology unit (unit: **Heap of compost** volume, length: **1.5 m by 1.5 m by 1.5 m**)
- Currency used for cost calculation: **KES**
- Exchange rate (to USD): 1 USD = 122.95 KES
- Average wage cost of hired labour per day: 200

Most important factors affecting the costs

Rate of man-days vary from one place to another. It is not easy to attach monetary value to some of the input e.g., animal urine, cow dung, and water. Exchange rate for January 2023, source: European Commission/ InfoEuro online at https://commission.europa.eu/funding-tenders/procedures-guidelines-tenders/information-contractors-and-beneficiaries/exchange-rate-inforeuro_en

Establishment activities

1. Digging of pits (Timing/ frequency: At least 3 months before planting time)
2. Framework construction with off cuts (Timing/ frequency: At least 3 months before planting time)
3. Filling stage one with inputs (Timing/ frequency: At least 3 months before planting time)

Establishment inputs and costs (per Heap of compost)

Specify input	Unit	Quantity	Costs per Unit (KES)	Total costs per input (KES)	% of costs borne by land users
Labour					
Framework construction	Man-days	2.0	200.0	400.0	100.0
Filling inputs	Man-days	1.0	200.0	200.0	100.0
Equipment					
Jembe (hoe)	No.	1.0	80.0	80.0	
Spade	No.	1.0	90.0	90.0	
Fork hoe	No.	1.0	70.0	70.0	
Wheelbarrow	No.	1.0	800.0	800.0	
Hummer	No.	1.0	100.0	100.0	100.0
Handsaw	No.	1.0	200.0	200.0	100.0
Plant material					
Twigs	Wheelbarrow	2.0	100.0	200.0	100.0
Dry matter	Wheelbarrow	6.0	50.0	300.0	100.0
Dry grass and leaves	90 Kg sack	3.0	50.0	150.0	100.0
Fresh tithonia	90 Kg sack	3.0	50.0	150.0	100.0
Fertilizers and biocides					
Ash	90 Kg sack	0.4	200.0	80.0	100.0
Animal urine	10 litre container	1.0	125.0	125.0	100.0
Soil or manure	Wheelbarrow	1.0	300.0	300.0	100.0
Fresh cow dung	Wheelbarrow	3.0	200.0	600.0	100.0
Construction material					
Timber off-cuts	Pieces	16.0	100.0	1600.0	100.0
Wooden posts	Pieces	4.0	50.0	200.0	100.0
Nails (assorted sizes)	Kgs	3.0	200.0	600.0	100.0
Other					
Water	20 litres container	4.0	5.0	20.0	100.0
Total costs for establishment of the Technology				**6'265.0**	
Total costs for establishment of the Technology in USD				*50.96*	

Maintenance activities

1. Turning at each stage (Timing/ frequency: 21 - 30 days after start of each stage)
2. Refilling at the first stage (Timing/ frequency: At turning from the first stage)

3. Distribution to the farm (Timing/ frequency: When planting and at first weeding (i.e., 3rd week after planting))

Maintenance inputs and costs (per Heap of compost)

Specify input	Unit	Quantity	Costs per Unit (KES)	Total costs per input (KES)	% of costs borne by land users
Labour					
Complete mixing and turning from stage one to stage two and from stage two to stage three	Man-days	4.0	200.0	800.0	100.0
Refilling with new materials at the first stage	Man-days	1.0	200.0	200.0	100.0
Transfer to storage	Man-days	2.0	200.0	400.0	100.0
Distribution to the farm	Man-days	2.0	200.0	400.0	100.0
Equipment					
Hoe	No.	1.0	80.0	80.0	
Fork hoe	No.	1.0	90.0	90.0	
Spade	No.	1.0	70.0	70.0	
Wheelbarrow	No.	1.0	400.0	400.0	
Plant material					
Dry matter	Wheelbarrow	6.0	50.0	300.0	100.0
Dry grass and leaves	90Kg sack	3.0	50.0	150.0	100.0
Fresh tithonia	90Kg sack	3.0	50.0	150.0	100.0
Fertilizers and biocides					
Ash	90 Kg sack	0.4	200.0	80.0	100.0
Animal urine	10 litre container	1.0	125.0	125.0	100.0
Soil or manure	Wheelbarrow	1.0	300.0	300.0	100.0
Fresh cowdung	Wheelbarrow	3.0	200.0	600.0	100.0
Other					
Water	20 litres container	4.0	5.0	20.0	100.0
Total costs for maintenance of the Technology				**4'165.0**	
Total costs for maintenance of the Technology in USD				*33.88*	

NATURAL ENVIRONMENT

Average annual rainfall
- < 250 mm
- 251-500 mm
- 501-750 mm
- 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
- sub-humid
- semi-arid
- arid

Specifications on climate

Monthly rainfall variability is high with some months such as January recording less than 5 mm of total rainfall.
Name of the meteorological station: Kakamega Meteorological Station
The climate in the area favours most agricultural activities.

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

Landforms
- ✓ plateau/plains
- ✓ ridges
- mountain slopes
- hill slopes
- footslopes
- valley floors

Altitude
- 0-100 m a.s.l.
- 101-500 m a.s.l.
- 501-1,000 m a.s.l.
- ✓ 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)
- shallow (21-50 cm)
- ✓ moderately deep (51-80 cm)
- deep (81-120 cm)
- very deep (> 120 cm)

Soil texture (topsoil)
- coarse/ light (sandy)
- ✓ medium (loamy, silty)
- 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%)
- 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

Water quality refers to: both ground and surface water

Species diversity
- ☐ high
- ☑ medium
- ☐ low

Habitat diversity
- ☐ high
- ☑ medium
- ☐ low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- ☐ subsistence (self-supply)
- ☑ 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
- ☐ very poor
- ☐ poor
- ☑ average
- ☐ rich
- ☐ very rich

Level of mechanization
- ☑ manual work
- ☑ animal traction
- ☐ mechanized/ motorized

Sedentary or nomadic
- ☐ Sedentary
- ☑ Semi-nomadic
- ☐ Nomadic

Individuals or groups
- ☑ 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
- ☐ 1-2 ha
- ☐ 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

Scale
- ☐ small-scale
- ☑ medium-scale
- ☐ large-scale

Land ownership
- ☐ state
- ☐ company
- ☐ communal/ village
- ☐ group
- ☑ individual, not titled
- ☑ individual, titled

Land use rights
- ☐ open access (unorganized)
- ☐ communal (organized)
- ☑ leased
- ☑ individual

Water use rights
- ☑ open access (unorganized)
- ☐ communal (organized)
- ☐ leased
- ☑ individual

Access to services and infrastructure

	poor			good
health			✓	
education			✓	
technical assistance			✓	
employment (e.g. off-farm)			✓	
markets			✓	
energy		✓		
roads and transport		✓		
drinking water and sanitation			✓	
financial services		✓		

Comments

The above rating varies from one village to the other.

IMPACTS

Socio-economic impacts

Crop production

decreased ☐☐☐☐☐☑☐ increased

Quantity before SLM: Less than 4
Quantity after SLM: More than 8
Quantity refers to the number of 90 Kg bags of maize produced per acre. Based on measurement by the farmer.

crop quality

decreased ☐☐☐☐☐☑☐ increased

Not easy to quantify. The crops do better compared to how they could do in the past, yet he does not use inorganic fertilizers. Based on estimation by the farmer.

fodder production

decreased ☐☐☐☐☐☐☑ increased

Quantity before SLM: 2
Quantity after SLM: 3 - 4
Quantity refers to harvesting cycles for nappier grass from the same farm. He applies compost on the pieces of land where he has grown fodder. The fodder does better than how it used to do before when he was not applying compost.

animal production

decreased ☐☐☐☐☐☑☐ increased

Quantity before SLM: 1 - 3
Quantity after SLM: 3 - 10
Quantity refers to the amount of milk in litres from one cow. He gets more milk from his cows as compared to what he used to get before the SLM since applying compost on the pieces of land where he has grown fodder makes the fodder to grow faster. Milk production is often at the peak during early lactation months.

risk of production failure

increased □□□□□□✓ decreased

Quantity before SLM: Over 50
Quantity after SLM: Less than 10
Quantity refers to the percentage probability of the crop failing to do well. Quote from the farmer, '... it was 50 50 getting any produce before I started using compost ...' meaning that there was high chance that the crop could fail due to poor soils. Compost is a rich source of organic matter; hence, ensure sustainable agricultural production.

expenses on agricultural inputs

increased □□□□□□✓ decreased

Quantity before SLM: Over 5,000
Quantity after SLM: 0
Quantity refers to the amount of money in Kenya shillings spend on inorganic fertilizers in a season. The farmers no longer spend money inorganic fertilizers.

farm income

decreased □□□□□□✓ increased

Quantity before SLM: Less than 2,000
Quantity after SLM: 20,000
Quantity refers to the amount of money in Kenya shillings received from the sale of farm produce, including compost in a year. The farmer is able to sell surplus crop and animal products as a result of bumper harvest due to the use of compost on his farm.

diversity of income sources

decreased □□□□□□✓ increased

Quantity before SLM: 1 - 3
Quantity after SLM: More than 3
Quantity refers to household income sources, including sale of surplus farm produce and compost. The farmer is able to sell surplus crop and animal products, and other on-farm products such and compost.

workload

increased □□✓□□□□ decreased

Quantity before SLM: Over 5
Quantity after SLM: Less than 1
Quantity refers to the number of hours that the farmer can be free in any working day. A lot of work is involved in the preparation and maintenance of compost in order to achieve the desired results.

Socio-cultural impacts

food security/ self-sufficiency

reduced □□□□□□✓ improved

Quantity before SLM: About 3 months of purchasing maize
Quantity after SLM: No months when there is total lack of food in the house
Quantity refers to the number of months in a year when there is total lack of food in the house, and the farmer has to buy all the food required in the house. The soils at the farm have been enhanced; hence, the farmer grows a variety of crops. Food is available in the household to sustain the family from one harvest to the next.

SLM/ land degradation knowledge

reduced □□□□□□✓ improved

Quantity before SLM: 10%
Quantity after SLM: Over 90%
Quantity refers to the estimated percentage of knowledge in SLM/ land management. Not only is the farmer equipped with skills on how to make compost but also with skills in other SLM technologies such as vermicomposting.

Ecological impacts

soil moisture

decreased □□□□□□✓ increased

Quantity before SLM: Less than 10
Quantity after SLM: 20 or more
Quantity refers to the farmer's estimated soil moisture content during the dry season when soil moisture challenges are expected to be high.

soil cover

reduced □□□□□□✓ improved

Quantity before SLM: 30 - 50
Quantity after SLM: 60 - 80
Quantity refers to the farmer's estimated percentage soil cover at the farm.

soil organic matter/ below ground C

decreased □□□□□□✓ increased

Quantity refers to the farmer's estimated percentage of organic matter at the farm. Based on estimation by the farmer.

vegetation cover

decreased □□□□□□✓ increased

Quantity before SLM: 30 - 50
Quantity after SLM: 60 - 80
Quantity refers to the farmer's estimated percentage vegetation cover at the farm.

plant diversity	decreased ☐☐☐☐☐☐✓ increased	Quantity before SLM: About 3 Quantity after SLM: More than 5 Quantity refers to the number of plants (crops) that the farmer establishes at the farm.
beneficial species (predators, earthworms, pollinators)	decreased ☐☐☐☐☐☐✓ increased	Not easy to quantify but the number of earthworms in the farm and bees visiting the farm to look for nectar has increased.
habitat diversity	decreased ☐☐☐☐☐☐✓ increased	Not easy to quantify but the number of earthworms in the farm has increased which is an indication of increased habitats for different animals at the farm.

Off-site impacts

damage on neighbours' fields	increased ☐☐☐☐☐✓☐ reduced	Quantity before SLM: 80 Quantity after SLM: 10 Quantity refers to the probability of the neighbours' farms being burned because of available plant residues. The farmer collects residues from his neighbours' farms for use in composting. The neighbours could have burned the residues leading to death of useful microorganisms (bacteria and fungi).
impact of greenhouse gases	increased ☐☐☐☐✓☐☐ reduced	Not easy to quantify. Composting improves carbon sequestration in the soil and by preventing methane emissions through aerobic decomposition, as methane-producing microbes are not active in aerobic conditions.

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

Use of compost reduces the dependence on inorganic fertilizers.

CLIMATE CHANGE

Gradual climate change

seasonal temperature decrease	not well at all ☐☐☐✓☐ very well	Season: wet/ rainy season

Climate-related extremes (disasters)

land fire	not well at all ☐☐☐✓☐ very well

ADOPTION AND ADAPTATION

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

- ☐ single cases/ experimental
- ☐ 1-10%
- ☑ 11-50%
- ☐ > 50%

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

- ☐ 0-10%
- ☐ 11-50%
- ☐ 51-90%
- ☑ 91-100%

Number of households and/ or area covered

The project was implemented in the entire ward. Most farmers are preparing compost as advised in the ProSoil project.

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

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

- With continued use of compost, there is no need for expensive inorganic fertilizers and pesticides that could also contaminate/ degrade the soil.
- Composting is not capital intensive.

Strengths: compiler's or other key resource person's view
- There is high production in the long run even without use of inorganic fertilizers.
- Composting is not capital intensive.

- Inputs such as tithonia are not easy to find. Farmers can plant tithonia as hedges on their farms.
- More labour intensive as compared to the traditional way of composting. Farmers have to be committed.

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome
- More labour intensive. Proper planning/ scheduling of farmm activities.

REFERENCES

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George Onyango
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Reviewer
William Critchley
Rima Mekdaschi Studer

Date of documentation: Feb. 9, 2023

Last update: July 3, 2023

Resource persons
Matthews George Anyanga - land user
George Onyango - SLM specialist
Innocent Faith - SLM specialist

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6648/

Linked SLM data
Approaches: Community Resource Persons (CRP) in agricultural extension https://qcat.wocat.net/en/wocat/approaches/view/approaches_6688/

Documentation was faciliated by

Institution
- CIAT International Center for Tropical Agriculture (CIAT International Center for Tropical Agriculture) - Kenya
- Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)

Project
- Soil protection and rehabilitation for food security (ProSo(i)l)

Key references
- Comparative effectiveness of different composting methods on the stabilization, maturation and sanitization of municipal organic solid wastes and dried faecal sludge mixtures, Mengistu, T., Gebrekidan, H., Kibret, K. et al., 2018, Environ Syst Res 6, 5 (2018): Free download at https://doi.org/10.1186/s40068-017-0079-4

Links to relevant information which is available online
- Composting Recycling Naturally: Simple Steps for Starting at Home: https://scdhec.gov/sites/default/files/Library/OR-1705.pdf

SLM technology: Vermicomposting – an effective liquid fertilizer and biopesticide

Vermicomposting structures (William Akwanyi)

Vermicomposting: an effective liquid fertilizer and biopesticide (Kenya)

DESCRIPTION

Vermicomposting is an on-farm waste management strategy where worms are used for biodecomposition of wastes to produce a natural liquid fertilizer and pesticide.

Vermitechnology is biodecomposition of wastes using worms such as red wigglers. It includes vermicomposting (production of compost) and vermiculture (production of worms to ensure sustainability of the enterprise).
A vermicomposting structure is installed under shade and covered with a black polythene sheet to protect worms from the heat of the sun, and to prevent volatilization of nitrogen. The structure itself can be made by cutting a 60 cm radius and 120 cm height drum into two halves lengthwise. The half to be used must be thoroughly cleaned of oil or chemical residue. A hole is drilled at one end of the half drum for the installation of a tap. A base is made using wooden rails fastened on wooden posts using nails. The container is angled at 30° with the outlet pipe or tap on the lower side to allow free flow of leachate/ vermijuice. Materials are introduced in the half drum, including a gunny sheet covering the entire inside surface and ends hanging outside on the edges of the drum, a 7 cm layer of small stones followed by a 0.5 cm layer of sand on the stones, 10 cm layer of bedding materials on the sand, and 10 cm layer of worm food (kitchen and/ or animal wastes) on the bedding material. 20 litres of water are evenly sprinkled on the worm food. The worms and casts are introduced and evenly spread on the food. A bucket is placed at the outlet to collect drops of vermijuice.
Bedding materials include maize cobs, chopped maize straw, agroforestry tree bark, husks, old cartons and paper, and sugarcane bagasse. Temperature and humidity are checked by a thermometer and a hydrometer respectively. However, temperature can be checked by hand also. It is advisable that food (waste) is decomposed before being added onto the bedding material to maintain the temperature within the desired range of 15 - 20°C. Worms coil at the top of the material whenever temperatures go higher. Humidity is often higher in culture bins than in composting beds. Hence, more leachate in culture bins than in composting beds. However, humidity content in both culture bins and composting beds should not exceed 60% since the worms can take in a lot of water and die.

Feeding of the worms is done every 2 weeks where a mixture of 1 kg of chopped fresh tithonia, 3 kg of fresh cow dung, and 3 kg of cooked maize meal ("ugali") is added and evenly spread on the decomposing material. Collected juice is returned to the system every 2 weeks for a period of 2 months. After the 2 months, the juice will be ready for use as folia fertilizer and pesticide. The casts become ready manure after about 2.5 - 3 weeks. It is harvested by dividing the container into 2 equal halves widthwise and not introducing food to the upper half to make the worms concentrate on materials on the lower half. The worm-free compost on the upper part is completely removed to be used as manure. The remaining material containing the worms is spread uniformly in the half drum. Worm food is then added evenly spread on top.
The system described above produces about 30 kg of ready-to-use compost and about 10 litres of vermijuice in 3 months. Provided that all inputs are available, a farmer can produce vermicompost and vermijuice 4 times from the same system in a year i.e., 40 litres of vermijuice and 120 kgs of ready-to-use compost in a year. Normally, a one-acre (0.4ha) farm requires about 20 tonnes of compost for planting maize. Vermijuice is mixed with water in the ratio of 1 part of vermijuice to 10 parts of water when required as a folia fertilizer and in the ratio of 1 part of vermijuice to 5 parts of water when required as a pesticide. 20 – 30 litres of vermijuice can be applied to a 0.4 ha farm. However, the amount required for fertilizer varies from farm to farm depending on the conditions of the soil and the crop(s) to be grown. It is important that soil testing is done to determine the conditions of the soil to ensure that the compost is added at the correct rate.
Vermicomposting requires less space and less maintenance labour compared to normal composting. It takes a shorter time to get compost from vermicomposting than from normal composting. On the other hand, large farms would require the installation of several vermicomposting units in order to meet the farm demand. The choice of either technology or both depends on a number of factors, including the size of the farm, the amount of compost required, the time required to produce the compost, etc.

LOCATION

Location: Matora A Village, Ebukuti Sub-location, Manyala Location, Marama South Ward, Butere Sub-county, Kakamega County in western Kenya, Kenya

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 34.43757, 0.15563

Spread of the Technology: applied at specific points/ concentrated on a small area

In a permanently protected area?: No

Date of implementation: 2017

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


Manure produced from the casts in vermicomposting (William Akwanyi)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose
- [x] 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
- [ ] 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
Land use mixed within the same land unit: Yes - Agro-silvopastoralism

Cropland
- Annual cropping: cereals - maize, legumes and pulses - beans, root/tuber crops - sweet potatoes, yams, taro/cocoyam, other, vegetables - leafy vegetables (salads, cabbage, spinach, other), vegetables - other. Cropping system: Maize/sorghum/millet intercropped with legume
- Perennial (non-woody) cropping: banana/plantain/abaca, fodder crops - grasses, passiflora - passion fruit, maracuja
- Tree and shrub cropping: avocado, fruits, other, mango, mangosteen, guava, papaya

Number of growing seasons per year: 2
Is intercropping practiced? Yes
Is crop rotation practiced? Yes

Grazing land
- Improved pastures

Animal type: cattle - dairy and beef (e.g. zebu), goats, poultry
Is integrated crop-livestock management practiced? Yes
Products and services: economic security, investment prestige, eggs, meat, milk

Species	Count
cattle - dairy and beef (e.g. zebu)	2
goats	3
poultry	4

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

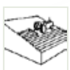
Purpose related to land degradation
- [x] prevent land degradation
- [x] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [ ] adapt to land degradation
- [ ] not applicable

Degradation addressed


chemical soil deterioration - Cn: fertility decline and reduced organic matter content (not caused by erosion), Ca: acidification, Cp: soil pollution, Cs: salinization/ alkalinization

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

SLM group
- integrated soil fertility management
- integrated pest and disease management (incl. organic agriculture)
- waste management/ waste water management

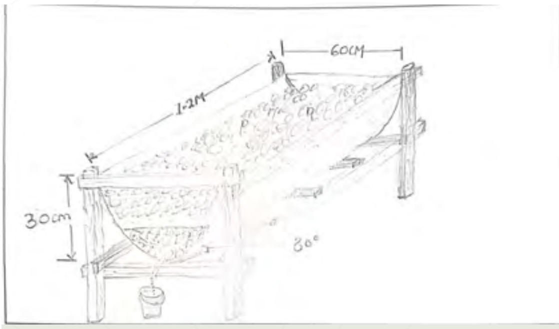
SLM measures


agronomic measures - A2: Organic matter/ soil fertility, A6: Residue management (A 6.3: collected)

TECHNICAL DRAWING

Technical specifications

The drawing above is of a half drum; 60 cm radius and 120 cm height.
The half drum is supported on rails fastened on wooden posts using nails.
The half drum is positioned in a slanting manner at 30° to the horizontal level to enable free flow of the juice.
The outlet of the vermijuice is on the lower side.
Materials introduced in the half drum include the following: a gunny sheet covering the entire inside surface and ends hanging outside on the edges of the drum; 7 cm layer of small stones followed by a 0.5 cm layer of sand on the stones, 10 cm layer of bedding materials on the sand, and 10 cm layer of worm food on the bedding material. The worm food material are determined by the required soil nutrients e.g., banana trunk for potassium (K)-rich manure and/ or vermijuice, crushed eggs for calcium (Ca)-rich, and tithonia for nitrogen (N)-rich.
The worms and cast are introduced and evenly spread on the food.
A bucket is placed at the outlet to receive dropping vermijuice.



Author: William Akwanyi

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology unit (unit: **A half drum vermicomposting unit as described in 2.2** volume, length: **0.17 cubic metres**)
- Currency used for cost calculation: **KES**
- Exchange rate (to USD): 1 USD = 122.95 KES
- Average wage cost of hired labour per day: 300

Most important factors affecting the costs

Rate of man-days vary from one place to another. It is not easy to attach monetary value to some of the input e.g., wastes and water.
Exchange rate for January 2023, source: European Commission/ InfoEuro online at https://commission.europa.eu/funding-tenders/procedures-guidelines-tenders/information-contractors-and-beneficiaries/exchange-rate-inforeuro_en

Establishment activities

1. Construction of vermicomposting unit, inclusive shed (Timing/ frequency: Before procuring worms)
2. Adding materials (Timing/ frequency: Before procuring worms)
3. Introduction of worms (Timing/ frequency: After completion of construction)

Establishment inputs and costs (per A half drum vermicomposting unit as described in 2.2)

Specify input	Unit	Quantity	Costs per Unit (KES)	Total costs per input (KES)	% of costs borne by land users
Labour					
Construction of the vermicomposting structure					
Construction of shade over the vermicomposting structure					
Equipment					
Hammer					
Hand saw					
Tape measure					
Plant material					
Bedding material					
Fertilizers and biocides					
Worms in cast					
Kitchen or animal wastes					
Construction material					
Half drum					
Gunny sheet					
Nails					
Iron sheets					
Other					
Gravel					
Sand					
Water					

Maintenance activities

1. Monitoring humidity and temperature (Timing/ frequency: Daily)
2. Feeding (Timing/ frequency: Biweekly)
3. Watering (Timing/ frequency: Biweekly)
4. Predator control (Timing/ frequency: Daily)
5. Harvesting compost (Timing/ frequency: Every 2.5 - 3 months)
6. Collection of vermijuice (Timing/ frequency: Daily)

Total maintenance costs (estimation)

2000.0

NATURAL ENVIRONMENT

Average annual rainfall
- [ ] < 250 mm
- [ ] 251-500 mm
- [ ] 501-750 mm
- [ ] 751-1,000 mm
- [x] 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
- [x] humid
- [ ] sub-humid
- [ ] semi-arid
- [ ] arid

Specifications on climate
Average annual rainfall in mm: 1300.0
Monthly rainfall variability is high with some months such as January recording less than 5 mm of total rainfall.
Name of the meteorological station: Kakamega Meteorological Station
The climate in the area favours most agricultural activities.

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

Landforms
- [x] plateau/plains
- [ ] ridges
- [ ] mountain slopes
- [ ] hill slopes
- [ ] footslopes
- [ ] 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
- [x] not relevant

Soil depth
- [ ] very shallow (0-20 cm)
- [ ] 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)
- [ ] fine/ heavy (clay)

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

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

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

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

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

Water quality refers to: both ground and surface water

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

Occurrence of flooding
- [ ] Yes
- [x] No

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

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

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

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

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

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

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

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

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

Gender
- [x] women
- [x] men

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

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

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

Land ownership
- [ ] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [ ] individual, not titled
- [x] individual, titled

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

Water use rights
- [x] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

health	poor	[ ]	[ ]	[x]	good
education	poor	[ ]	[ ]	[x]	good

Comments
The above rating varies from one village to the other.

technical assistance	poor	□□✓ good
employment (e.g. off-farm)	poor	□□✓ good
markets	poor	□✓□ good
energy	poor	□□✓ good
roads and transport	poor	□✓□ good
drinking water and sanitation	poor	□□✓ good
financial services	poor	□✓□ good

IMPACTS

Socio-economic impacts

Crop production	decreased □□□□□✓□ increased	Quantity before SLM: 3 Quantity after SLM: 8 Number of 90Kg bags of maize harvested per acre of land. Based on estimate by the farmer.
crop quality	decreased □□□□□✓□ increased	Not easy to quantify by the farmer. Based on estimate by the farmer.
fodder production	decreased □□□□□✓□ increased	Quantity before SLM: 3 Quantity after SLM: 5 Number of harvesting cycles in one season. Based on estimate by the farmer.
fodder quality	decreased □□□□□✓□ increased	Not easy for the farmer to quantify. Based on estimate by the farmer.
animal production	decreased □□□□□✓□ increased	Quantity before SLM: 2 Quantity after SLM: 6 Amount of milk in litres from one cow. Based on estimate by the farmer.
land management	hindered □□□□□✓□ simplified	Not easy for the farmer to quantify. Land management has been eased because use of manure from vermicomposting improves the soil structure making it easier to plough.
expenses on agricultural inputs	increased □□□□□□✓ decreased	Quantity before SLM: 10,000 Quantity after SLM: 0 Quantity refers to the amount of money in KES spend on fertilizers. The farmer no longer purchases fertilizers.
farm income	decreased □□□□□✓□ increased	Quantity before SLM: 2,000 Quantity after SLM: 50,000 Quantity refers to the amount of money earned from sell of farm produce. Currently, he sells manure, worms, and vermijuice and also offers services in construction of vermicomposting structures.
diversity of income sources	decreased □□□□□✓□ increased	Quantity before SLM: 3 Quantity after SLM: 5 Quantity refers to the number of farm products that the farmer sells to earn income. Based on estimate by the farmer.

Socio-cultural impacts

food security/ self-sufficiency	reduced □□□□□✓□ improved	Quantity before SLM: 4 Quantity after SLM: 1 Quantity refers to the number of months when there in no food in the house and the household has to purchase all food required in the house.
SLM/ land degradation knowledge	reduced □□□□□□✓ improved	Based on estimate by the farmer.

Ecological impacts

acidity	increased □□□□□✓□ reduced	Based on estimate by the farmer.
vegetation cover	decreased □□□□✓□□ increased	Quantity before SLM: 20 Quantity after SLM: 50 Quantity refers to the farmer's estimated vegetation cover at his farm.
plant diversity	decreased □□□□□✓□ increased	Quantity before SLM: 3 Quantity after SLM: 8 Quantity refers to the number of crops that the farmer establishes on his farm.

beneficial species (predators, earthworms, pollinators)	decreased / increased	There are earthworms at the farm.
habitat diversity	decreased / increased	Not easy for the farmer to quantify.

Off-site impacts

impact of greenhouse gases	increased / reduced	Not easy to quantify. Compost improves carbon sequestration in the soil.

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

Use of vermicompost and vermijuice reduces the farmer's dependence on inorganic fertilizers and pesticides.

CLIMATE CHANGE

Climate-related extremes (disasters)

epidemic diseases	not well at all / very well

ADOPTION AND ADAPTATION

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

- ☐ single cases/ experimental
- ☑ 1-10%
- ☐ 11-50%
- ☐ > 50%

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

- ☑ 0-10%
- ☐ 11-50%
- ☐ 51-90%
- ☐ 91-100%

Number of households and/ or area covered

The project was implemented in the entire ward. Very few farmers have vermicomposting structures.

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)
- ☑ Design

The farmer does not fit taps on the composting structures as outlets for the vermijuice since someone can accidentally close the tap and forget to open, especially during humidity checking leading to high humidity which can cause the death of the worms.

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- It is an agribusiness venture.
- It is a source of manure and pesticide.

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

- Compost and vermijuice can be sold to earn income.
- Structures can be made from locally available material.

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

- Not effective for large scale farming. Establishment of many bigger structures.
- The technology is not common among many farmers. Need for increased awareness creation among farmers, especially on proper knowledge on composting.

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

- Possible death of worms due to unfavourable temperature and humidity. Ensure regular checking of temperature and humidity.

REFERENCES

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Reviewer
William Critchley
Rima Mekdaschi Studer

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George Onyango - SLM specialist
Innocent Faith - SLM specialist

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6685/

Linked SLM data
Approaches: Community Resource Persons (CRP) in agricultural extension https://qcat.wocat.net/en/wocat/approaches/view/approaches_6688/

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- Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)

Project
- Soil protection and rehabilitation for food security (ProSo(i)l)

Key references
- Kakamega County Integrated Development Plan, 2018-2022: Free download at https://kakamega.go.ke/public-participation-county-development-plans/

Links to relevant information which is available online
- Vermicompost Suppression of Pythium Aphanidermatum Seedling Disease: Practical Applications and an Exploration of The Mechanisms of Disease Suppression: https://ecommons.cornell.edu/bitstream/handle/1813/31195/alh54.pdf;sequence=1

A multi-purpose tree nursery (William Akwanyi)

Promotion of different trees for agroforestry (Kenya)

DESCRIPTION

Promoting the values of different trees and their benefits in agroforestry contributes to increased adoption by farmers.

Agroforestry involves the integration of trees and/ or shrubs in a farming system on the same land where crops or pastures are grown. It offers significant environmental, economic, and social benefits. Agroforestry also enables farmers to diversify their on-farm income. Furthermore, it contributes to climate change adaptation and mitigation and improves the environment within the farm, especially soils. However, not every farmer is willing to adopt agroforestry. Trees and shrubs take up space that would have been dedicated to crops or pasture: this is a primary reason why farmers are not willing to plant trees and/ or shrubs on their farms. Similarly, many farmers do not clearly understand the values of some trees and shrubs. It is, therefore, essential to overcome the barriers to adopting agroforestry among farmers.

The ProSoil project has created awareness among farmers in Kakamega, Bungoma, and Siaya Counties about the more efficient and profitable tree and shrub-based value chains to attract farmers to agroforestry and pave the way for greater uptake. The farmers were targeted through their groups. Each group consisting of about 25 farmers, and with at least 30% women. Farmers are introduced to trees and/ or shrubs that blend well with their farming system. In addition, farmers choose trees and/ or shrubs based on the sizes of their farming land and their respective benefits. Farmers can plant trees and shrubs as single stands or integrate them into farming land. They can also plant agroforestry trees around their homesteads. A single stand can have, for example, mangos, avocados, and/or other trees. The project advocates for a more sustainable win-win approach where farmers and the environment benefit from an agroforestry system. Some of the benefits of trees and shrubs, as highlighted by the project, include the following:

a) Soil erosion control: trees and shrubs are planted on across slopes to slow down runoff and trap sediment (consequently, accumulating soil – this can form terraces after several years). Their roots hold the soil in place and reduce the impact of moving water.
b) Stabilising stream banks and gullies (e.g., Leucaena leucocephala, Sesbania grandiflora, Moringa oleifera, etc.): help to reduce soil erosion along streams and gullies when planted at the medium- to high-level watermark. Their roots hold the soil in place and reduce the impact of moving water.
c) Green manure (e.g., Sesbania sesban, Tithonia sp., etc.): from foliage and twigs.
d) Live fences (e.g., Tithonia sp.): used as boundaries to provide privacy and protection from browsing animals.
e) Windbreakers (e.g., Casuarina equisetifolia, Grevillea robusta, Leucaena leucocephala, etc.): planted in one or two rows/ lines closely together along the edges of the farm and perpendicular to winds to protect crops, soils, and structures from the detrimental effects of wind.
f) Fodder (e.g., Grevillea robusta, Sesbania sesban, Leucaena leucocephala, etc.): foliage is food for livestock.

LOCATION

Location: Nyagudha village, South Sakwa Ward, Bondo Sub-county, Siaya County, Nyanza Region, Kenya

Geo-reference of selected sites
- 34.23007, -0.21317

Initiation date: 2019

Year of termination: n.a.

Type of Approach

☐ traditional/ indigenous
☐ recent local initiative/ innovative
☐ project/ programme based
☑ Both traditional practice and project based: farmers have been growing trees and shrubs on their farms but the ProSoil project introduced them to more beneficial trees and better ways of producing the trees e.g., through grafting.

g) Food (e.g., mangoes, avocadoes, etc.): a human food source.
h) Carbon sequestration (all trees and shrubs): they act as carbon sinks by capturing carbon dioxide from the atmosphere.


A mango stand (William Onura)


Agroforestry: trees intercropped with maize (Jared Ayien)

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims / objectives of the approach
Aim: To promote the adoption of agroforestry.

Objectives:
1) To introduce farmers to the diverse benefits of trees in farming.
2) To encourage farmers to incorporate trees and/ or shrubs in their farming.

Conditions enabling the implementation of the Technology/ ies applied under the Approach
- **Social/ cultural/ religious norms and values**: Trees play a central role in the socio-cultural lives of people and are used for a wide range of cultural practices.
- **Collaboration/ coordination of actors**: Other institutions such as the county governments pass agroforestry information to farmers through the public agricultural extension officers. County governments are important collaborators in the ProSoil project.
- **Policies**: Kenya's 10 Percent Tree Cover Strategy includes the component of promoting farm forestry through various platforms e.g., radio and TV.
- **Knowledge about SLM, access to technical support**: ProSoil project has supported the dissemination of information about the importance of agroforestry as an SLM technology and how to propagate trees e.g., through grafting. As a result, some farmers have established trees nurseries.
- **Markets (to purchase inputs, sell products) and prices**: The increasing awareness about the benefits of many trees has led to an increase in the demand for the different products from the trees e.g., fruits, honey, medicines, etc. This potential of trees to generate income encourages farmers to plant trees.

Conditions hindering the implementation of the Technology/ ies applied under the Approach
- **Social/ cultural/ religious norms and values**: Cultural beliefs: e.g., women are not supposed to plant (some) trees as this is considered a male role. This hinders women from full participation in agroforestry activities.
- **Availability/ access to financial resources and services**: Some farmers do not have adequate financial resources to purchase seedling of some tree and shrub seedlings.
- **Legal framework (land tenure, land and water use rights)**: Trees and/ or shrubs take several years to mature. This is closely linked to land tenure since most people would prefer to establish trees only on their farms.
- **Land governance (decision-making, implementation and enforcement)**: Women and youth have little or no control over land in most communities. Hence, they cannot make decisions to plant (some) trees on the family land.

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

What stakeholders / implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	Farmers, farmer groups (women, youth, and mixed gender)	Recipients of the trainings in agroforestry.
SLM specialists/ agricultural advisers	GIZ ProSoil project SLM specialists; specialists from the implementing partner, Welthungerhilfe; and county SLM specialists from the departments of agriculture and environment.	Provides technical advice to the farmers and link farmers to markets and tree nurseries.
local government	County government agriculture and environment	Provides technical advice to the farmers and link

	departments	farmers to markets and tree nurseries.
international organization	GIZ	Financial support to the technical team and farmers during capacity building.

Lead agency
GIZ

Involvement of local land users/ local communities in the different phases of the Approach

	none	passive	external support	interactive	self-mobilization	
initiation/ motivation					✓	Farmers involved in the training in agroforestry.
planning				✓		Farmers consulted on where and when to establish demos of agroforestry tree nurseries.
implementation					✓	Although farmers are advised which trees are better for their farms, they are the final decision makers on which trees and shrubs to incorporate in their farms.
monitoring/ evaluation		✓				Interviews with implementing farmers.
None	✓					

Flow chart

The ProSoil project (GIZ and WHH) provides financial (transport reimbursement) and material (seedlings) support to farmers through their groups (Ndati Development Self-Help Group). The project also facilitates the county departments of Agriculture and Environment to train farmers in agroforestry and increase their awareness about the socio-economic and ecological benefits of different trees. at the farm.

Author: William Akwanyi

Decision-making on the selection of SLM Technology

Decisions were taken by
- ☐ land users alone (self-initiative)
- ☑ mainly land users, supported by SLM specialists
- ☐ all relevant actors, as part of a participatory approach
- ☐ mainly SLM specialists, following consultation with land users
- ☐ SLM specialists alone
- ☐ politicians/ leaders

Decisions were made based on
- ☑ evaluation of well-documented SLM knowledge (evidence-based decision-making)
- ☐ research findings
- ☑ personal experience and opinions (undocumented)

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE MANAGEMENT

The following activities or services have been part of the approach
- ☑ Capacity building/ training
- ☑ Advisory service
- ☑ Institution strengthening (organizational development)
- ☑ Monitoring and evaluation
- ☐ Research

Capacity building/ training

Training was provided to the following stakeholders
- ☑ land users
- ☐ field staff/ advisers

Form of training
- ☐ on-the-job
- ☑ farmer-to-farmer
- ☑ demonstration areas
- ☐ public meetings
- ☐ courses

Subjects covered
1. Different trees in agroforestry and their benefits
2. Tree nursery management
3. Grafting
4. Agroforestry systems
5. Value addition to agroforestry products and marketing

Advisory service

Advisory service was provided
- ☑ on land users' fields
- ☑ at permanent centres
- ☑ Specific locations where the farmers interact with the technical officers and at their farms.

Farmers were trained in their groups at specific venues during sessions organized by the ProSoil project/ WHH. Other farmers are learning from the trained farmers. These specialists also advice farmers during farm visits.

Institution strengthening

Institutions have been strengthened / established
- no
- ☑ yes, a little
- yes, moderately
- yes, greatly

at the following level
- ☑ local
- regional
- national

Describe institution, roles and responsibilities, members, etc.
Farmers have formed groups such as Ndati Development Self-Help Group e.g., to run tree nurseries. The groups consist of several men and women of diverse ages. Farmers develop funding and other support proposals through the groups.

Type of support
- financial
- ☑ capacity building/ training
- ☑ equipment

Further details
Trainings in agroforestry, markets, tree propagation, etc.
Nursery materials and equipment including water tanks, seeds and grafting tools

Monitoring and evaluation
GIZ and Welthungerhilfe regularly follows up with farmers to check on the implementation of technologies promoted under this approach.

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component
- < 2,000
- 2,000-10,000
- ☑ 10,000-100,000
- 100,000-1,000,000
- > 1,000,000

Precise annual budget: n.a.

ProSoil project facilitated trainings on the SLM technologies under this approach, including transport reimbursement to farmers and trainers and remuneration to trainers during trainings. Farmers meet the costs of land preparation, acquiring seeds and seedlings, planting trees, and managing the trees. The stated budget is for training one farmer group of about 25 farmers.

The following services or incentives have been provided to land users
- ☑ Financial/ material support provided to land users
- Subsidies for specific inputs
- Credit
- ☑ Other incentives or instruments

Financial/ material support provided to land users
The ProSoil project through Welthungerhilfe supported the farmers (through their group) with trainings and setting up demo plots.

Other incentives or instruments

Linkage to markets for the tree and shrub products. GIZ, WHH, and the county department of agriculture and environmental invite farmers to field days where the farmer can link up with potential markets.

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

	No	Yes, little	Yes, moderately	Yes, greatly
Did the Approach empower local land users, improve stakeholder participation? Farmers were empowered with skill on how to propagate trees. Stakeholder participation was enhanced through collaboration with other actors such as the county government.				✓
Did the Approach enable evidence-based decision-making? Farmers were motivated to plant some trees and shrubs on their farms after benchmarking farms which had established and benefited from similar trees.				✓
Did the Approach help land users to implement and maintain SLM Technologies? After learning about the importance of different trees, farmers incorporated trees in their farming systems e.g., planting trees and/ or shrubs in vegetative cross slope barriers.			✓	
Did the Approach improve knowledge and capacities of land users to implement SLM? The trainings given to farmers included how to plant different trees and areas within a farm setting where such trees are best suited. This knowledge was helpful in the incorporation of trees in the implementation of vegetative cross-slope barriers, green manure cover crops, and retention ditches.				✓
Did the Approach mitigate conflicts? Planting of quick growing shrubs has provided source of fuel wood at the household level reducing conflicts resulting in neighbouring farmers invading farms for fuel wood			✓	
Did the Approach lead to improved food security/ improved nutrition? Some of the agroforestry trees promoted under the different technologies and for which this approach sought to create awareness about are sources of food.			✓	
Did the Approach improve access to markets? The trainings include linking farmers to market for some of the agroforestry products.		✓		

Did the Approach improve the capacity of the land users to adapt to climate changes/ extremes and mitigate climate related disasters?
Some of the trees are sources of food during months when there is scarcity of food e.g., mangoes mature mostly during the dry season when there is scarcity of food in the households.

Did the Approach lead to employment, income opportunities?
Some farmers have established tree nurseries. They sell tree seedlings to earn income. Some have employed tree nursery operators.

Main motivation of land users to implement SLM

- [x] increased production
- [x] increased profit(ability), improved cost-benefit-ratio
- [x] reduced land degradation
- [x] reduced risk of disasters
- [ ] reduced workload
- [ ] payments/ subsidies
- [ ] rules and regulations (fines)/ enforcement
- [ ] prestige, social pressure/ social cohesion
- [ ] affiliation to movement/ project/ group/ networks
- [x] environmental consciousness
- [ ] customs and beliefs, morals
- [x] enhanced SLM knowledge and skills
- [x] aesthetic improvement
- [ ] conflict mitigation

Sustainability of Approach activities

Can the land users sustain what hat been implemented through the Approach (without external support)?

- [ ] no
- [x] yes
- [ ] uncertain

Farmers have established group tree nurseries as sources of seedlings and income. Some of the trees promoted under this approach can easily be propagated by farmers.

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Trees contribute to environmental management - increase in carbon sequestration (capture of carbon dioxide), control of soil erosion, and conservation of water.
- Trees have multiple products, including food, humus, timber, firewood, etc.
- Most trees do not require costly and tedious maintenance.

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

- Trees can be planted at the homestead. Hence, an added value of the homestead.
- The benefits of trees go beyond the farm and the farmer e.g., beauty which is enjoyed by anyone who looks at the trees.

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

- Tree seedlings require a lot of manure and proper care to protect them from animals. Farmers to make their own compost at the farm.
- Some seedlings are expensive. Increase awareness among farmers about seed preparation and tree nursery management.

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

- Trees can take up land that would have been used for food production. Proper planning of the farm.

REFERENCES

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Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/approaches/view/approaches_6706/

Linked SLM data
Technologies: Vegetative cross-slope barriers https://qcat.wocat.net/en/wocat/technologies/view/technologies_6705/

Documentation was faciliated by

Institution
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- Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)

Project
- Soil protection and rehabilitation for food security (ProSo(i)l)

Key references
- Extension Approaches to Promote Effective Adoption of Agroforestry Practices: Lessons Learned from Indonesia: Free download at http://apps.worldagroforestry.org/downloads/Publications/PDFS/PO19073.pdf

Links to relevant information which is available online
- Paving the way for greater uptake of agroforestry farming systems: https://www.niras.com/news/promoting-agroforestry-in-the-development-context/#:~:text=Agroforestry%20involves%20the%20integration%20of,dependent%20on%20a%20single%20crop.

Examples of minimum tillage tools (William Akwanyi)

Improving farmers' access to tools for conservation agriculture (Kenya)

Kuendeleza kilimo hifadhi

DESCRIPTION

Improving farmers' access to minimum tillage tools is an approach to increasing the adoption of conservation agriculture (CA) through linking them to institutions that fabricate the tools.

Using minimum tillage tools in land preparation, planting, and weed management helps to achieve the principle of minimal soil disturbance in conservation agriculture (CA). However, one of the main challenges facing the adoption of minimum tillage is the high cost of minimum tillage tools. In this approach, the ProSoil project sought to overcome the challenges of accessibility to and high cost of minimum tillage tools. GIZ through Gesellschaft für Agrarprojekte in Übersee (GFA) collaborated with the County Departments of Agriculture's Agricultural Technology Development Centers (ATDCs) to train local artisans (welders) on how to fabricate minimum tillage tools at reduced cost and ensure easy access. Currently, the farmers can order hand-held minimum tillage tools such as jab planters, hand-held scrapers, shallow weeders, hand-held subsoilers, animal draft power (ADP) subsoilers, ADP rippers, and chaka hoes from ATDCs and local fabricators at reduced costs. In addition, farmers with large pieces of land can hire heavy minimum tillage implements from ATDCs at affordable rents. The project has also partnered with the Kenya Agricultural and Livestock Research Organization (KALRO) to ensure continuous research on the minimum tillage tools and how to improve them based on the different farm settings.

To increase knowledge about minimum tillage, GFA facilitated local community-based organizations to train farmers on the importance of minimum tillage and how to use minimum tillage tools. In Gem Yala area of Siaya County, Kenya, GFA partnered with Rural Energy and Food Security Organization (REFSO) to offer these pieces of training to the farmers through their groups and link them to local manufacturers. Each group consisted of about 25 farmers of which at least 30% were women. The trainings take place at designated venues in localities that are easily accessible by farmers from different locations.

Farmers like this approach because they have been linked to the manufacturers of the tools and have had their capacity built on how to use the tools. They are therefore able to access the tools easily and at affordable prices. They are also motivated to adopt minimum tillage after having benchmarked in other farms are seen how minimum tillage has improved production.

LOCATION

Location: Gem North Ward in Gem Yala Sub-county, Siaya County, Nyanza Region, Kenya

Geo-reference of selected sites

- 34.28804, 0.0558
- 34.43843, 0.09885

Initiation date: 2020

Year of termination: n.a.

Type of Approach

- ☐ traditional/ indigenous
- ☐ recent local initiative/ innovative
- ☑ project/ programme based

A farmer demonstrating how to use a jab planter (William Onura)

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims / objectives of the approach

Aim: To increase the adoption of conservation agriculture (CA).

Objective: To improve farmers' access to minimum tillage tools.

Conditions enabling the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values**: Most farmers have accepted the technology.
- **Availability/ access to financial resources and services**: Less capital investments in maintaining the technologies under the approach.
- **Collaboration/ coordination of actors**: Collaboration with Kenya Agricultural, Livestock Research Organisation (KALRO) and Agricultural Technology and Development Centres (ATDC), local artisans, farmer groups, and Rural Energy and Food Security Organization (REFSO) in tool production and training.
- **Knowledge about SLM, access to technical support**: Working together with partners from the county department of agriculture to increase awareness about the tools.
- **Workload, availability of manpower**: Reduced workload in the long run.

Conditions hindering the implementation of the Technology/ ies applied under the Approach

- **Knowledge about SLM, access to technical support**: Not preferred by farmer who want to have benefits in the short term.

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

What stakeholders / implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	Farmers - men, women, and youth.	Targeted by the technologies and implement them.
community-based organizations	Umoya Farmers Self-Help Group	Convening farmers during trainings.
SLM specialists/ agricultural advisers	SLM specialists from the ProSoil project, Rural Energy and Food Security Organization (REFSO) and the Agricultural Technology Development Centre (ATDC).	Technical support and advisories to farmers i.e., pass the SLM knowledge to the community resource persons in the community.
researchers	Kenya Agricultural and Livestock Research Organization (KALRO)	Continuous research on the CA tools and how to improve them based on the different settings.
private sector	Rural Energy and Food Security Organization (REFSO)	Worked hand-in-hand with other SLM specialists to pass the SLM knowledge to the farmers.
local government	Agricultural extension officers from the county government department of agriculture i.e., the Agricultural Technology Development Centre (ATDC).	Worked hand-in-hand with other SLM specialists to pass the SLM knowledge to the farmers.
international organization	GIZ	Proposal design and financial support to the implementation of the approach.

Lead agency

GIZ

Involvement of local land users/ local communities in the different phases of the Approach

	none	passive	external support	interactive	self-mobilization	
initiation/ motivation		✓				Farmers in the community, targeted by the SLM technologies under the approach and awareness on access to the minimum tillage tools.
planning				✓		Agricultural Technology Development Centre (ATDC) and Rural Energy and Food Security Organization (REFSO) jointly agree with farmers on when to engage each other, especially time and venue for training and awareness creation on access to tools.
implementation					✓	Once trained, farmers implement the SLM technologies on their own, but may seek further advice from the SLM specialists where necessary.
monitoring/ evaluation		✓				The planning for and conduct of monitoring and/ or evaluation is a role of GIZ and WHH. Farmers are mainly interviewed based on pre-determined questions.
Research				✓		Continued research by ATDC and KALRO in consultation with farmers to develop tools that are suitable for different settings/ farmlands.

Flow chart

Author: William Akwanyi

The ProSoil (GIZ and WHH) provides financial support for research by the Kenya Agricultural and Livestock Researchj Organization (KALRO) and for training of farmers by Rural Energy and Food Security Organization (REFSO) and of local artisans by the Agricultural Technology Development Centre (ATDC). Umoya Farmers Self-Help Group convenes farmers for training.

Decision-making on the selection of SLM Technology

Decisions were taken by
- [ ] land users alone (self-initiative)
- [ ] mainly land users, supported by SLM specialists
- [x] all relevant actors, as part of a participatory approach
- [ ] mainly SLM specialists, following consultation with land users
- [ ] SLM specialists alone
- [ ] politicians/ leaders

Decisions were made based on
- [x] evaluation of well-documented SLM knowledge (evidence-based decision-making)
- [x] research findings
- [ ] personal experience and opinions (undocumented)

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE MANAGEMENT

The following activities or services have been part of the approach
- [x] Capacity building/ training
- [x] Advisory service
- [x] Institution strengthening (organizational development)
- [x] Monitoring and evaluation
- [x] Research

Capacity building/ training

Training was provided to the following stakeholders
- [x] land users
- [x] field staff/ advisers
- [x] Local artisans

Form of training
- [x] on-the-job
- [x] farmer-to-farmer
- [x] demonstration areas
- [ ] public meetings
- [ ] courses

Subjects covered

1. Benefits of conservation agriculture - minimum tillage
2. Different types of minimum tillage tools
3. How to use different minimum tillage tools
4. Linkage to minimum tillage tools fabricators

Advisory service

Advisory service was provided
- [x] on land users' fields
- [x] at permanent centres

SLM specialists advise farmers at their farms whenever they visit them. Farmers can also visit ATDC, KALRO, and REFSO offices for advice. Farmers are also trained at designated venues in groups.

Institution strengthening

Institutions have been strengthened / established
- [ ] no
- [ ] yes, a little
- [x] yes, moderately
- [ ] yes, greatly

at the following level
- [x] local
- [ ] regional
- [ ] national

Describe institution, roles and responsibilities, members, etc.
About 10 REFSO SLM specialists have been capacity built/ trained.

Type of support
- [ ] financial
- [x] capacity building/ training
- [ ] equipment

Further details
Training on CA, its benefits, and how and where to access CA tools.

Monitoring and evaluation
GIZ and GFA regularly follows up with local artisans and the Agricultural Technology Development Centre (ATDC) to check on the number of farmers who have bought/ access minimum tillage tools.

Research
Research treated the following topics
- ☐ sociology
- ☐ economics / marketing
- ☐ ecology
- ☐ technology
- ☑ Tool suitability

Research was done by the Agricultural Technology Development Centre (ATDC) and the Kenya Agricultural and Livestock Research Organization (KALRO) to determine which minimum tillage tools are suitable for which farm settings.

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component
- ☐ < 2,000
- ☐ 2,000-10,000
- ☐ 10,000-100,000
- ☑ 100,000-1,000,000
- ☐ > 1,000,000

Precise annual budget: n.a.

Training costs met by GIZ ProSoil project. The cost covers training of a group of about 25 farmers and a group of about 20 local fabricators, and research in tool suitability.

The following services or incentives have been provided to land users
- ☑ Financial/ material support provided to land users
- ☑ Subsidies for specific inputs
- ☐ Credit
- ☐ Other incentives or instruments

Financial/ material support provided to land users
GIZ through GFA supported farmers in their groups with minimum tillage tools for demonstration purposes.

	partly financed	fully financed
equipment: tools GIZ through GFA supported farmers in their groups with CA tools for demonstration purposes.		☑

Labour by land users was
- ☑ voluntary
- ☐ food-for-work
- ☐ paid in cash
- ☐ rewarded with other material support

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

	No	Yes, little	Yes, moderately	Yes, greatly
Did the Approach empower local land users, improve stakeholder participation? Farmers have been empowered with skills on how to use minimum tillage tools and where and how to access them.				☑
Did the Approach enable evidence-based decision-making? Demonstration/ learning plots were important in enabling farmers to learn from the practitioners and from each other based on evidence.				☑
Did the Approach help land users to implement and maintain SLM Technologies? Farmer were trained on minimum tillage.				☑
Did the Approach improve coordination and cost-effective implementation of SLM? The Agriculture Technology Development Centre (ATDC) trained local artisans on how to fabricate minimum tillage tools and sells them to farmers at a lower price than that in the other farmers' shops.				☑
Did the Approach improve knowledge and capacities of land users to implement SLM? Farmer were taken through pieces of trainings on how to use the minimum tillage tools.				☑
Did the Approach improve knowledge and capacities of other stakeholders? Local artisans were trained on how to fabricate minimum tillage tools.				☑
Did the Approach build/ strengthen institutions, collaboration between stakeholders? Collaboration between farmers and public extension officers i.e., Agriculture Technology Development Centre (ATDC) SLM specialists. More farmers are consulting these officers for advice.			☑	
Did the Approach empower socially and economically disadvantaged groups? The minimum tillage tools provided to the farmers in their groups are used by farmers who cannot afford to buy the tools.			☑	
Did the Approach lead to employment, income opportunities? More local artisans were trained on the fabrication of minimum tillage tools. They sell these tools to farmers and earn income.				☑

Main motivation of land users to implement SLM

- ☑ increased production
- ☑ increased profit(ability), improved cost-benefit-ratio
- ☑ reduced land degradation
- ☐ reduced risk of disasters
- ☑ reduced workload
- ☐ payments/ subsidies
- ☐ rules and regulations (fines)/ enforcement
- ☐ prestige, social pressure/ social cohesion
- ☐ affiliation to movement/ project/ group/ networks
- ☐ environmental consciousness
- ☐ customs and beliefs, morals
- ☑ enhanced SLM knowledge and skills
- ☐ aesthetic improvement
- ☐ conflict mitigation

Sustainability of Approach activities

Can the land users sustain what hat been implemented through the Approach (without external support)?

- ☐ no
- ☑ yes
- ☐ uncertain

The tools are fabricated and sold to farmers at lower prices than conventional prices i.e., prices in other shops.

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Increased access to minimum tillage tools.
- The tools are fabricated and sold at lower prices than the prices in other shops.

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

- The ProSoil has linked farmers to local fabricators to ensure ease of access to tools.

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

- Very few artisans fabricate minimum tillage tools. Training of more local artisans on how to fabricate the tools and set up businesses.

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

- Inaccessibility of the tools. Increase awareness among the local artisans so that they can fabricate the tools and set up businesses and provide more affordable solution to farmers.

REFERENCES

Compiler
William Akwanyi

Editors
Christopher Nyakan
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Innocent Faith
Noel Templer

Reviewer
William Critchley
Rima Mekdaschi Studer

Date of documentation: April 27, 2023

Last update: July 3, 2023

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Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/approaches/view/approaches_6738/
Video: https://player.vimeo.com/video/20230311124840

Linked SLM data
Technologies: Permanent soil cover https://qcat.wocat.net/en/wocat/technologies/view/technologies_6699/
Technologies: Permanent soil cover https://qcat.wocat.net/en/wocat/technologies/view/technologies_6699/

Documentation was faciliated by

Institution

- CIAT International Center for Tropical Agriculture (CIAT International Center for Tropical Agriculture) - Kenya
- Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)

Project

- Soil protection and rehabilitation for food security (ProSo(i)l)

Key references

- Conservation Agriculture Technical Manual by SUSTAINET E.A.: Free download at https://www.weadapt.org/sites/weadapt.org/files/legacy-new/knowledge-base/files/1051/507bcb0bb6e92technical-manual-on-conservation-agriculture-sustanet.pdf

Links to relevant information which is available online

- Conservation agriculture: https://infonet-biovision.org/EnvironmentalHealth/Conservation-agriculture

A push-pull plot (William Akwanyi)

Push-pull crop pest control (Kenya)

DESCRIPTION

Push-pull technology is a strategy that controls pests, improves the productivity of cereal crops and fodder, and controls soil erosion.

Push–pull technology was developed by the International Centre of Insect Physiology and Ecology (ICIPE) in collaboration with Rothamsted Research, (UK) in Kenya in the 1990s for the control of stemborer and striga weed in resource-poor maize farming systems. It is a strategy for controlling pests by using plants that repel them i.e., "push" crops and plants that trap pests i.e., "pull" crops. In Kakamega, Siaya, and Bungoma counties of western Kenya (i.e., the ProSoil project areas), the production of maize, millet, and sorghum has greatly been affected by poor soil fertility; insect pests, especially stemborer; and a parasitic weed called striga. Under the ProSoil project, Desmodium intortum is the main repellent "push" crop while napier grass (Pennisetum purpureum), brachiaria (Brachiaria decumbens), and mulatto (Brachiaria ruziziensis) are the main "pull" or trap plants.

In a typical push-pull system, the attractant "pull" plant is planted as a border around the field where the main crop e.g., maize, millet, or sorghum has been intercropped with the "push" crop. Desmodium produces repellent volatile chemicals that push away stemborer moths from the main field towards the edge where there is the "pull" or trap crop. The attractant trap plant emits volatile compounds which serve as a haven for the stemborers. As the stemborer moths lay eggs on the pull/ trap plant (in this case bracharia) and the eggs hatch and develop into larvae or caterpillar stage, a sticky substance like glue secreted by the bracharia physically traps the larvae; hence, inhibiting further development. In addition, desmodium stimulates the germination of striga and then effectively inhibits its growth through its roots' exudates.

"Push-pull" technology improves the productivity of cereal crops, controls soil erosion, and contributes to conservation agriculture (minimum tillage). Desmodium and bracharia are both high-quality animal fodder plants and because of their perennial nature, they maintain ground cover. Bracharia is rich in crude protein. Desmodium is a leguminous green manure cover crop and, therefore, it fixes nitrogen in the soil and improves soil organic matter. Desmodium does not suppress the main crop since it is not a climber.

One acre (0.4 ha) of land (in a push-pull system) requires about 0.75 kg of desmodium seeds and about 0.5 kg of brachiaria seeds. Desmodium is planted at a spacing of 75 cm between rows and 60 cm between plants in the same row. The cereal crop is established in rows parallel to the desmodium crop rows (e.g., 75 cm from row to row and 30 cm from plant to plant in the same row for maize). Brachiaria is planted in two shallow trenches (50 cm apart) and because the seeds are very tiny, they are sown on the surface of the trenches and covered with a very thin layer of soil to keep them in place, in darkness, until they sprout. They are later thinned to give a spacing of 25 cm between plants.

LOCATION

Location: Khalaba Ward, Matungu Sub-county, in Kakamega County, Kakamega County in western Kenya, Kenya

No. of Technology sites analysed: 2-10 sites

Geo-reference of selected sites
- 34.54351, 0.42841
- 34.54315, 0.42841

Spread of the Technology: evenly spread over an area (approx. < 0.1 km2 (10 ha))

In a permanently protected area?: No

Date of implementation: 2019

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

A farmer demonstrating how to prepare a push-pull plot for the establishment of a cereal crop (William Akwanyi)

A farmer showing the different crops (repellant and attractant crops) in a push-pull system (William Akwanyi)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

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

Land use

Land use mixed within the same land unit: Yes - Agro-silvopastoralism

Cropland

- Annual cropping: cereals - maize, cereals - sorghum, fodder crops - clover, fodder crops - grasses, legumes and pulses - beans, vegetables - other. Cropping system: Maize/sorghum/millet intercropped with legume
- Perennial (non-woody) cropping: banana/plantain/abaca, fodder crops - grasses, fodder crops - legumes, clover, sugar cane
- Tree and shrub cropping: avocado, fodder trees (Calliandra, Leucaena leucocephala, Prosopis, etc.), fruits, other, mango, mangosteen, guava, papaya

Number of growing seasons per year: 2
Is intercropping practiced? Yes
Is crop rotation practiced? Yes

Grazing land

- Cut-and-carry/ zero grazing
- Improved pastures

Animal type: cattle - dairy, goats, poultry
Is integrated crop-livestock management practiced? Yes
Products and services: economic security, investment prestige, eggs, manure as fertilizer/ energy production, meat, milk

Species	Count
cattle - dairy	3
poultry	55
goats	4

Water supply

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

Purpose related to land degradation

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

Degradation addressed

soil erosion by water - Wt: loss of topsoil/ surface erosion

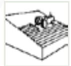
soil erosion by wind - Et: loss of topsoil

SLM group

- rotational systems (crop rotation, fallows, shifting cultivation)
- integrated crop-livestock management

SLM measures

- integrated pest and disease management (incl. organic agriculture)



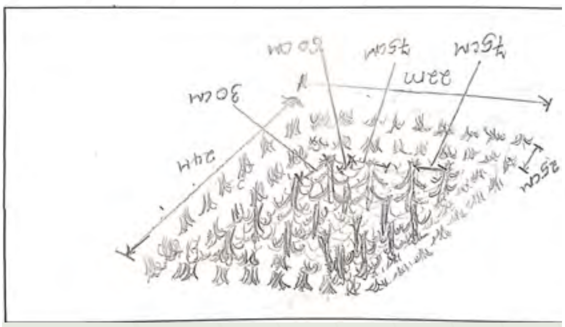
agronomic measures - A1: Vegetation/ soil cover, A2: Organic matter/ soil fertility, A3: Soil surface treatment

vegetative measures - V2: Grasses and perennial herbaceous plants

TECHNICAL DRAWING

Technical specifications

Trap crop at the edge (brachiaria): 50 cm x 25 cm
Repellant crop (desmodium): 75 cm x 60 cm
Cereal crop (maize intercropped with desmodium): 75 cm x 30 cm



Author: William Akwanyi

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology area (size and area unit: **0.0528 ha**)
- Currency used for cost calculation: **KES**
- Exchange rate (to USD): 1 USD = 124.21 KES
- Average wage cost of hired labour per day: KES 250.00

Most important factors affecting the costs

Rate of man-days vary from one place to another, farmer to farmer, and with type of work. Exchange rate for February 2023, source: European Commission/ InfoEuro online at https://commission.europa.eu/funding-tenders/procedures-guidelines-tenders/information-contractors-and-beneficiaries/exchange-rate-inforeuro_en

Establishment activities

1. Land preparation (Timing/ frequency: Before rains)
2. Seed sourcing (Timing/ frequency: Before rains)
3. Planting (Timing/ frequency: After rains)

Establishment inputs and costs (per 0.0528 ha)

Specify input	Unit	Quantity	Costs per Unit (KES)	Total costs per input (KES)	% of costs borne by land users
Labour					
Land preparation	Man-days	4.0	250.0	1000.0	100.0
Equipment					
Slasher	No.	1.0	70.0	70.0	
African machete (panga)	No.	1.0	80.0	80.0	
Jab planter	No.	1.0	1000.0	1000.0	
Plant material					
Bracharia seeds	Kgs	0.1	420.0	42.0	
Desmodium seeds	Kgs	0.26	420.0	109.2	
Maize seeds	Kgs	1.0	180.0	180.0	100.0
Fertilizers and biocides					
Manure	Wheelbarrows	30.0	70.0	2100.0	
Total costs for establishment of the Technology				**4'581.2**	
Total costs for establishment of the Technology in USD				*36.88*	

Maintenance activities

1. Shallow weeding (Timing/ frequency: Twice during maize crop growing period)
2. Ripping (Timing/ frequency: Before maize re-establishement)
3. Root management (Timing/ frequency: Before maize re-establishement)

Maintenance inputs and costs (per 0.0528 ha)

Specify input	Unit	Quantity	Costs per Unit (KES)	Total costs per input (KES)	% of costs borne by land users
Labour					
Shallow weeding	Man-days	2.0	250.0	500.0	
Root management	Man-days	2.0	250.0	500.0	

Ripping	Man-days	4.0	250.0	1000.0	
Equipment					
Shallow weeder	No.	1.0	80.0	80.0	
Chaka hoe	No.	1.0	130.0	130.0	
African machete (panga)	No.	1.0	80.0	80.0	
Total costs for maintenance of the Technology				**2'290.0**	
Total costs for maintenance of the Technology in USD				*18.44*	

NATURAL ENVIRONMENT

Average annual rainfall
- ☐ < 250 mm
- ☐ 251-500 mm
- ☐ 501-750 mm
- ☐ 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
- ☐ sub-humid
- ☐ semi-arid
- ☐ arid

Specifications on climate

Average annual rainfall in mm: 1300.0
Monthly rainfall variability is high with some months such as January recording less than 5 mm of total rainfall.
Name of the meteorological station: Kakamega Meteorological Station
The climate in the area favours most agricultural activities.

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

Landforms
- ☑ plateau/plains
- ☐ ridges
- ☐ mountain slopes
- ☐ hill slopes
- ☐ footslopes
- ☐ valley floors

Altitude
- ☐ 0-100 m a.s.l.
- ☐ 101-500 m a.s.l.
- ☐ 501-1,000 m a.s.l.
- ☑ 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)
- ☐ shallow (21-50 cm)
- ☑ moderately deep (51-80 cm)
- ☐ deep (81-120 cm)
- ☐ very deep (> 120 cm)

Soil texture (topsoil)
- ☐ coarse/ light (sandy)
- ☑ medium (loamy, silty)
- ☐ 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%)
- ☐ 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

Water quality refers to: ground water

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
- ☐ subsistence (self-supply)
- ☑ 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
- ☐ very poor
- ☐ poor
- ☑ average
- ☐ rich
- ☐ very rich

Level of mechanization
- ☑ manual work
- ☐ animal traction
- ☐ mechanized/ motorized

Sedentary or nomadic
- ☑ Sedentary
- ☐ Semi-nomadic
- ☐ Nomadic

Individuals or groups
- ☑ 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
- ☑ 1-2 ha
- ☐ 2-5 ha
- ☐ 5-15 ha

Scale
- ☐ small-scale
- ☑ medium-scale
- ☐ large-scale

Land ownership
- ☐ state
- ☐ company
- ☐ communal/ village
- ☐ group
- ☑ individual, not titled

Land use rights
- ☐ open access (unorganized)
- ☐ communal (organized)
- ☑ leased
- ☑ individual

Water use rights

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

- [x] individual, titled

- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

health	poor			✓	good
education	poor			✓	good
technical assistance	poor			✓	good
employment (e.g. off-farm)	poor		✓		good
markets	poor			✓	good
energy	poor		✓		good
roads and transport	poor		✓		good
drinking water and sanitation	poor		✓		good
financial services	poor		✓		good

Comments

The above rating varies from one village to the other.

IMPACTS

Socio-economic impacts

Crop production

decreased						✓		increased	Quantity before SLM: 2 Quantity after SLM: 5 Quantity refers to the number of 90 Kg bags of maize produced per acre. Based on the farmer's experience.

crop quality

decreased						✓		increased	Not easy to quantify. The crops do better compared to the past. Based on the farmer's estimate.

fodder production

decreased							✓	increased	Quantity before SLM: 0 Quantity after SLM: 10 Quantity refers to amount of bracharia and desmodium in tonnes per year. Based on the farmer's estimate.

fodder quality

decreased							✓	increased	Not easy to quantify. Fodder does better compared to how it was before the technology. Based on the farmer's estimate.

animal production

decreased						✓		increased	Quantity before SLM: 2 Quantity after SLM: 8 Quantity refers to the amount of milk in litres from one cow. Based on the farmer's estimate.

risk of production failure

increased						✓		decreased	Quantity before SLM: 70 Quantity after SLM: 30 Quantity refers to the percentage probability of the crop failing to do well. Based on the farmer's estimate.

land management

hindered					✓			simplified	Not easy to quantify but it is easier to prepare land through no tillage than to plough. Based on the farmer's estimate.

expenses on agricultural inputs

increased							✓	decreased	Quantity before SLM: 7,000 Quantity after SLM: 0 Quantity refers to the amount of money in Kenya shillings spend on inorganic fertilizers in a season. The farmer no longer buys money inorganic fertilizers.

farm income

decreased							✓	increased	Quantity before SLM: 1,000 Quantity after SLM: 15,000 Quantity refers to amount of money from farming per year.

diversity of income sources

decreased					✓			increased	Quantity before SLM: 2 Quantity after SLM: 4 Quantity refers to the number of household income sources. Based on the farmer's estimate.

workload

increased						✓		decreased	Not easy to quantify but it is easier to prepare land through no tillage than to plough. Based on the farmer's estimate.

Socio-cultural impacts

SLM/ land degradation knowledge

reduced							✓	improved	Quantity before SLM: 20 Quantity after SLM: 80 Quantity refers to the estimated percentage of knowledge in SLM/ land management. Based on the farmer's estimate. He says his SLM knowledge has greatly increased.

Ecological impacts

soil loss

increased ✓ decreased — Not easy for the farmer to quantify. Based on the farmer's estimate. Soil erosion has been controlled to some considerable degree at the farm.

soil accumulation

decreased ✓ increased — Not easy for the farmer to quantify. Based on the farmer's estimate.

habitat diversity

decreased ✓ increased — Not easy for the farmer to quantify. The number of plants at the farm has increased.

Off-site impacts

buffering/ filtering capacity (by soil, vegetation, wetlands)

reduced ✓ improved — Not easy for the farmer to quantify.

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

Gradual climate change

annual temperature increase — not well at all ✓ very well

seasonal temperature increase — not well at all ✓ very well — Season: dry season

Climate-related extremes (disasters)

insect/ worm infestation — not well at all ✓ very well

ADOPTION AND ADAPTATION

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

- ☐ single cases/ experimental
- ☑ 1-10%
- ☐ 11-50%
- ☐ > 50%

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

- ☐ 0-10%
- ☐ 11-50%
- ☐ 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

- Controls pests and weeds (striga).
- Controls soil erosion.
- Reduces workload due to permanent cover on the soil - minimum tillage.
- Desmodium does not interfere with the cereal crop.

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

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

- Can be problematic if desmodium roots are not managed. Root pruning before cereal crop establishment.

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

REFERENCES

Compiler
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Date of documentation: March 18, 2023

Last update: July 4, 2023

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Innocent Faith - SLM specialist

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6701/
Video: https://player.vimeo.com/video/20230211152954

Linked SLM data
n.a.

Documentation was faciliated by

Institution
- CIAT International Center for Tropical Agriculture (CIAT International Center for Tropical Agriculture) - Kenya
- Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)

Project
- Soil protection and rehabilitation for food security (ProSo(i)l)

Key references
- Soil cover: Free download at http://www.act-africa.org/image/05SOIL~1.PDF

Links to relevant information which is available online
- Push-Pull Technology: http://www.icipe.org/impacts/demonstration-research-impacts-communities/push-pull-technology#:~:text=Cereals%2C%20which%20include%20maize%2C%20sorghum,sub%20Saharan%20Africa%20(SSA).

A farm under a mucuna (velvet bean) cover crop (William Akwanyi)

Permanent soil cover (Kenya)

DESCRIPTION

Permanent soil cover with cover crops and/or crop residues helps to control soil erosion, suppress weeds and build up soil fertility. It can also add organic matter to the soil.

Permanent soil cover is having all-year-round cover on the soil. This can be either in the form of cover crops which are either planted with other crops at the same time, or relay planted later in the season after the main crops have established, or in the form of crop residues (mulch) which is naturally decomposed by microbes. Permanent soil cover provides a shield or umbrella to the soil protecting it from the heat of the sun and the impact of rain. It makes up a fundamental component of conservation agriculture where minimum tillage reduces soil disturbance.

Some of the crops used for permanent soil cover [those promoted by the ProSoil project] include Mucuna pruriens (velvet bean), Canavalia ensiformis, Dolichos lablab, and Desmodium intortum. All of these are legumes, which fix nitrogen from the atmosphere, thus improving soil fertility. In choosing a cover crop, farmers prefer those that fit into their normal cropping systems, and which have multiple purposes, including those that produce edible seeds and vegetables, those that improve soil fertility, those that can be used as animal fodder, and those that can suppress weeds. Some farmers prefer crops that can provide firewood or fencing material and those that can be used for medicinal purposes. Another important factor that farmers consider when choosing a cover crop is the amount and type of work that the cover crop will need, for example for land preparation before planting, weeding, and producing and harvesting the seeds. The crops most preferred are those that cover the soil quickly and completely, and which can also be used for food and fodder, including mucuna. Farmers also like mucuna because of its big pods and grains that are easier to deal with. Farmers can easily multiply mucuna seeds since they do not require complicated treatments; hence, do not need to continue spending money on the seeds.

In establishing a permanent soil cover using cover crops, farmers first intercrop seasonal crops (e.g., maize and beans) and later introduce a green manure cover crop (e.g., mucuna) after about 6 weeks (or at the time when the beans start to produce pods) to ensure that the green manure cover crop does not suppress the main crop(s). The maize is planted at 75 cm row spacing and 25 cm between plants in the same row. However, within each row, the third hole/ space is left for the cover crop (i.e., mucuna). Thus, mucuna is planted after every three maize plants in the same row. The bean intercrop is planted between the maize rows at the spacing of 37.5 cm from the maize row and 20 cm between bean plants in the same row. This spacing requires about 5 kg of cover crop (mucuna) seeds per acre. The crops continue to grow together and upon harvesting the main crops, the cover crop continues to grow on the farm covering the soil until the following cropping season.

Permanent soil cover is beneficial in the farm in various ways including, enhancing soil water infiltration, protecting soil from agents of erosion, increasing soil organic matter, suppressing weeds, aiding in nutrient cycling, and improving the habitat of soil micro- and macro-organisms. Maintaining permanent soil cover through mulching faces some limitations, including competing uses of crop residues e.g., as animal feeds and fuel. Similarly, drought may be a major limitation to maintaining permanent soil cover using cover crops, especially in areas that receive very low rainfall and where the farmer has not invested in irrigation.

LOCATION

Location: Kisa Central Ward in Khwisero Sub-county; and Koyonzo and Khalaba wards in Matungu Sub-county, Kakamega County in western Kenya, Kenya

No. of Technology sites analysed: 2-10 sites

Geo-reference of selected sites
- 34.58472, 0.14269

Spread of the Technology: evenly spread over an area

In a permanently protected area?: No

Date of implementation: 2021

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

Mucuna cover crop after the main crop (maize) has been harvested (William Akwanyi)

Mulching using maize stover (William Onura)

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
- ☑ adapt to climate change/ extremes and its impacts
- ☐ mitigate climate change and its impacts
- ☐ create beneficial economic impact
- ☐ create beneficial social impact

Land use

Land use mixed within the same land unit: Yes - Agro-silvopastoralism

Cropland

- Annual cropping: cereals - maize, fodder crops - grasses, fodder crops - other, legumes and pulses - beans, vegetables - melon, pumpkin, squash or gourd, vegetables - other. Cropping system: Maize/sorghum/millet intercropped with legume
- Perennial (non-woody) cropping: banana/plantain/abaca, fodder crops - grasses, fodder crops - legumes, clover
- Tree and shrub cropping: avocado, fodder trees (Calliandra, Leucaena leucocephala, Prosopis, etc.), fruits, other, mango, mangosteen, guava, papaya

Number of growing seasons per year: 2
Is intercropping practiced? Yes
Is crop rotation practiced? Yes

Grazing land

- Cut-and-carry/ zero grazing
- Improved pastures

Animal type: cattle - dairy, cattle - dairy and beef (e.g. zebu), poultry
Is integrated crop-livestock management practiced? Yes
Products and services: economic security, investment prestige, eggs, manure as fertilizer/ energy production, meat, milk

Species	Count
cattle - dairy	1
cattle - dairy and beef (e.g. zebu)	2
poultry	20

Water supply

- ☑ rainfed
- ☐ mixed rainfed-irrigated
- ☐ full irrigation

Purpose related to land degradation

- ☑ prevent land degradation
- ☐ reduce land degradation
- ☐ restore/ rehabilitate severely degraded land
- ☑ adapt to land degradation
- ☐ not applicable

Degradation addressed

soil erosion by water - Wt: loss of topsoil/ surface erosion

soil erosion by wind - Et: loss of topsoil

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

physical soil deterioration - Pc: compaction

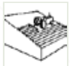
biological degradation - Bc: reduction of vegetation cover, Bs: quality and species composition/ diversity decline

water degradation - Ha: aridification

SLM group

- improved ground/ vegetation cover
- minimal soil disturbance
- integrated soil fertility management

SLM measures



agronomic measures - A1: Vegetation/ soil cover, A2: Organic matter/ soil fertility, A3: Soil surface treatment (A 3.1: No tillage), A6: Residue management (A 6.4: retained)

TECHNICAL DRAWING

Technical specifications

Maize/ mucuna spacing: row to row = 75 cm, plant to plant in the same row = 25 cm, mucuna planted in every third hole/ space in the same row
Bean spacing: bean rows between the maize/ mucuna rows, bean row to maize/ mucuna row = 37.5 cm, plant to plant in the same row = 20 cm

Author: William Akwanyi

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology area (size and area unit: **1 acre**)
- Currency used for cost calculation: **KES**
- Exchange rate (to USD): 1 USD = 124.21 KES
- Average wage cost of hired labour per day: KES 250.00

Most important factors affecting the costs

Rate of man-days vary from one place to another, farmer to farmer, and with type of work. Exchange rate for February 2023, source: European Commission/ InfoEuro online at https://commission.europa.eu/funding-tenders/procedures-guidelines-tenders/information-contractors-and-beneficiaries/exchange-rate-inforeuro_en

Establishment activities

n.a.

Maintenance activities

1. Land preparation (Timing/ frequency: Before rains)
2. Planting (Timing/ frequency: After rains)
3. Shallow weeding (Timing/ frequency: During the second weeding of the main crop at 1.5 months)
4. Uncoiling (e.g., mucuna from the main crop) (Timing/ frequency: Bi-weekly)

Maintenance inputs and costs (per 1 acre)

Specify input	Unit	Quantity	Costs per Unit (KES)	Total costs per input (KES)	% of costs borne by land users
Labour					
Slashing	Man-days	5.0	250.0	1250.0	100.0
Sub-soiling	Man-days	10.0	250.0	2500.0	100.0
Planting	Man-days	4.0	250.0	1000.0	100.0
Shallow weeding and uncoiling (e.g., mucuna from the main crop)	Man-days	9.0	250.0	2250.0	100.0
Equipment					
Slasher	No.	1.0	70.0	70.0	
Hand-held sub-soiler	No.	1.0	70.0	70.0	
Jab planter	No.	1.0	1000.0	1000.0	
Shallow weeder	No.	1.0	80.0	80.0	
Plant material					
Cover crop seeds	Kgs	5.0	150.0	750.0	
Total costs for maintenance of the Technology				**8'970.0**	
Total costs for maintenance of the Technology in USD				*72.22*	

NATURAL ENVIRONMENT

Average annual rainfall

- ☐ < 250 mm
- ☐ 251-500 mm
- ☐ 501-750 mm
- ☐ 751-1,000 mm
- ☑ 1,001-1,500 mm
- ☐ 1,501-2,000 mm
- ☐ 2,001-3,000 mm

Agro-climatic zone

- ☑ humid
- ☐ sub-humid
- ☐ semi-arid
- ☐ arid

Specifications on climate

Average annual rainfall in mm: 1300.0
Monthly rainfall variability is high with some months such as January recording less than 5 mm of total rainfall.
Name of the meteorological station: Kakamega Meteorological Station
The climate in the area favours most agricultural activities.

- [ ] 3,001-4,000 mm
- [ ] > 4,000 mm

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

Landforms
- [ ] plateau/plains
- [x] ridges
- [ ] mountain slopes
- [ ] hill slopes
- [ ] footslopes
- [ ] 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
- [x] not relevant

Soil depth
- [ ] very shallow (0-20 cm)
- [ ] 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)
- [ ] fine/ heavy (clay)

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

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

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

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

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

Water quality refers to: both ground and surface water

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

Occurrence of flooding
- [ ] Yes
- [x] No

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

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

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

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

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

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

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

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

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

Gender
- [x] women
- [x] men

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

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

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

Land ownership
- [ ] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [x] individual, not titled
- [x] individual, titled

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

Water use rights
- [x] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

health	poor			✓	good
education	poor			✓	good
technical assistance	poor			✓	good
employment (e.g. off-farm)	poor		✓		good
markets	poor		✓		good
energy	poor		✓		good
roads and transport	poor		✓		good
financial services	poor	✓			good

Comments

The above rating varies from one village to the other.

IMPACTS

Socio-economic impacts

Crop production	decreased	increased	Quantity before SLM: Less than 3 Quantity after SLM: More than 7 Quantity refers to the number of 90 Kg bags of maize produced per acre. Based on the farmer's estimate.
crop quality	decreased	increased	Not easy to quantify. The crops do better compared to how they could do in the past, yet he does not use inorganic fertilizers. Based on the farmer's estimate.
fodder production	decreased	increased	Quantity before SLM: 2 Quantity after SLM: 5 Quantity refers to harvesting cycles per year for nappier grass from the same farm. Based on the farmer's estimate.
fodder quality	decreased	increased	Not easy to quantify. Fodder does better compared to how it was before the technology. Based on the farmer's estimate.
animal production	decreased	increased	Quantity before SLM: 2 Quantity after SLM: 5 Quantity refers to the amount of milk in litres from one cow. Based on the farmer's estimate.
risk of production failure	increased	decreased	Quantity before SLM: 70 Quantity after SLM: 40 Quantity refers to the percentage probability of the crop failing to do well. Based on the farmer's estimate.
land management	hindered	simplified	Not easy to quantify but it is easier to prepare land through no tillage than to plough.
expenses on agricultural inputs	increased	decreased	Quantity before SLM: 10,000 Quantity after SLM: 0 Quantity refers to the amount of money in Kenya shillings spend on inorganic fertilizers in a season. The farmer no longer buys money inorganic fertilizers. Based on the farmer's experience.
diversity of income sources	decreased	increased	Quantity before SLM: 2 Quantity after SLM: 3 Quantity refers to the number of household income sources.
workload	increased	decreased	Not easy to quantify but it is easier to prepare land through no tillage than to plough.

Socio-cultural impacts

food security/ self-sufficiency	reduced	improved	Quantity before SLM: 3 Quantity after SLM: 1 Quantity refers to the number of months in a year when there is total lack of food in the house, and the farmer has to buy all the food required in the house. Based on the farmer's estimate.
SLM/ land degradation knowledge	reduced	improved	Refers to the estimated percentage of knowledge in SLM/ land management. Based on the farmer's estimate. His knowledge in SLM has greatly increased.

Ecological impacts

soil moisture	decreased	increased	Refers to the farmer's estimated soil moisture content during the dry season when soil moisture challenges are expected to be high.
soil cover	reduced	improved	Quantity before SLM: 40 Quantity after SLM: 60 Quantity refers to the farmer's estimated percentage soil cover at the farm.
soil loss	increased	decreased	Not easy for the farmer to quantify. According to him, soil erosion has reduced.
soil accumulation	decreased	increased	Not easy for the farmer to quantify. Based on the farmer's estimate.

nutrient cycling/ recharge	decreased ✓ increased	Not easy for the farmer to quantify. Based on the farmer's estimate.
soil organic matter/ below ground C	decreased ✓ increased	Not easy to quantify as there is no data. Based on the farmer's estimate.
vegetation cover	decreased ✓ increased	Quantity before SLM: 30 Quantity after SLM: 60 Quantity refers to the farmer's estimated percentage vegetation cover at the farm.
biomass/ above ground C	decreased ✓ increased	Not easy for the farmer to quantify. Based on the farmer's estimate.
plant diversity	decreased ✓ increased	Quantity before SLM: 4 Quantity after SLM: 11 Quantity refers to the number of plants (crops) that the farmer establishes at the farm. Based on the farmer's estimate.
invasive alien species	increased ✓ reduced	Quantity before SLM: 6 Quantity after SLM: 4 Quality refers to the number of species of weeds and invasive plants at the farm. Based on the farmer's estimate.
habitat diversity	decreased ✓ increased	Not easy for the farmer to quantify. Based on the farmer's estimate.

Off-site impacts

buffering/ filtering capacity (by soil, vegetation, wetlands)	reduced ✓ improved	No recorded data is available for reference. All are estimates based on the farmer's explanation or as given by him.

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

Gradual climate change

annual temperature increase	not well at all ✓ very well	
seasonal temperature increase	not well at all ✓ very well	Season: dry season

ADOPTION AND ADAPTATION

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

- ☐ single cases/ experimental
- ☐ 1-10%
- ☐ 11-50%
- ☑ > 50%

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

- ☐ 0-10%
- ☐ 11-50%
- ☐ 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

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

Calliandra incorporated into a vegetative cross-slope barrier (William Akwanyi)

Vegetative cross-slope barriers (Kenya)

DESCRIPTION

Cross-slope barriers in the form of vegetative strips are established on sloping lands to reduce runoff velocity and prevent soil loss, thereby contributing to the conservation of soil, water, and plant nutrients.

Vegetative cross-slope barriers are strips of perennial plants that are established along the contours of sloping lands. They act as soil and water conservation measures to reduce runoff velocity and consequently prevent soil loss. The strips are mostly between 0.3 m and 1.5 m wide and consist initially of one or two rows of plants. They slow down the speed of runoff during heavy rainfall. This facilitates infiltration, and eroded sediment in the runoff is trapped on the upslope side of the barriers. Hence, they contribute to the conservation of soil, water, and plant nutrients. The most used plants/ crops used in establishing vegetative cross-slope barriers are perennial erect grasses, including Brachiaria sp., napier grass (Pennisetum purpureum), and vetiver grass (Vetiver zizanioides). Depending on species (vetiver being an exception), vegetative cross-slope barriers can serve as important sources of fodder for livestock. Some farmers prefer to establish crops (e.g., bananas and pineapples) or trees and shrubs (e.g., (e.g., Calliandra calothyrus, Grevillea robusta or Sesbania sesban) as cross-slope barriers at appropriate spacing (depending on the tree/ shrub) to serve as windbreakers as well as providing additional measures to control soil erosion. Alternatively, these may be combined with grasses. These can also serve as important sources of food, fodder, fuel, and timber.

In establishing vegetative cross-slope barriers, the distance between the barriers is dictated by the slope of the land. The ProSoil project through Welthungerhilfe trained Community Resource Persons (CRPs) on how to survey contours using a line level. The CRPs by extension train farmers on how to measure slope for their fields and how to determine the distance between the barriers using a predetermined scale. Once established, minimal labour is required for maintenance. The main vegetation (grasses) must be harvested or cut back to a height of less than 0.5 m before planting a crop in the main field to prevent them from suppressing the crops through shading. The trees, and shrubs may need to be trimmed (coppiced) during the cropping period to allow adequate sunlight to reach the crops. The cut material can be collected and used as fodder or firewood as appropriate or be incorporated during land preparation, or during weeding as mulch.

Farmers like the technology because it contributes to soil, water, and nutrient conservation and it reduces the steepness of the slope as soil eroded from the upper part of the slope accumulates on the upslope side of the barrier resulting, eventually, in distinct terrace-like benches. As a result, farmers find it easier to cultivate on these terraces. Vegetative cross-slope barriers can be associated with retention ditches, especially where farmers find it important to harvest the water. They can also provide firewood and fodder, especially where palatable cut and carry varieties of grass are used.

LOCATION

Location: Khalaba Ward, Matungu Sub-county in Kakamega County, Kakamega County in western Kenya, Kenya

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 34.54194, 0.41211

Spread of the Technology: evenly spread over an area (0.003804 km²)

In a permanently protected area?: No

Date of implementation: 2019

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

A vegetative cross-slope barrier (George Onyango)

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
- ☑ adapt to climate change/ extremes and its impacts
- ☐ mitigate climate change and its impacts
- ☐ create beneficial economic impact
- ☐ create beneficial social impact

Land use

Land use mixed within the same land unit: Yes - Agroforestry

Cropland

- Annual cropping: cereals - maize, fodder crops - clover, fodder crops - grasses, fodder crops - other, legumes and pulses - beans, legumes and pulses - soya, oilseed crops - groundnuts, root/tuber crops - cassava. Cropping system: Maize/sorghum/millet intercropped with legume
- Perennial (non-woody) cropping
- Tree and shrub cropping: avocado, fodder trees (Calliandra, Leucaena leucocephala, Prosopis, etc.), fruits, other, mango, mangosteen, guava

Number of growing seasons per year: 2
Is intercropping practiced? Yes
Is crop rotation practiced? Yes

Grazing land

- Cut-and-carry/ zero grazing
- Improved pastures

Animal type: cattle - dairy and beef (e.g. zebu), poultry
Is integrated crop-livestock management practiced? Yes
Products and services: economic security, investment prestige, eggs, manure as fertilizer/ energy production, meat, milk

Species	Count
cattle - dairy and beef (e.g. zebu)	3
poultry	10

Water supply

- ☑ rainfed
- ☐ mixed rainfed-irrigated
- ☐ full irrigation

Purpose related to land degradation

- ☑ prevent land degradation
- ☑ reduce land degradation
- ☐ restore/ rehabilitate severely degraded land
- ☐ adapt to land degradation
- ☐ not applicable

Degradation addressed

soil erosion by water - Wt: loss of topsoil/ surface erosion, Wg: gully erosion/ gullying

SLM group

- agroforestry
- integrated crop-livestock management
- cross-slope measure

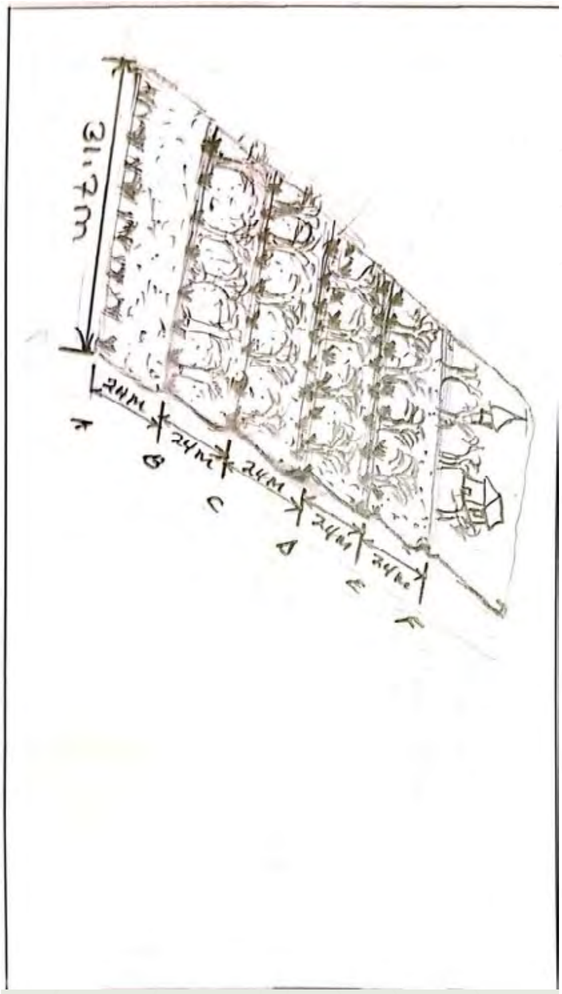
SLM measures

vegetative measures - V1: Tree and shrub cover, V2: Grasses and perennial herbaceous plants

TECHNICAL DRAWING

Technical specifications

Length of the farm (down the slope): 120 m
Width of the farm (along the contour): 31.7 m
Number of vegetative cross-slop barriers established: 6
Width of barriers: ranges between 0.3 m and 0.5 m
Slope: 4%
Width of the established terraces/ distance between any two barriers: 24 m
Plants used: brachiaria and napier grass (grasses), grevillea and calliandra (trees and shrub), bananas (crops)
1st barrier on the upper side (F) is on a retention ditch
Last barrier (A) is on the upper side of a channel that collects excess runoff and prevents damage to neighbours' farms on the lower side of the farm



Author: William Akwanyi

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology area (size and area unit: **0.00761 ha**; conversion factor to one hectare: **1 ha = 1 ha = 2.47 acres**)
- Currency used for cost calculation: **KES**
- Exchange rate (to USD): 1 USD = 124.21352 KES
- Average wage cost of hired labour per day: 250

Most important factors affecting the costs

Rate of man-days vary from one place to another and also depend on the kind of work. Exchange rate for January 2023, source: European Commission/ InfoEuro online at https://commission.europa.eu/funding-tenders/procedures-guidelines-tenders/information-contractors-and-beneficiaries/exchange-rate-inforeuro_en The stated costs are estimates.

Establishment activities

1. Contour surveying to establish locations for the vegetative cross slope barriers (Timing/ frequency: Before planting)
2. Planting (Timing/ frequency: After rains)

Total establishment costs (estimation)

8000.0

Maintenance activities

1. Weeding (Timing/ frequency: After every harvest)
2. Adding manure/ compost (Timing/ frequency: After every harvest)
3. Regular inspection to fill large gaps in the barriers that are 30 Cm or more by replanting (Timing/ frequency: Monthly during the rainy season)

Maintenance inputs and costs (per 0.00761 ha)

Specify input	Unit	Quantity	Costs per Unit (KES)	Total costs per input (KES)	% of costs borne by land users
Labour					
Weeding	Man-days	3.0	250.0	750.0	100.0

Adding manure/ compost	Man-days	2.0	250.0	500.0	100.0
Equipment					
Hoe (jembe) for weeding	No.	1.0	90.0	90.0	100.0
Wheelbarrow for carrying manure/ compost	No.	1.0	500.0	500.0	100.0
Spade for scooping manure/ wheelbarrow	No.	1.0	100.0	100.0	100.0
Fertilizers and biocides					
Manure/ compost	Wheelbarrows	20.0	50.0	1000.0	100.0
Total costs for maintenance of the Technology				**2'940.0**	
Total costs for maintenance of the Technology in USD				*23.67*	

NATURAL ENVIRONMENT

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

Specifications on climate
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Rainfall pattern is bimodal. Monthly rainfall variability is high with some months such as January recording less than 5 mm of total rainfall.
Name of the meteorological station: Kakamega Meteorological Station

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

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- [x] plateau/plains
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- [ ] 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
- [x] not relevant

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

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

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

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- [x] poor drinking water (treatment required)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Water quality refers to: both ground and surface water

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

Occurrence of flooding
- [ ] Yes
- [x] No

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

Habitat diversity
- [ ] high
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CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

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- [ ] 10-50% of all income
- [x] > 50% of all income

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- [ ] poor
- [x] average
- [ ] rich
- [ ] very rich

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

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

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

Gender
- [x] women
- [x] men

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

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

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

Land ownership
- [ ] state
- [ ] company

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

- [ ] 1-2 ha
- [ ] 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

- [ ] large-scale

- [ ] communal/ village
- [ ] group
- [x] individual, not titled
- [x] individual, titled

- [ ] leased
- [x] individual

Water use rights
- [x] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [x] individual

Access to services and infrastructure

	poor		good
health			✓
education			✓
technical assistance			✓
employment (e.g. off-farm)		✓	
markets			✓
energy		✓	
roads and transport		✓	
drinking water and sanitation			✓
financial services		✓	

IMPACTS

Socio-economic impacts

Crop production

decreased ☐☐☐☐☐✓☐ increased

Quantity before SLM: 2
Quantity after SLM: 6
Quantity refers to the number of 90 Kg bags of maize produced per acre. Although vegetative cross-slope barriers reduced the available space for crops, other SLM technologies such as retention ditches and the use of compost contributed to the increase in the production. According to the farmer, the soil at the farm was highly eroded before the SLM technologies were introduced.

crop quality

decreased ☐☐☐☐☐☐✓ increased

Not easy to quantify but according to the farmer, the crops are doing better compared to how they were before the cross-slope barriers were established.

fodder production

decreased ☐☐☐☐✓☐☐ increased

the farmer estimates that the amount of napier grass harvested from the farm within a year has increased. Farmer not able to quantify.

fodder quality

decreased ☐☐☐☐☐✓☐ increased

Not easy to quantify but according to the farmer, napier grass is doing better compared to how it was before the cross-slope barriers were established.

animal production

decreased ☐☐☐☐☐✓☐ increased

Quantity before SLM: 4
Quantity after SLM: 7
Amount of milk produced by one cow during early lactation period.

land management

hindered ☐☐☐☐☐✓☐ simplified

Easy of working on less eroded soils. A farmer's estimate.

expenses on agricultural inputs

increased ☐☐☐☐☐☐✓ decreased

Quantity before SLM: 5000
Quantity after SLM: 0
Expenditure on fertilizer in KES. The farmer no longer uses fertilizer.

farm income

decreased ☐☐☐☐✓☐☐ increased

Quantity before SLM: 0
Quantity after SLM: 6000
The farmer earns income from selling napier grass - per year. This is based on the farmer's estimate.

diversity of income sources

decreased ☐☐☐☐☐✓☐ increased

The farmer considers the money earned from selling napier grass as an extra source of income.

Socio-cultural impacts

food security/ self-sufficiency

reduced ☐☐☐☐☐☐✓ improved

Quantity before SLM: 2
Quantity after SLM: 0.5
Number of months in a year when there is total lack of food in the house, and the farmer has to buy all the food required in the house. Based on the farmer's estimate.

SLM/ land degradation knowledge

reduced ☐☐☐☐☐☐✓ improved

Level of knowledge in SLM/ land management. This is a farmer's estimate that she has increased her knowledge in SLM.

Ecological impacts

surface runoff

increased ✓ decreased

The farmer notes that the amount of water leaving the farm and silting other farms in the lower areas. has greatly reduced.

soil loss

increased ✓ decreased

the farmer notes that the amount of silt deposited in the lower parts of the farm and in other farms on the lower side of the farm has reduced.

soil accumulation

decreased ✓ increased

the farmer notes that the amount of soil trapped by the vegetative cross slope barriers is high and this leads to an increase in soil accummulation at the farm.

Off-site impacts

damage on neighbours' fields

increased ✓ reduced

Amount of runoff leaving the farm with potential to cause soil erosion in neighbouring farms.

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

Gradual climate change

annual temperature increase — not well at all ✓ very well

seasonal temperature increase — not well at all ✓ very well — Season: dry season

Climate-related extremes (disasters)

local rainstorm — not well at all ✓ very well

ADOPTION AND ADAPTATION

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

- [ ] single cases/ experimental
- [ ] 1-10%
- [x] 11-50%
- [ ] > 50%

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

- [ ] 0-10%
- [x] 11-50%
- [ ] 51-90%
- [ ] 91-100%

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

- [ ] Yes
- [x] 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

- Soil erosion control.
- increased yields.

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

- More benefits, including firewood and other products from trees planted on the cross slope barriers.

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

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

- Reduces area meant for crop production. Ensure optimum use of manure to offset production loss.

REFERENCES

Compiler
William Akwanyi

Editors
George Onyango
Innocent Faith
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Reviewer
William Critchley
Rima Mekdaschi Studer

Date of documentation: March 19, 2023

Last update: July 5, 2023

Resource persons
Amirah Munyolo Osundwa - land user
George Onyango - SLM specialist
Innocent Faith - SLM specialist

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6705/

Linked SLM data
Approaches: Promotion of different trees for agroforestry https://qcat.wocat.net/en/wocat/approaches/view/approaches_6706/

Documentation was faciliated by

Institution
- CIAT International Center for Tropical Agriculture (CIAT International Center for Tropical Agriculture) - Kenya
- Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)

Project
- Soil protection and rehabilitation for food security (ProSo(i)l)

Links to relevant information which is available online
- Vegetative Barriers for Erosion Control: https://extension.missouri.edu/publications/g1653

A retention ditch dug to collect surface runoff (William Akwanyi)

Retention ditches for soil and water conservation (Kenya)

Mitaro ya kuhifadhi maji (Kiswahili)

DESCRIPTION

Retention ditches are channels aligned along the contour which are designed for surface runoff management. They improve water infiltration into the ground and prevent soil erosion.

Retention ditches are soil and water conservation practices. They are channels dug along contours (i.e., across the slope), especially at the uppermost part of the farm to retain stormwater/ surface runoff. They typically comprise two components: (a) vegetational-biological and (b) mechanical-structural components which are integrated to collect surface runoff, allowing for sediment carried by runoff to settle as water infiltrates into the ground. The mechanical-structural component consists of channels dug in such a way that they follow the contour and run perpendicular to the flow of water in areas where runoff naturally flows or collects. The soil excavated from the ditch forms a bund below the ditch. Retention ditches prevent surface runoff from outside the farm from flowing into or through the farm. The vegetational-biological component consists of plants grown on the bunds. The plant roots bind the soil thus increasing the slope stability, especially of the bunds; thus, preventing soil from collapsing and falling back into the channel. Retention ditches thus harvest and retain water (especially in low rainfall areas) preventing fertile soil from being washed away by surface runoff and increasing water availability for plants. In high-rainfall areas, they play the role of discharging excessive runoff into waterways.

Retention ditches are dug to about 60 cm deep and about 50 cm wide. To ensure stability, especially in areas with unstable soils, the top width is made wider than the bottom width allowing for slanting walls that are more stable than vertical walls. An understanding of the slope angle is an important factor in the designing and construction of retention ditches. A line-level (a spirit level attached to a string suspended between two poles) can be used to determine the measure slope. The slope angle determines the size of the ditch (depth and width) and the spacing between successive ditches on the same piece of land. In low-rainfall areas (such as Siaya), retention ditches are spaced at about 50 – 70 m while in high-rainfall areas the space between the ditches are closer (about 20 m). Similarly, the size of the retention ditches increases with increasing slope.

Some crops, especially bananas, arrowroot, etc. that demand a lot of water can be established in the ditches. Maintenance of retention ditches involves regular desilting, whenever the ditch is about 1/3 filled with silt. Hoes, shovels/ spades, and a panga (machete) are some of the tools used in digging and maintaining retention ditches. Farmers like retention ditches because they help in controlling soil erosion.

LOCATION

Location: Uloma Village, Bondo Municipality, Bondo Sub-county, Siaya County, Nyanza Region, Kenya

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 34.25235, -0.05657

Spread of the Technology: evenly spread over an area (approx. < 0.1 km2 (10 ha))

In a permanently protected area?: No

Date of implementation: 2018

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

Surface runoff collector at the road (William Akwanyi)

Silt accumulation in a retention ditch (William Akwanyi)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

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

Land use

Land use mixed within the same land unit: Yes - Agro-silvopastoralism

Cropland

- Annual cropping: cereals - maize, fodder crops - grasses, fodder crops - other, legumes and pulses - beans, legumes and pulses - other, vegetables - other. Cropping system: Fallow - maize/sorghum/millet intercropped with legume
- Perennial (non-woody) cropping: banana/plantain/abaca, fodder crops - grasses, fodder crops - legumes, clover
- Tree and shrub cropping: avocado, fodder trees (Calliandra, Leucaena leucocephala, Prosopis, etc.), fruits, other, mango, mangosteen, guava, papaya

Number of growing seasons per year: 2
Is intercropping practiced? Yes
Is crop rotation practiced? Yes

Grazing land

- Cut-and-carry/ zero grazing
- Improved pastures

Animal type: cattle - dairy and beef (e.g. zebu), poultry
Is integrated crop-livestock management practiced? Yes
Products and services: eggs, meat, milk

Species	Count
cattle - dairy and beef (e.g. zebu)	3
poultry	100

Water supply

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

Purpose related to land degradation

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

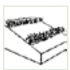
Degradation addressed

soil erosion by water - Wt: loss of topsoil/ surface erosion, Wg: gully erosion/ gullying

SLM group

- cross-slope measure
- water diversion and drainage

SLM measures



vegetative measures - V1: Tree and shrub cover, V2: Grasses and perennial herbaceous plants

structural measures - S4: Level ditches, pits

TECHNICAL DRAWING

Technical specifications
Ditch dimensions: length = 70m, width = 50cm, depth = 60cm
Slope of the field = 4%
Plants on the berm: nappier grass

Author: William Akwanyi

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs
- Costs are calculated: per Technology area (size and area unit: **0.4 ha**)
- Currency used for cost calculation: **KES**
- Exchange rate (to USD): 1 USD = 122.95 KES
- Average wage cost of hired labour per day: 300

Most important factors affecting the costs
Rate of man-days vary from one place to another and also depend on the kind of work. Exchange rate for January 2023, source: European Commission/ InfoEuro online at https://commission.europa.eu/funding-tenders/procedures-guidelines-tenders/information-contractors-and-beneficiaries/exchange-rate-inforeuro_en

Establishment activities
1. Slope measurement and determination of position for the retention ditch (Timing/ frequency: During the dry season)
2. Digging the ditches (Timing/ frequency: Before onset of rains)

Establishment inputs and costs (per 0.4 ha)

Specify input	Unit	Quantity	Costs per Unit (KES)	Total costs per input (KES)	% of costs borne by land users
Labour					
Digging the ditches	Man days	10.0	300.0	3000.0	100.0
Equipment					
Hoe	No.	1.0	80.0	80.0	100.0
Panga (broad blade)	No.	1.0	60.0	60.0	100.0
Wheelbarrow	No.	1.0	800.0	800.0	100.0
Spade	No.	1.0	90.0	90.0	100.0
Planting rope	No.	1.0	60.0	60.0	100.0
Spirit level	No.	1.0	600.0	600.0	
Other					
Slope measurement and determination of position for the retention ditch (professional service)	Professional service	1.0	2000.0	2000.0	
Total costs for establishment of the Technology				**6'690.0**	
Total costs for establishment of the Technology in USD				*54.41*	

Maintenance activities
1. Desilting (Timing/ frequency: Whenever the ditch is about 1/3 filled with silt)

Total maintenance costs (estimation)
2000.0

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
- [ ] sub-humid
- [x] semi-arid
- [ ] arid

Specifications on climate
Rainfall pattern is bimodal. Monthly rainfall variability is high with some months such as January recording less than 5 mm of total rainfall.
Name of the meteorological station: Bondo Meteorological Station
The area is found near Lake Victoria which influences the climate.

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

Landforms
- [x] plateau/plains
- [ ] ridges
- [ ] mountain slopes
- [ ] hill slopes
- [ ] footslopes
- [ ] 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
- [x] convex situations
- [ ] concave situations
- [ ] not relevant

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

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

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

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

Water quality refers to: both ground and surface water

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
- ☐ subsistence (self-supply)
- ☑ 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
- ☐ very poor
- ☐ poor
- ☑ average
- ☐ rich
- ☐ very rich

Level of mechanization
- ☑ manual work
- ☐ animal traction
- ☐ mechanized/ motorized

Sedentary or nomadic
- ☐ Sedentary
- ☑ Semi-nomadic
- ☐ Nomadic

Individuals or groups
- ☑ 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
- ☑ 1-2 ha
- ☑ 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

Scale
- ☐ small-scale
- ☑ medium-scale
- ☐ large-scale

Land ownership
- ☐ state
- ☐ company
- ☐ communal/ village
- ☐ group
- ☐ individual, not titled
- ☑ individual, titled

Land use rights
- ☐ open access (unorganized)
- ☐ communal (organized)
- ☐ leased
- ☑ individual

Water use rights
- ☐ open access (unorganized)
- ☑ communal (organized)
- ☐ leased
- ☐ individual

Access to services and infrastructure

health	poor	☐	☐	☑	good
education	poor	☐	☐	☑	good
technical assistance	poor	☐	☐	☑	good
employment (e.g. off-farm)	poor	☐	☑	☐	good
markets	poor	☐	☑	☐	good
energy	poor	☐	☐	☑	good
roads and transport	poor	☐	☑	☐	good
drinking water and sanitation	poor	☐	☑	☐	good
financial services	poor	☐	☑	☐	good

Comments

The above rating varies from one village to the other.

IMPACTS

Socio-economic impacts

Crop production

decreased ☐ ☐ ☐ ☐ ☑ ☐ ☐ increased

Quantity before SLM: 2
Quantity after SLM: 4
Quantity refers to the number of 90 Kg bags of maize produced per acre. Based on estimation by the farmer.

crop quality

decreased ☐ ☐ ☐ ☐ ☐ ☑ ☐ increased

Not easy to quantify but according to the farmer, the crops are doing better compared to how they were before the retention ditches were dug.

fodder production

decreased ☐ ☐ ☐ ☐ ☑ ☐ ☐ increased

Quantity before SLM: 1
Quantity after SLM: 3
Quantity refers to harvesting cycles for nappier grass from the same farm. Based on estimation by the farmer.

fodder quality

decreased ☐ ☐ ☐ ☐ ☐ ☑ ☐ increased

Not easy to quantify but according to the farmer, fodder is doing better compared to how it was before the retention ditches were dug.

animal production	decreased ☐☐☐☐☐✓☐ increased	Quantity before SLM: 1 Quantity after SLM: 3 Quantity refers to the amount of milk in litres from one cow. Milk production is often at the peak during early lactation months. Based on estimation by the farmer.
risk of production failure	increased ☐☐☐☐☐✓☐ decreased	Quantity before SLM: 80 Quantity after SLM: 40 Quantity refers to the percentage probability of the crop failing to do well. Based on estimation by the farmer.
workload	increased ☐☐✓☐☐☐☐ decreased	Refers to the number of hours that the farmer can be free in any working day. During the rainy season, the farmer spends some time desilting the ditches. Based on estimation by the farmer.

Socio-cultural impacts

food security/ self-sufficiency	reduced ☐☐☐☐☐✓☐ improved	Quantity before SLM: 5 Quantity after SLM: 2 Quantity refers to the number of months in a year when there is total lack of food in the house, and the farmer has to buy all the food required in the house. Based on estimation by the farmer.
SLM/ land degradation knowledge	reduced ☐☐☐☐☐✓☐ improved	Quantity before SLM: 10% Quantity after SLM: 80% Quantity refers to the estimated percentage of knowledge in SLM/ land management. This is a farmer's estimate.

Ecological impacts

harvesting/ collection of water (runoff, dew, snow, etc)	reduced ☐☐☐☐☐✓☐ improved	Not easy to quantify. Based on estimation by the farmer.
surface runoff	increased ☐☐☐☐☐☐✓ decreased	Refers to the amount of water that flows through the farm. Not easy to quantify. Based on estimation by the farmer.
soil loss	increased ☐☐☐☐☐✓☐ decreased	Not easy to quantify.
vegetation cover	decreased ☐☐☐☐✓☐☐ increased	Refers to the farmer's estimated percentage vegetation cover at the farm. Based on estimation by the farmer.

Off-site impacts

downstream flooding (undesired)	increased ☐☐☐☐☐✓☐ reduced	Not easy to quantify. Retention ditches have reduced the amount of water that flows to the farms in the lower areas. This has reduced soil erosion in these farms.
downstream siltation	increased ☐☐☐☐☐✓☐ decreased	Not easy to quantify. All silt is deposited in the retention ditches and scooped by the farmer for replenishing parts of the farm with low soil levels.
damage on neighbours' fields	increased ☐☐☐☐☐✓☐ reduced	Not easy to quantify. Retention ditches have reduced the amount of water that flows to the farms in the lower areas. This has reduced soil erosion in these farms.

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

The retention ditches have generally improved crop production.

CLIMATE CHANGE

Gradual climate change

annual temperature increase	not well at all ☐☐☐✓☐ very well		
seasonal temperature increase	not well at all ☐☐✓☐☐ very well	Season: dry season	

ADOPTION AND ADAPTATION

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

- ☐ single cases/ experimental
- ☐ 1-10%
- ☑ 11-50%
- ☐ > 50%

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

- ☐ 0-10%
- ☑ 11-50%
- ☐ 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

- Controls soil erosion. Silt collected in the ditches is used to replenish other sections of the farm with poor soils.
- Improved crop yields.

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

- Controls road damage due to runoff as most of the water is collected by the ditches before it destroys the road.

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

- Establishment investment is capital and labour intensive. The farmer has to be committed.
- Maintenance is labour intensive. The farmer has to be committed. Proper planning of farm work.

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

- If not managed properly by regular removal of silt, the ditch can easily fill up. The farmer must be committed to remove silt regularly.
- May overflow and collapse during high rainfall leading to high levels of soil erosion. Proper designing in consideration of runoff volumes and slope angle. Regular maintenance.

REFERENCES

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Date of documentation: March 7, 2023

Last update: July 3, 2023

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George Onyango - SLM specialist

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6675/

Linked SLM data
Approaches: Community Resource Persons (CRP) in agricultural extension https://qcat.wocat.net/en/wocat/approaches/view/approaches_6688/

Documentation was faciliated by

Institution
- CIAT International Center for Tropical Agriculture (CIAT International Center for Tropical Agriculture) - Kenya
- Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)

Project
- Soil protection and rehabilitation for food security (ProSo(i)l)

Key references
- Climate Smart Extension Manual by KCEP - CRAL, 2021: Download free at https://www.kalro.org/files/kcep/CSA-extension-manual-18-06-21.pdf

Links to relevant information which is available online
- Siaya County Integrated Development Plan, 2018-2022: https://repository.kippra.or.ke/bitstream/handle/123456789/1218/2018-2022%20%20Siaya%20County%20CIDP.pdf?sequence=1&isAllowed=y

An infographic of the different food products from mucuna. (William Akwanyi)

Mucuna value-addition for female farmers (Kenya)

N/A

DESCRIPTION

Promoting mucuna seed processing for food and nutrition security and income generation encourages women farmers to plant mucuna as a cover crop that improves soil productivity.

Mucuna pruriens (velvet bean) is tropical legume that is widely known for its ability to rehabilitate soils by increasing organic matter. Unlike many other legumes of the bean family, mucuna seeds (beans) are not very palatable. In addition, raw and unprepared mucuna beans can cause severe digestive disorders. However, due to its emerging health and economic benefits, many farmers are now adopting the crop. Consequently, the crop is simultaneously helping in soil conservation by controlling soil erosion and improving soil structure alongside suppressing weeds.

Promoting the economic benefits of mucuna through value addition is a key factor in ensuring farmers adopt mucuna as a conservation agriculture crop. Mucuna value addition involves various stages of beans preparation/ treatment aimed at reducing the potential of L-DOPA toxicity. The ProSoil project promoted the uptake of mucuna as a green manure cover crop by training farmers on mucuna bean value-addition. In Matungu area of Kakamega County, Kenya, the ProSoil project partnered with a local farmer-based self-help group, Tunza Udongo Self Help Group ['tunza udongo' is a Kiswahili phrase for 'take care of the soil'] which facilitated the convening women farmers. The project facilitated specialists in mucuna value addition from the Ministry of Agriculture who trained the farmers.

To spread this approach, the trained farmers train other farmers. In addition to the training in mucuna value-addition, the farmers were informed about the ecological and economic importance of mucuna and its propagation. The ProSoil project (GIZ and WHH) and Ministry of Agriculture invite the farmers to events such as farmer field days where they can exhibit different products from mucuna, network, and link up with potential markets. On the other hand, Tunza Udongo Self Help plays an important role in collective marketing.

One aim of promoting mucuna value addition is to increase its uptake by farmers as a green manure cover crop which is an important measure in conservation agriculture. Mucuna beans preparation is a domestic chore equivalent to other chores that are traditionally performed by women. Consequently, the entire farming household benefits from the income from the sale of mucuna products (skin free beans, flour, beverage, and baked products). The prices of these products vary in time and space depending on the availability of and demand for the products. However, the average prices are KES 100.00 per kg of skin free beans, KES 120.00 per kg of flour, and KES 150.00 per kg of beverage. Farmers also sell unprocessed mucuna beans as seed at KES 100.00 – 200.00 per kg depending on the availability of, and demand for, the seeds.

LOCATION

Location: Emachina Village, Ejinja Sub-location, Koyonzo Location, Koyonzo Ward, Matungu Sub-county, Kakamega County in western Kenya, Kenya

Geo-reference of selected sites

- 34.46052, 0.42549

Initiation date: 2019

Year of termination: n.a.

Type of Approach

- ☐ traditional/ indigenous
- ☐ recent local initiative/ innovative
- ☑ project/ programme based


Beans from different varieties of mucuna plant. (William Akwanyi)


Sun drying boiled mucuna beans on a black polythene sheet. (William Akwanyi)

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims / objectives of the approach
To increase its farmers' uptake of mucuna as a green manure cover crop which is an important measure in conservation agriculture.

Conditions enabling the implementation of the Technology/ ies applied under the Approach
- **Social/ cultural/ religious norms and values**: Perceived health benefits of mucuna and food and nutritional value.
- **Collaboration/ coordination of actors**: Market linkages by GIZ and Welthungerhilfe partners.
- **Land governance (decision-making, implementation and enforcement)**: Like many other crops of the bean family, mucuna is entirely managed by women.
- **Knowledge about SLM, access to technical support**: Training by Welthungerhilfe specialists.
- **Markets (to purchase inputs, sell products) and prices**: Availability of market as a result of increasing demand for mucuna products due to perceived health benefits of mucuna.
- **Workload, availability of manpower**: Processing requires equipment that are commonly available in most households.
- **Other**: Githeri is Kenyan traditional meal, especially in Central Kenya. Adding processed mucuna beans to githeri makes it appealing. This is a motivation for many farmers to adopt mucuna.

Conditions hindering the implementation of the Technology/ ies applied under the Approach
- **Workload, availability of manpower**: Processing of mucuna beans is labour intensive.

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

What stakeholders / implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	The farmers in the area who are mostly small-scale farmers due to the small parcels of land. Women farmers constituted 75%.	Mucuna value addition is a domestic chore equivalent to other women centric domestic chores that are traditionally performed by women. Hence, commonly done by women who are targeted by the value addition. However, the end result benefits the entire farming household.
community-based organizations	Tunza Udongo Self-Help Group	Convening farmers for training.
SLM specialists/ agricultural advisers	GIZ ProSoil project SLM specialists and specialists from the implementing partner, Welthungerhilfe.	Provided technical advice to the farmers on how to process mucuna as a way of encouraging households to adopt mucuna as a green manure cover crop.
local government	Extension staff from the county department of agriculture	Training farmers
international organization	GIZ	Financial support to the technical team and farmers during capacity building.

Lead agency
GIZ

Involvement of local land users/ local communities in the different phases of the Approach

	none	passive	external support	interactive	self-mobilization	
initiation/ motivation					✓	Farmers involved in the training on mucuna value addition.
planning				✓		Farmers consulted on where and when to conduct trainings and demonstrate mucuna value-addition.
implementation					✓	Each farmer processes his/ her own mucuna and decides on whether or not to sell the surplus products. Farmers look for their own markets. GIZ and Welthungerhilfe may link farmers to potential buyers.
monitoring/ evaluation		✓				Interviews with implementing farmers.
None	✓					

Flow chart

The ProSoil Project consists of GIZ and the implementing partners in this case Welthungerhilfe (WHH). The project provides financial support to farmers through their groups for convening farmers for the trainings. The farmers are trained by technical staff from the County Ministry of Agriculture and sometimes by specialists from the ProSoil project. The county technical staff (trainers) are paid by the project through either GIZ or WHH.

Author: William Akwanyi

Decision-making on the selection of SLM Technology

Decisions were taken by
- [ ] land users alone (self-initiative)
- [x] mainly land users, supported by SLM specialists
- [ ] all relevant actors, as part of a participatory approach
- [ ] mainly SLM specialists, following consultation with land users
- [ ] SLM specialists alone
- [ ] politicians/ leaders

Decisions were made based on
- [x] evaluation of well-documented SLM knowledge (evidence-based decision-making)
- [ ] research findings
- [x] personal experience and opinions (undocumented)

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE MANAGEMENT

The following activities or services have been part of the approach
- [x] Capacity building/ training
- [x] Advisory service
- [x] Institution strengthening (organizational development)
- [x] Monitoring and evaluation
- [ ] Research

Capacity building/ training

Training was provided to the following stakeholders
- [x] land users
- [x] field staff/ advisers
- [x] Agriculture extension officers from the county department of agriculture

Form of training
- [ ] on-the-job
- [x] farmer-to-farmer
- [x] demonstration areas
- [ ] public meetings
- [x] courses

Subjects covered
1. Agronomic practices for mucuna
2. Harvesting and post-harvest handling of mucuna beans
3. Processing of mucuna beans
4. Value addition to mucuna beans
5. Packaging of mucuna products
6. Marketing of mucuna products

Advisory service

Advisory service was provided
- [x] on land users' fields
- [ ] at permanent centres
- [x] Specific locations where the farmers interact with the technical officers

Technical officers advise farmers at their homesteads whenever they visit them. Meetings are held on needs basis between farmers and the technical officers where pieces of advice are given to farmers.

Institution strengthening

Institutions have been strengthened / established
- [ ] no
- [x] yes, a little
- [ ] yes, moderately
- [ ] yes, greatly

at the following level
- [x] local
- [ ] regional
- [ ] national

Describe institution, roles and responsibilities, members, etc.
Farmer groups, groups promote farmer-to-farmer peer learning.

Type of support
- [ ] financial
- [x] capacity building/ training
- [ ] equipment

Further details
Knowledge on how to market their products.

Monitoring and evaluation

The ProSoil project (GIZ and Welthungerhilfe) and the County Department of Agriculture regularly follows up with farmers to check on the implementation of technologies promoted under this approach through annual surveys involving key informant interviews (KII), focus group discussions (FGDs), and household surveys.

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component

- ☐ < 2,000
- ☐ 2,000-10,000
- ☑ 10,000-100,000
- ☐ 100,000-1,000,000
- ☐ > 1,000,000

Precise annual budget: n.a.

Costs met by GIZ ProSoil project and included facilitation of transport to farmers (25 farmers) and trainers and remuneration to trainers. Other costs include support to farmers to purchase mucuna seeds.

The following services or incentives have been provided to land users

- ☑ Financial/ material support provided to land users
- ☐ Subsidies for specific inputs
- ☐ Credit
- ☐ Other incentives or instruments

Financial/ material support provided to land users

Welthungerhilfe supported the farmers (through their group) with mucuna seeds.

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

	No	Yes, little	Yes, moderately	Yes, greatly
Did the Approach enable evidence-based decision-making? As a result of the economic value of mucuna i.e., sale of mucuna products for income, farmers made the decision to plant mucuna on their farms.				☑
Did the Approach help land users to implement and maintain SLM Technologies? Income generated from sell of value-added mucuna product motivated farmers to plant mucuna which is a green manure permanent soil cover crop.				☑
Did the Approach improve knowledge and capacities of land users to implement SLM? Farmers were trained on agronomic practices for mucuna, hence improving their knowledge of using mucuna as a cover crop in conservation agriculture.				☑
Did the Approach empower socially and economically disadvantaged groups? Women often have very little control over land-use, but they are able to plant mucuna even on very small pieces of land for and sell its products for income.				☑
Did the Approach improve gender equality and empower women and girls? Women were able to plant mucuna even on very small pieces of land for and sell its products for income.				☑
Did the Approach encourage young people/ the next generation of land users to engage in SLM? Income generated from sell of mucuna products is amotivation for young people to plant mucuna.			☑	
Did the Approach lead to improved food security/ improved nutrition? Mucuna beans can be processed into various food products - flour for baking bread, edible beans, and beverage. The farmer reported that she has experienced positive well-being since she started eating mucuna products. She stated that mucuna can be used to treat various diseases, including ulcers, arthritis, and blood pressure problems.				☑
Did the Approach improve the capacity of the land users to adapt to climate changes/ extremes and mitigate climate related disasters? Farmers plant mucuna as a cover crop to prevent water lost from their soils.				☑

Main motivation of land users to implement SLM

- ☑ increased production
- ☑ increased profit(ability), improved cost-benefit-ratio
- ☑ reduced land degradation
- ☐ reduced risk of disasters
- ☐ reduced workload
- ☐ payments/ subsidies
- ☐ rules and regulations (fines)/ enforcement
- ☐ prestige, social pressure/ social cohesion
- ☐ affiliation to movement/ project/ group/ networks
- ☐ environmental consciousness
- ☐ customs and beliefs, morals
- ☑ enhanced SLM knowledge and skills
- ☐ aesthetic improvement
- ☐ conflict mitigation

Sustainability of Approach activities

Can the land users sustain what hat been implemented through the Approach (without external support)?

- ☐ no
- ☑ yes
- ☐ uncertain

Farmers produce their own mucuna seed and use the surplus beans as food or process them into different products. Mucuna is a perennial crop and farmers are able to retain it in the farm for more than one season. The farmers are also motivated to continue planting mucuna and producing different products for sell.

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- It is an income generating activity.

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

- Keeps people busy at home while at the same time generating income.
- Mucuna has several health benefits.

Strengths: compiler's or other key resource person's view
- Improves livelihoods of the land users.
- Yields are often high. Hence, the beans for value addition are available.
- Growing market due to increasing awareness about the value of the crop.

- Labour intensive Commitment and proper planning of farm work.
- A lot of fuel required to boil the beans. Farmers to incorporate agroforestry trees at their farms as a source of firewood.

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome
- Consumption rate is low due to its low palatability. At the same time, it is consumed in small quantities. Expand the market through market research.
- Fear of L-DOPA poisoning. Increase awareness about processing mucuna before consumption.

REFERENCES

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Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/approaches/view/approaches_6684/
Video: https://player.vimeo.com/video/807802820

Linked SLM data
Technologies: Permanent soil cover https://qcat.wocat.net/en/wocat/technologies/view/technologies_6699/
Technologies: Permanent soil cover https://qcat.wocat.net/en/wocat/technologies/view/technologies_6699/

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- Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)

Project
- Soil protection and rehabilitation for food security (ProSo(i)l)

Key references
- Promoting Mucuna Beans Production for Soil Rehabilitation, Incomes, Food and Nutrition Security in Kenya, by Mary Stella Wabwoba and Kenneth Mutoro, 2019, ISSN: 2644-2981: Free download at https://irispublishers.com/gjnfs/fulltext/promoting-mucuna-beans-production-for-soil-rehabilitation-incomes-food-and-nutrition-security.ID.000543.php

Links to relevant information which is available online
- Processing of Mucuna for Human Food in the Republic of Guinea: https://www.redalyc.org/pdf/939/93911288020.pdf

Field visit organised as part of the demonstration of the Community Resource Persons (CRP) approach (William Akwanyi)

Community Resource Persons (CRP) in agricultural extension (Kenya)

Mtu wa rasilimali za jamii/ Mkufunzi wa wakufunzi

DESCRIPTION

Community Resource Persons (CRP) form a farmer-to-farmer learning approach that bridges the gap in agricultural extension, increases farmers' access to agricultural information (SLM knowledge), and increases the adoption of SLM practices.

Community Resource Persons (CRPs) are farmers at the community-level who promote the adoption of SLM technologies by offering agricultural extension services. GIZ implements the ProSoil project in the Western Kenya counties of Kakamega, Siaya, and Bungoma through partners i.e., Welthungerhilfe (WHH) and Gesellschaft für Agrarprojekte in Übersee (GFA Consulting Group/ GFA). Further, these partners collaborate with other local non-governmental organizations (NGOs) and community-based organizations (CBOs) in the implementation of the project. Farmer groups belonging to local communities characterized by men, women, and youth are recruited by field officers from the implementing partners and trained in Sustainable Land Management (SLM) practices. The training is done by technical staff from the County Department of Agriculture. The implementing partners facilitate the trainings. The trained farmers (CRPs) are issued with certificates of recognition signed by GIZ ProSoil project manager, the head of the implementing partner, and the County Director of Agriculture at the County Department of Agriculture. These CBOs and farmer groups work closely with agricultural extension officers from the county departments of agriculture to disseminate different agricultural technologies and SLM measures. The aim of CRPs is to bridge the gap in agricultural extension by overcoming the problem of low extension staff-to-farmer ratios. The objective is to sustain the adoption of various SLM measures promoted by the project among the beneficiaries and non-project farmers.

In Bukembe East Ward, Bungoma County, GFA collaborates with Kimaeti Farmers CBO to implement the Soil Protection and Rehabilitation of Degraded Soil for Food Security (ProSoil) project. Kimaeti Farmers CBO recruited agriculture field technicians who were then trained in SLM practices by GFA. The trained field technicians sensitize local communities in various operational areas about the project and recruit farmer groups: 25 farmers per group. Each field technician manages several groups per sub location and takes them through trainings and demonstrations on soil protection and rehabilitation technologies. Farmer groups are also trained on group organization development and management to enhance group cohesion. Each farmers group selects 3 CRPs who undergo specialized training to equip them with more skills and expertise to follow up, mentor and coach fellow farmers. These CRPs also monitor implementation of various technologies, gather farmer feedback, and even reach out to other farmers in the community not reached by the project. This extension service is usually done voluntarily. However, some farmers reward the CRPs for the advisory services in cash or kind. In some cases, CRPs who are specialised in some SLM technologies e.g., construction of structures for vermicomposting become co-trainers and may enter into contractual agreements with GIZ, GFA, or any other institution that wants their services. In this case, they are paid as agreed on the contracts.

LOCATION

Location: Bukembe East Ward, Kanduyi Sub-county, Bungoma County, Bungoma County in Western Kenya, Kenya

Geo-reference of selected sites
- 34.64873, 0.56222
- 34.64872, 0.56216
- 34.64872, 0.56222

Initiation date: 2021

Year of termination: n.a.

Type of Approach
- [ ] traditional/ indigenous
- [ ] recent local initiative/ innovative
- [x] project/ programme based

Each CRP manages a cluster of 5–7 farmers. They also reach out to farmers within their respective communities according to consultatively agreed calendars/timeframes. Every available opportunity is used by CRPs to spread SLM knowledge, including meeting farmers at their farms; convening farmers at common locations within their communities where they talk to them about SLM; farmer field days organised by the implementing partners, or the county department of agriculture, etc. Hence, CRPs attract the attention of many farmers, including those who are direct beneficiaries of the ProSoil project and those who are not direct beneficiaries. CRPs are thus important in improving farmers' access to agricultural information at little or no cost since CRPs work on a voluntary basis.

The CRP approach has been successful in bringing together female and male, and youthful, middle-aged, and elderly farmers of different socio-cultural and economic backgrounds on issues of common interest i.e., SLM, household food security, and economic empowerment. This has enhanced communication, built social solidarity, and enhanced social cohesion among the farmers.

Farmers and CRPs at a demonstration farm learning about the importance of maintaining maximum soil cover (Erastus Wasikoyo, Kimaeti CBO Field Technician)

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims / objectives of the approach
Aim: To bridge the gap in agricultural extension.

Objectives:
1. To improve farmers' access to agricultural information.
2. To sustain the adoption of new technologies trained to the project beneficiaries and non-project farmers.
3. To overcome the problem of low extension staff-to-farmer ratio through farmer-to-farmer learning.

Conditions enabling the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values**: 1. General acceptance by the community. 2. Ability to bring together of different socio-cultural and economic backgrounds on issues of common interest i.e., SLM, household food security, and economic empowerment which has enhanced communication, built social solidarity, and enhanced social cohesion among community members.
- **Institutional setting**: Availability and willingness of Kimaeti CBO to collaborate with GFA.
- **Collaboration/ coordination of actors**: Linkages and partnerships among different organizations and institutions, including GIZ, GFA, Kimaeti CBO, etc. which expanded the outreach of the approach.
- **Legal framework (land tenure, land and water use rights)**: Access to farming land where farmers implement SLM technologies.
- **Knowledge about SLM, access to technical support**: SLM knowledge among technical staff in the collaborating institutions and documented references.
- **Workload, availability of manpower**: CRPs from the communities who are willing to work with fellow farmers.

Conditions hindering the implementation of the Technology/ ies applied under the Approach

- **Availability/ access to financial resources and services**: CRPs work on voluntary basis; hence, may not be motivated to reach out to farmers in areas that are very far from their reach.
- **Land governance (decision-making, implementation and enforcement)**: Women and youth farmers are limited in their access, use, and control of land. Hence, they may not be able to implement certain SLM technologies even if they gained knowledge about them through CRPs who are fellow farmers e.g., agroforestry.
- **Workload, availability of manpower**: Voluntary nature of the CRPs' support - CRPs are likely to sacrifice their own farmwork at the expense of the CRP work, something that may discourage them if they get poor harvest.

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

What stakeholders / implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	Farmers - men, women, and youth.	Targeted by the technologies, they learn from other farmers, and implement the technologies.
community-based organizations	Kimaeti Farmers Community-Based Organization	Has recruited a team of trained SLM specialists who pass the SLM knowledge to the community resource persons in the community.
SLM specialists/ agricultural advisers	SLM specialists from GIZ ProSoil project, GFA, and Kimaeti Farmers Community-Based Organization.	SLM specialists from GIZ ProSoil project - supported in the technical design of the approach. SLM specialists from GFA - ProSoil implementing partner, trains the Community-Based Organizations that implement the approach. SLM specialists from Kimaeti Farmers Community-Based Organization - pass the SLM knowledge to the community resource persons in the community.
local government	Agricultural extension officers from the county government department of agriculture.	Work hand-in-hand with SLM specialists to pass the SLM knowledge to the farmers.
international organization	GIZ	Proposal design and financial support to the implementation of the approach.

Lead agency
GIZ

Involvement of local land users/ local communities in the different phases of the Approach

	none	passive	external support	interactive	self-mobilization	
initiation/ motivation		✓				Farmers in the community, targeted by the SLM technologies, they implement the technologies.
planning				✓		Community resource persons and other farmers in the community jointly agree on when to engage each other, especially time and venue for capacity building.
implementation				✓		Based on the status of the farmers, including land size, available capital, status of land degradation, etc. community resource persons and other farmers decide which SLM technologies are best for each farm.
monitoring/ evaluation		✓				The planning for and conduct of monitoring and/ or evaluation is a role of GIZ and WHH. Farmers are mainly interviewed based on pre-determined questions.
Research	✓					

Flow chart

The ProSoil Project (GIZ and GFA) provides financial resources for the training of CRPs. The CRPs are trained by SLM specialists from the County Department of Agriculture. The CRPs provide advisory services to farmers.

Author: William Akwanyi

Decision-making on the selection of SLM Technology

Decisions were taken by
- [ ] land users alone (self-initiative)
- [x] mainly land users, supported by SLM specialists
- [ ] all relevant actors, as part of a participatory approach
- [ ] mainly SLM specialists, following consultation with land users
- [ ] SLM specialists alone
- [ ] politicians/ leaders

Decisions were made based on
- [x] evaluation of well-documented SLM knowledge (evidence-based decision-making)
- [ ] research findings
- [x] personal experience and opinions (undocumented)

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE MANAGEMENT

The following activities or services have been part of the approach
- [x] Capacity building/ training
- [x] Advisory service
- [x] Institution strengthening (organizational development)
- [x] Monitoring and evaluation
- [ ] Research

Capacity building/ training

Training was provided to the following stakeholders
- ☑ land users
- ☑ field staff/ advisers

Form of training
- ☑ on-the-job
- ☑ farmer-to-farmer
- ☑ demonstration areas
- ☐ public meetings
- ☐ courses

Subjects covered
1. Conservation Agriculture
2. Agroforestry
3. Soil and Water Conservation measures
4. Integrated Soil Fertility and Pest Management (ISF&PM)
5. Push-pull
6. Good Agronomic Practices

Advisory service

Advisory service was provided
- ☑ on land users' fields
- ☑ at permanent centres

CRPs advise farmers at their farms whenever they visit them. Meetings are held on needs basis between farmers and the CRPs where pieces of advice are given to farmers.

Institution strengthening

Institutions have been strengthened / established
- ☐ no
- ☐ yes, a little
- ☐ yes, moderately
- ☑ yes, greatly

at the following level
- ☑ local
- ☐ regional
- ☐ national

Describe institution, roles and responsibilities, members, etc.
Kimaeti Farmers CBOs and farmer groups at community level whose member farmers are capacity build and are able to learn from each other.

Type of support
- ☐ financial
- ☑ capacity building/ training
- ☐ equipment

Further details
Kimaeti Farmers CBO technical officers have been trained in SLM practices.

Monitoring and evaluation
GIZ and GFA regularly follows up with farmers to check on the implementation of technologies promoted under this approach.

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component
- ☐ < 2,000
- ☐ 2,000-10,000
- ☑ 10,000-100,000
- ☐ 100,000-1,000,000
- ☐ > 1,000,000

Precise annual budget: n.a.

Training costs for training 25 CRPs met by GIZ through GFA.

The following services or incentives have been provided to land users
- ☐ Financial/ material support provided to land users
- ☐ Subsidies for specific inputs
- ☐ Credit
- ☑ Other incentives or instruments

Other incentives or instruments
Value addition to promote marketability of farm produce e.g., mucuna. This encouraged farmers to grow mucuna as a green manure cover crop.

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

	No	Yes, little	Yes, moderately	Yes, greatly
Did the Approach enable evidence-based decision-making? Farmers were motivated to implement the SLM technologies that they were trained on by the CRPs, especially having seen how the CRPs had benefited from the SLM practices.				✓
Did the Approach help land users to implement and maintain SLM Technologies? The CRPs reached out to the land users/ farmers and taught them how to implement the SLM technologies.				✓
Did the Approach improve coordination and cost-effective implementation of SLM? Farmers are not paying for the extension services that they receive from the CRPs.			✓	
Did the Approach mobilize/ improve access to financial resources for SLM implementation?	✓			
Did the Approach improve knowledge and capacities of land users to implement SLM? SLM knowledge received from the CRPs.				✓
Did the Approach build/ strengthen institutions, collaboration between stakeholders? Collaboration of GFA and GIZ, GFA and Kimaeti Farmers CBO strengthened.				✓
Did the Approach empower socially and economically disadvantaged groups? Farmers with limited resources to invest in capacity building/ training received free SLM knowledge.				✓

Main motivation of land users to implement SLM

Sustainability of Approach activities

- [x] increased production
- [ ] increased profit(ability), improved cost-benefit-ratio
- [x] reduced land degradation
- [ ] reduced risk of disasters
- [ ] reduced workload
- [ ] payments/ subsidies
- [ ] rules and regulations (fines)/ enforcement
- [x] prestige, social pressure/ social cohesion
- [ ] affiliation to movement/ project/ group/ networks
- [ ] environmental consciousness
- [ ] customs and beliefs, morals
- [x] enhanced SLM knowledge and skills
- [ ] aesthetic improvement
- [x] conflict mitigation

Can the land users sustain what hat been implemented through the Approach (without external support)?

- [ ] no
- [x] yes
- [ ] uncertain

Most of the SLM practices promoted under the approach have greatly improved the farms. Hence, a motivation to continue implementing even without donor support.

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Easy access to CRPs since they are members of the same communities with the target farmers.
- Evidence-based learning from fellow farmers is a motivation for farmers to invest in SLM.
- It could be a source of income for the CRPs; some earn an income by providing extension services to other farmers

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

- A cost-effective method of disseminating agricultural information.

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

- CRPs may lack resources to reach out to farmers since they work on voluntary basis. Formal recognition of CRPs by the government of Kenya. Government setting aside some funds to support the CRPs
- Resistance from some farmers. CRPs to be provided with some form of identification,

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

REFERENCES

Compiler
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Full description in the WOCAT database

https://qcat.wocat.net/en/wocat/approaches/view/approaches_6688/

Linked SLM data

Technologies: Retention ditches for soil and water conservation https://qcat.wocat.net/en/wocat/technologies/view/technologies_6675/
Technologies: Compost for organic waste management and improved crop yields https://qcat.wocat.net/en/wocat/technologies/view/technologies_6648/
Technologies: Vermicomposting: an effective liquid fertilizer and biopesticide https://qcat.wocat.net/en/wocat/technologies/view/technologies_6685/
Technologies: Lime application to acid soils https://qcat.wocat.net/en/wocat/technologies/view/technologies_6702/
Technologies: Lime application to acid soils https://qcat.wocat.net/en/wocat/technologies/view/technologies_6702/

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Project

- Soil protection and rehabilitation for food security (ProSo(i)l)

Links to relevant information which is available online

- Training Community Resource Persons and Panchayat members in Tamil Nadu: https://indo-germanbiodiversity.com/project-details-265.html

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