Sustainable Land Management (SLM)

A compilation of SLM technologies and approaches to enhance Integrated Soil Fertility Management in Ethiopia

2024

Co-published by: Centre for Development and Environment (CDE), University of Bern, Switzerland, Alliance of Bioversity International & CIAT and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Funded by: German Federal Ministry for Economic Cooperation and Development (BMZ)

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Citation: Nekesa, T., Golli, S., Jaquet, S., Katsir, S., Vollmann Tinoco, V., Helbig, T., Teferi, E. (2024). Sustainable Land Management (SLM). A compilation of SLM technologies and approaches to enhance Integrated Soil Fertility Management in Ethiopia. World Overview of Conservation Approaches and Technologies (WOCAT) / Centre for Development and Environment (CDE), University of Bern, Switzerland, Alliance of Bioversity International & CIAT and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

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Table of contents

List of acronyms

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

List of figures

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]

Intercropping ©GIZ

[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 commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ) as part of Germany's special iniative "Transformation of Agricultural and Food Systems".

Under the coordination of Noel Templer, Gerba Leta collected data on the SLM practices. We thank the WOCAT team members Nicole Harari, Joana Eichenberger, and Rima Mekdaschi Studer, and the GIZ team in Ethiopia, for their invaluable contributions. We also acknowledge the diligent work of the technical editors and reviewers Noel Templer, Julia Doldt, Kidist Yilma, Torben Helbig, Likissa Kurmana Dufera, William Critchley, and Rima Mekdaschi Studer.

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 ProSoil partner countries to protect land from erosion and restore and maintain soil fertility. The programme 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 standardized 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 organization, a steering committee member of the WOCAT network, supported WOCAT's work on documentation, sharing, mainstreaming, and scaling out SLM practices in ProSoil project countries.

Lime application and ploughing land with oxen ©GIZ

Foreword

Agriculture plays a significant role in Ethiopia's economy. The country's diverse climate and topography allow for the cultivation of a wide variety of crops, including wheat, teff, maize, coffee, and various fruits, and vegetables. Agriculture not only provides livelihoods for a large portion of the population but also contributes substantially to the country's export earnings.

In the Ethiopian highlands, soil degradation has been a significant concern for the agricultural sector. Subsistence-oriented smallholders are the foundation of the local agri-food systems, often farming intensively with limited means to replenish soil nutrients and biomass. As a result, the land is often infertile and degraded due to erosion, nutrient depletion, acidification, and low soil organic matter content leading to low yields. Climate change, frequent droughts, and population growth exacerbate the situation and put increasing pressure on soil resources.

The Integrated Soil Fertility Management Project (ISFM+) is part of the Global Programme Soil Protection and Rehabilitation for Food Security and supports the Ethiopian Government in promoting Integrated Soil Fertility Management (ISFM) technologies and approaches. Improving soil fertility is an essential pre-requisite for achieving the targets set out in the Ethiopian national development agenda for both increasing agricultural productivity on a sustainable basis and improving human health and food security. Therefore, the ISFM+ project has built the capacity of land users and decision-makers through the promotion of Integrated Soil Fertility Management practices in the regions of Amhara, Oromia, Tigray, Sidama, Southern Ethiopia, and Central Ethiopia. These include the judicious use of inorganic fertilizer, organic manure, and, on acidic soils, the application of lime. ISFM builds on locally adapted technologies, thereby improving soil health, productivity, and biodiversity. It also enhances climate resilience by increasing carbon stocks in soils.

Fourteen selected SLM practices under the ISFM+ project were documented by the Alliance of Bioversity International and CIAT and published on the World Overview of Conservation Approaches and Technologies (WOCAT) global database for scaling out. By documenting and disseminating these ISFM technologies, this compilation aims to support the efforts of policymakers, practitioners, and communities working to safeguard Ethiopia's soil health and agricultural productivity. It is our hope that this resource will contribute to informed decision-making, foster knowledge exchange, and ultimately help build a more resilient and sustainable agricultural sector in Ethiopia.

Steffen Schulz (PhD.)

Integrated Soil Fertility Management Project Manager

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH Ethiopia

Context

Soil fertility is the soil's ability to support plant growth through favorable chemical, physical, and biological conditions. Favorable conditions ensure the availability of essential nutrients for plant growth. Conversely, declining soil fertility, a form of land degradation, undermines plant growth. Soil fertility decline in Ethiopia, caused by nutrient mining, acidification, organic matter loss, and soil erosion, has resulted in limited crop productivity (IRLI, 2020). About 3.5 million hectares of the country's soils are highly acidic, reducing nutrient availability for crop production. The Ethiopian highlands are highly vulnerable to declining soil fertility due to steep slopes, erosion, population pressure, deforestation, and unsustainable agricultural practices. Agriculture is a major contributor to soil fertility decline in the country's highlands:

Agriculture related causes of soil fertility depletion in Ethiopia

- Continuous cropping systems and cultivation
- Inefficient fertilizer use
- Overgrazing
- Land use conversion for agriculture
- Monoculture farming
- Complete removal of crop residues
- Improper irrigation management

Figure 1: Soil fertility depletion in Ethiopian agriculture

Urine collection ©GIZ

Soil fertility decline is also a major cause of declining capital food production, affecting Ethiopia's socio-economic development. While agriculture accounts for one-third of the country's gross domestic product (GDP) (Diao et al., 2023), the estimated cost of soil and essential nutrients loss is 3 per cent of agricultural GDP (ICRISAT, 2018). Smallholder subsistence farmers account for the bulk of local agricultural production; however, the production is characterized by intensive land use with limited nutrient replenishment. As a result, soil health is generally degraded, contributing to low agricultural productivity and affecting livelihoods.

To address soil fertility decline, the ProSoil project, Integrated Soil Fertility Management (ISFM+), has built the capacity of land users and decision makers through the promotion of ISFM+ practices in selected areas of Amhara, Central Ethiopia, South Ethiopia, Sidama, and Tigray regions. ISFM+ takes into consideration locally adapted and relevant technologies for improved soil fertility, soil health, and productivity, contributing to (a) increasing on-farm biomass production, (b) reducing nutrient and biomass losses from the farming system, and (c) improving the agronomic use efficiency of production inputs. The practices improve food security and livelihoods and promote biodiversity by enhancing soil quality. Moreover, they enhance climate resilience as fertile soils are significant carbon reservoirs.

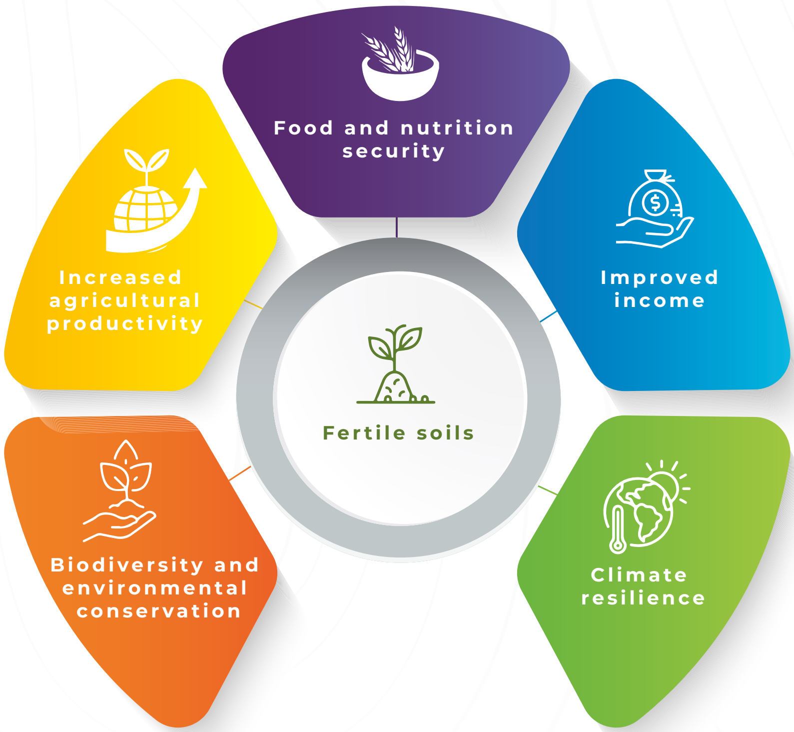


Figure 2: Significance of fertile soils

Methodology

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

1. **The selection of practices for documentation.** The ProSoil project has disseminated SLM practices across the Amhara, Central Ethiopia, South Ethiopia, Sidama, and Tigray regions. The 14 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 organized 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 Adama. 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-Ethiopia 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 project 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

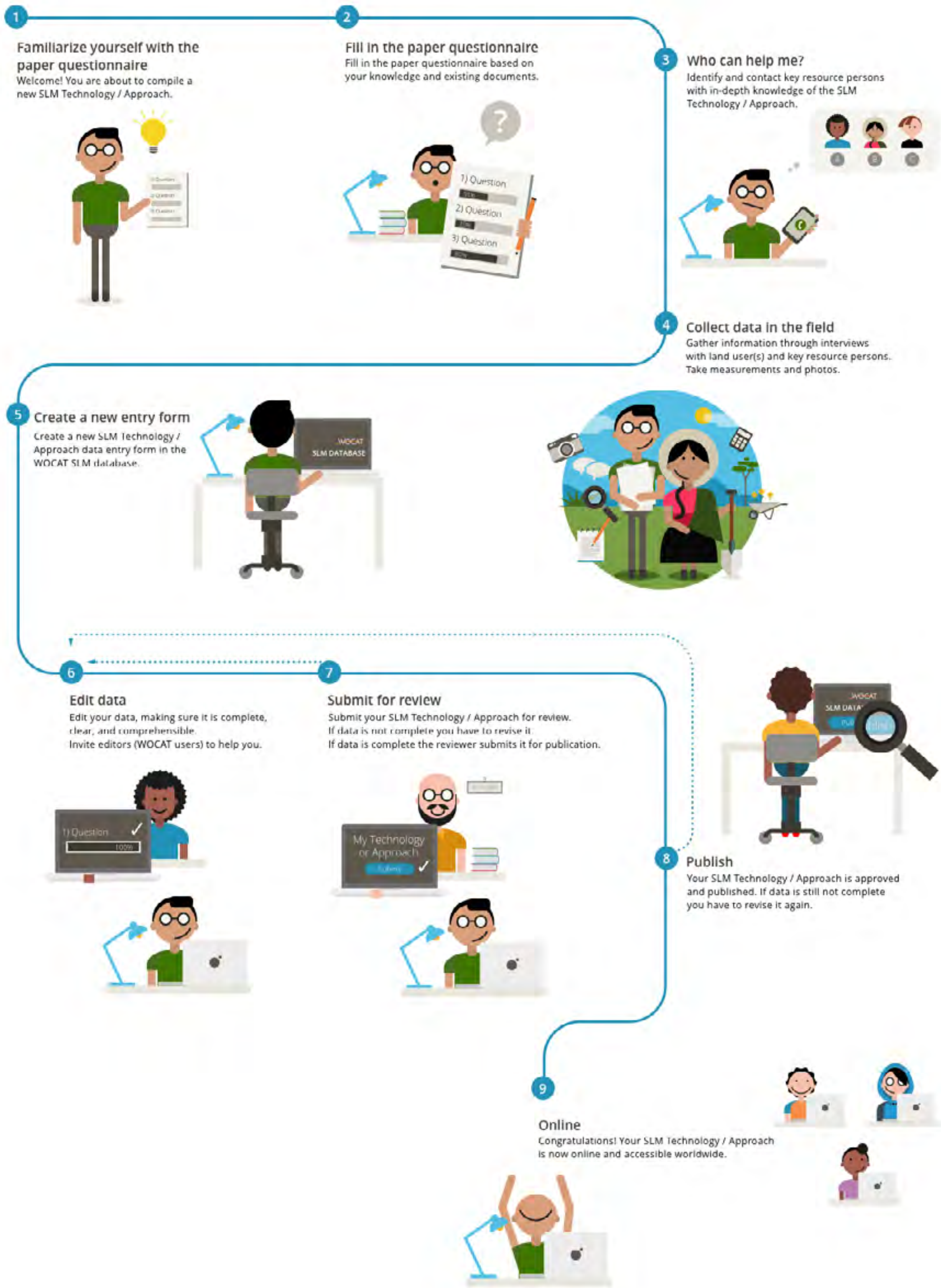


Figure 3: Steps of the WOCAT documentation process

Categories of SLM practices

Soil fertility management

- SLM approach: ISFM
- SLM approach: Soil fertility improvement cluster
- SLM technology: Green manures
- SLM technology: Treating acid soils with lime
- SLM technology: Vermicomposting
- SLM technology: Improved compost
- SLM technology: Livestock urine collection and use
- SLM technology: Bioslurry

Agricultural and agroforestry practices and techniques

- SLM approach: Integrated agroforestry system
- SLM technology: Multistorey agroforestry
- SLM technology: Relay intercropping

Water and soil management and infrastructure

- SLM technology: Crop residue management
- SLM technology: Cover crops

Farmers' research and extension

- SLM approach: Farmers' Research and Extension Group (FREG)

A household member from Adale Bise kebele of Mattu district who is simultaneously producing organic fertilizers using vermicomposting and biogas/bioslurry production technology. (Gerba Leta)

Integrated Soil Fertility Management (ISFM) (Ethiopia)

Qindoomina Misooma Gabbina Biyyee (Afaan Oromoo) /Yeteqenaje ye Afer Limat (Amharic)

DESCRIPTION

The Integrated Soil Fertility Management (ISFM) approach has been adopted under the Integrated Soil Fertility Management Project (ISFM+). It was introduced as a quick-win solution to increase both crop and biomass production through the incremental promotion of varied but complementary technology packages.

The Integrated Soil Fertility Management (ISFM) approach is intended to increase both crop and biomass production through the incremental promotion of varied but complementary technology packages. These include the production and use of organic fertilizers, treatment of soil acidity, and improved retention of crop residue. All help in reducing the depletion (mining) of soil nutrients. One characteristic feature is the engagement of research and development partners at all levels such as in joint problem identification, learning, participatory planning, piloting technology, and exchange visits. The approach involves model farmers and also focuses on farmers with limited means to purchase chemical fertilizers. It enhances the production of organic fertilizers to increase both soil fertility and crop productivity.
Furthermore, ISFM enables farmers to generate off-farm and on-farm income through the production and sale of organic fertilizers, vermiworms, and green manure seeds, etc. The partners assist in identifying soil-related issues, as well as enhancing the adoption and institutionalization of the approach. ISFM aims to improve stakeholders' understanding of land degradation issues and the necessity of SLM by creating access to relevant seasonal training, exposure visits, collective learning, and action.
Project focal persons representing partners at different levels and development agents (DAs) are used to facilitate the process and serve as potential links with stakeholders. At the local level, the Farmers Research and Extension Group (FREG) sub-approach supports the implementation of the technologies on an incremental basis (see WOCAT database). Also, the Soil Fertility Improvement Cluster approach (see WOCAT database) assists in scaling out of the ISFM approach by adopting and superimposing technologies such as vermicompost with improved compost production. Farmer ambassadors are identified from the FREG model based on their performance. They assist in mainstreaming and dissemination of the approach and technologies to indirect beneficiaries. The implementation process of the ISFM involves district and kebele selection, identification of watersheds and voluntary farmers, provision of capacity-building training, conducting participatory planning, supplying inputs, and technical support. To realize the aims, the ISFM+ allocates financial support to the partners at different levels via Local Subsidy Contract.
Project staff including federal and regional advisors are involved. They provide training, technical backstopping, reviewing progress, M&E, and feedback services. District focal person closely follows up on the implementation - with the support of DAs in steering farmers' group meetings and collective learning. In addition, DAs assist in piloting on farm short and long-term demonstrations, organizing field days and exchange visits, collecting data, and overseeing activities.

LOCATION

Location: Addis Ababa, Ethiopia

Geo-reference of selected sites
- 38.79984, 9.02149

Initiation date: 2015

Year of termination: 2025

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

Land users like the technologies introduced and implemented via the ISFM approach. The promotion of collective learning and action leads to increased soil fertility, and improved crop production and smallholders' livelihoods. The creation of new sources of income for land users is among the benefits they appreciate the most. However, farmers are less enthusiastic by the way that group meetings clash with their other activities and this leads to some members dropping out. Also, the cost of technologies promoted by the ISFM such as combined uses of chemical fertilizers, bio-fertilizers (for legumes), organic fertilizers, and quality seeds are envisaged as a possible constraint among others.

ISFM+ focal persons and other member of the development partners progress assessment and planning meeting. (Gerba Leta)

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims / objectives of the approach

The main objective of the approach is to promote the integration of technologies, collective learning, and action for treating degraded soil, increasing soil fertility and crop productivity while ensuring sustainable uses of land.

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

- **Availability/ access to financial resources and services**: Access to financial resources improved farmers' access to materials and inputs on their own. This promotes the adoption and scaling up of the technology using ISFM approach.
- **Institutional setting**: Institutional setting such as farmers' group formation promotes collective learning and action.
- **Collaboration/ coordination of actors**: Is central to promoting effective implementation of the approach that entails various research and development actors.
- **Policies**: Such as adopting lime production, distribution and use policy enables successful implementation of the approach.
- **Workload, availability of manpower**: Family labor enables production of organic fertilizers and effective implementation of lime and other technologies which are labor intensive.

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

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	Model farmers, and other smallholders (followers).	Lead group meeting, facilitate collective learning and action based on the pilot practices/activities.
SLM specialists/ agricultural advisers	Focal persons and experts from soil fertility improvement /extension unit of the district.	Facilitate implementation of the technology via the approach, and serve as a link between stakeholders.
researchers	Soil researchers from Regional Research Institutes, and respective technologies.	Soil testing, production of bio fertilizer, and supporting the different technologies with research findings.
NGO	SNV Ethiopia, Nutrition Sensitive Agriculture, and other GIZ projects.	Integration of efforts such as on biogas/bioslurry production and other respective project implementation activities.
private sector	Agro dealers, and other services providers	Facilitate the distribution of lime and improved seeds, provide services on mechanization such as maintenance, etc.
local government	District office of agriculture, and woreda administration.	Partnerships, acknowledge implementation of the project and provide administrative support when

		required.
national government (planners, decision-makers)	Ministry of Agriculture and Research System.	Support in mainstreaming the technology and approach, policy formulation and research support testing soil and tools...
international organization	CIAT, CIMMYT, ICRISAT...	Provide research and technical support in joint areas of intervention.

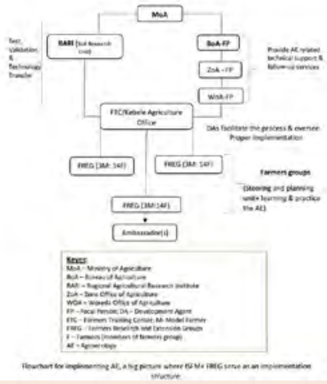
Lead agency
Integrated Soil Fertility Management Project (ISFM+).

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

	none	passive	external support	interactive	self-mobilization	
initiation/ motivation			✓			District focal person and development agents. Facilitate the implementation right from awareness raising, farmers' group formation, training, supply inputs, and technically support the implementation.
planning				✓		Regional advisor, focal persons, and the farmers. Each engaged in a participatory planning exercise.
implementation				✓		Farmers, focal persons, and development agents. Farmers implement the technologies being guided by the approach. Whereas, the focal person and development agents oversee and provide technical support.
monitoring/ evaluation				✓		Focal person, development agents, and land users. They conduct participatory M&E to ensure collective learning.

Flow chart

ISFM approach that run from the federal to kebele where FREG is the pillar approach serving the land users as a platform for collective learning and action at local level.



Author: Gerba Leta

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

Soil degradation, rehabilitation of the degraded soil using different technologies and agronomic practices notably lime, organic fertilizers, bio fertilizer, crop residue management, mixed cropping, green manuring, application of minimum tillage practices, etc.

Advisory service

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

Advisory services are provided by the focal person and development agents at Farmers Training Center and on the farmers' field.

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.
Farmers Research and Extension Group (FREG) has been established at the local level and has been serving as an approach at the local level. It has been serving as a local platform that brings members of the farmers' group together in participatory planning and joint learning of the technologies piloted on the farmer's field and short and long-term demonstrations.

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

Further details
The project provides financial support through the Local Subsidy Contract. Capacity building is central to the implementation of the project. Farm tools as an incentive for the best-performing farmers and on-field soil testing equipment are provided to support the partner organizations scaling out the implementation of ISFM.

Monitoring and evaluation

Monitoring and evaluation is the pillar of the project activities and the adopted approach. The project along with implementing partners pilot short-term and long-term demonstrations, monitor the progress, and evaluate the achievements. Therefore, M&E is a regular activity in which the federal and regional project advisors rely on to generate feedbacks to amend or improve the implementation of the project activities.

Research

Research treated the following topics
- [ ] sociology
- [ ] economics / marketing
- [ ] ecology
- [x] technology

The research targets the feasibility of the technologies introduced via the ISFM approach and the project itself. The role of integrating different technology packages in improving soil fertility and crop productivity is also among the focuses of the research.

FINANCING AND EXTERNAL MATERIAL SUPPORT

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

Precise annual budget: n.a.

ISFM+ is the source of the budget. A local Subsidy Contract (LSC) has been provided to partner organizations to effectively implement and follow up the activities with an additional allocation of finance for inputs and services.

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

Financial/ material support provided to land users

The project introduces technologies, provides inputs (improved seeds, chemical fertilizers, lime), and seldom supplies farm tools for a few well-performing models as an incentive.

Other incentives or instruments

Farm tools for outstanding farmers as well as a solar panel for residents in a rural setting as an incentive for well-performing in adopting the approach and proper implementation of the project.

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? Land users learned the benefit of integrating three or more technologies/practices to improve soil fertility, and crop productivity and ensure the SLM is being in place.			✓	
Did the Approach enable evidence-based decision-making? The approach certainly enables evidence-based decision-making by comparing the yield from the plots with treatment (technology packages) versus the control (without full packages).				✓
Did the Approach help land users to implement and maintain SLM Technologies? The combination of three or more technologies, all in one inspires the land users to adopt and sustainably implement the SLM technologies.				✓

Did the Approach improve coordination and cost-effective implementation of SLM? Coordination at a local level is not up to the expectation.	☐☑☐☐
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? It improves the knowledge and skills of land users to implement SLM by promoting collective learning and action that highly increases peer learning through observation and social learning.	☐☐☐☑
Did the Approach improve knowledge and capacities of other stakeholders? It impacts or improves the knowledge and skills of indirect beneficiaries through farmer's ambassadors.	☐☑☐☐
Did the Approach build/ strengthen institutions, collaboration between stakeholders? It strengthens the inter-farmers collaboration and coordination that is seldom constrained by the overlaps with local activities such as public meetings and other communal affairs mostly known as new arrivals.	☐☐☑☐
Did the Approach mitigate conflicts?	☑☐☐☐
Did the Approach empower socially and economically disadvantaged groups? Farmers who have no financial means to access and use chemical fertilizers and other inputs involved via the approach.	☐☑☐☐
Did the Approach improve gender equality and empower women and girls? One-third of a member of the farmers' group are women farmers- a signal for improvement of participation by gender.	☐☐☑☐
Did the Approach encourage young people/ the next generation of land users to engage in SLM? There is an assumption that young people learn from the family and neighbors who engaged in the implementation of the approach. This certainly inspires the young generation to take up and implement SLM activities.	☐☑☐☐
Did the Approach improve issues of land tenure/ user rights that hindered implementation of SLM Technologies?	☑☐☐☐
Did the Approach lead to improved food security/ improved nutrition? Through promoting technologies/practices that improve production and productivity. By promoting legumes crop production using biofertilizers and as part of intercropping practices that ensure the nutrition security of the family farmers.	☐☐☑☐
Did the Approach improve access to markets? It improves participants' access to the inputs market (selling organic fertilizers, green manure seeds, vermiworms, and surplus products).	☐☑☐☐
Did the Approach lead to improved access to water and sanitation?	☑☐☐☐
Did the Approach lead to more sustainable use/ sources of energy? Mainly through supporting biogas/bioslurry technology, and the introduction of woodlots to family farmers via agroecology projects that adopt a similar approach.	☐☑☐☐
Did the Approach improve the capacity of the land users to adapt to climate changes/ extremes and mitigate climate related disasters? This is partly through adopting minimum tillage practices, crop residue management, and the production and use of organic fertilizers that reduce carbon emissions and foster carbon sequestration.	☐☑☐☐
Did the Approach lead to employment, income opportunities? It creates income opportunities by promoting surplus production, production, and sale of organic fertilizers, vermiworms, and green manure seeds.	☐☐☑☐

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

As the production of organic fertilizers adopted on an individual basis and tangible benefit acquired from the implementation of the integrated approach introduced via the approach as well as the increasingly growing supply of lime for acid soil amendments similar to other chemical fertilizers, the likelihood of sustaining the approach for implementing integrated technologies is inevitable. Besides, the public organizations for instance bureaus of Agriculture and line offices such as in west Oromia of Jimma and Buno-Bedele zones institutionalized the production and uses of organic fertilizers via huge investments in establishing vermiculture centers to reach out to the large majority of smallholders subjected to soil degradation issues.

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- It promotes collective learning and action among smallholders living in a homogenous landscape facing similar land/soil degradation issues.

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

- Integrating technologies/practices and inputs via the approach has cost implications. Promote the land user's awareness of the cost-

- It enhances soil fertility and soil health by introducing integrated technologies and creating evidence-based learning.
- Gain widespread publicity that allows the public and land users to build trust in the approach and component technologies that positively impact the livelihood of smallholders and the land in general.

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

- The approach has been adopted and institutionalized within the government's mainstream rural development and agricultural extension.
- The project and the implementation approach are in line with the government's short and long-term plan to ensure the food and nutrition security of the nations while conserving natural resource basis.
- Integration is basic to address the nexus of issues that combine knowledge and skills development, the introduction of important agricultural inputs, technologies, or practices, all in one.

benefit of adopting the approach and introduction of subsidy to some inputs such as agriculture lime for acid soil amendments.
- The approach drives labor-demanding technologies and practices. Promote collective action through adopting labor share arrangements as well as efficiently use family labor for follow-up of the production of organic fertilizers by task sharing.
- The high investment cost for some technologies is promoted by the approach. Enable land users to make the right choices of diverse technologies catered through the project and the adopted approach.
- Delay in supply of agricultural inputs such as agricultural lime Encourage private sectors involvement or the agro dealers in the supply of the agricultural inputs.

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

- The limited scope of the project implementation sites. To try to reach out to similar landscapes with similar land degradation issues including the marginal regions. Or else, institutionalize the approach at the national level so that the public sector takes up and popularizes it in areas with similar problems.
- The collaboration and collective action at local levels through the existing platform is staggered by new arrivals and other local administrative chores. Local government actors and partners need to be well aware and give due emphasis beyond considering the intervention implemented through ISFM as merely project activities that usually come and go.

REFERENCES

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Date of documentation: April 19, 2023

Last update: May 1, 2023

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Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/approaches/view/approaches_6732/

Linked SLM data
Technologies: Bioslurry https://qcat.wocat.net/en/wocat/technologies/view/technologies_6646/
Technologies: Vermicomposting https://qcat.wocat.net/en/wocat/technologies/view/technologies_6643/
Technologies: Green Manures https://qcat.wocat.net/en/wocat/technologies/view/technologies_6645/
Technologies: Crop Residue Management https://qcat.wocat.net/en/wocat/technologies/view/technologies_6644/
Technologies: Livestock Urine Collection and Use https://qcat.wocat.net/en/wocat/technologies/view/technologies_6623/
Technologies: Cover crops https://qcat.wocat.net/en/wocat/technologies/view/technologies_6628/
Technologies: Treating acid soils with lime https://qcat.wocat.net/en/wocat/technologies/view/technologies_6641/
Technologies: Relay Intercropping https://qcat.wocat.net/en/wocat/technologies/view/technologies_6630/

Documentation was faciliated by

Institution
- CIAT International Center for Tropical Agriculture (CIAT International Center for Tropical Agriculture) - Kenya

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

Key references

- Leta, G., Schulz, S., Alemu, G. 2020. Agricultural extension approach: evidence from an Integrated Soil Fertility Management project in Ethiopia. Frontiers of Agricultural Science and Engineering, 7(4): 1-13. DOI: 10.15302/J-FASE-2020331: Free online

Links to relevant information which is available online
- Integrated Soil Fertility Management: https://ifdc.org/integrated-soil-fertility-management-isfm/

The land user, Mr. Mohammed Abdulqadir demonstrating improved compost production, harvest and storage system before use. (Gerba Leta)

Soil Fertility Improvement Cluster (Ethiopia)

Foyyainsaa Gabbina Biyyee gareedhan

DESCRIPTION

The Soil Fertility Improvement Cluster approach engages five or more farmers living in a village who share skills and labour to prepare and use improved compost as well as to demonstrate it to non-member of the group.

The Soil Fertility Improvement Cluster approach engages five or more farmers living in a village who share skills and labour. Soil fertility improvement interventions in Kersa district of Jimma zone follows this approach. A cluster introduces diverse benefits to the participants including access to a package of inputs, and other benefits and services. Furthermore, it creates awareness and facilitates the adoption and diffusion of various soil fertility improvement technologies such as the preparation and use of improved compost. Kersa district, as one of the scaling out woredas for the Integrated Soil Fertility Management Project (ISFM+), strives to spread appropriate technologies against the growing issues of soil degradation, particularly soil acidity. The approach aims to promote collective learning and action where labour is shared amongst the participating farmers.

The district/Woreda Office of Agriculture's Soil Fertility Improvement Unit organises annual training for 20 to 40 model farmers from different kebeles, of which five or more are located in the same village and can form a cluster. At the end of the training, the woreda office of agriculture donates a spade or other farm tool as an incentive to engage the participants in the preparation of organic fertilizers such as improved compost and vermicompost. Strict follow-up is carried out, with technical support provided by woreda development actors.

On top of the training organized on improved soil fertility by the woreda office of agriculture experts, a local NGO known as "FC Ethiopia" provides experience exchange visits to other parts of Oromia where improved compost was piloted. This technology involves different activities for the production of improved compost (described in detail as a Technology in the WOCAT database). Farmers' participation in training, exchange visits, collective learning and action, and lessons learning from the actual use of this organic fertilizer vis-à-vis using synthetic fertilizers motivates farmers to uptake and implement the technology. Land users like the simplicity of preparing the compost which takes less time than conventional compost preparation.

LOCATION

Location: Babo kebele, Oromia, Jimma zone, Ethiopia

Geo-reference of selected sites
- 36.92973, 7.69544

Initiation date: 2022

Year of termination: n.a.

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

Structure for improved compost production inside the backyard coffee plantation of a member of a cluster. (Gerba Leta)

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims / objectives of the approach

To learn and prepare improved compost in a group, and restore the increasingly growing problems of soil acidity, the main causes of soil degradation in the area.

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

- **Availability/ access to financial resources and services**: It enables land users to easily source some necessary materials such as polyethylene sheet.
- **Institutional setting**: Cluster formation at the local level enables collective learning and labor sharing among the participant farmers.
- **Collaboration/ coordination of actors**: Simplify group learning and scaling up/out of the technology at a larger scale.
- **Knowledge about SLM, access to technical support**: Farmers' cluster or group approach improves access to technologies and technical support. Moreover, it improves farmer knowledge about SLM.
- **Markets (to purchase inputs, sell products) and prices**: It enables the farmers to produce surplus organic fertilizer and sell it out to those who require it.
- **Workload, availability of manpower**: The availability of family labor simplifies the production and use of improved compost.

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

- **Workload, availability of manpower**: The workload and shortage of family labor have a negative effect on the preparation of improved compost.

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

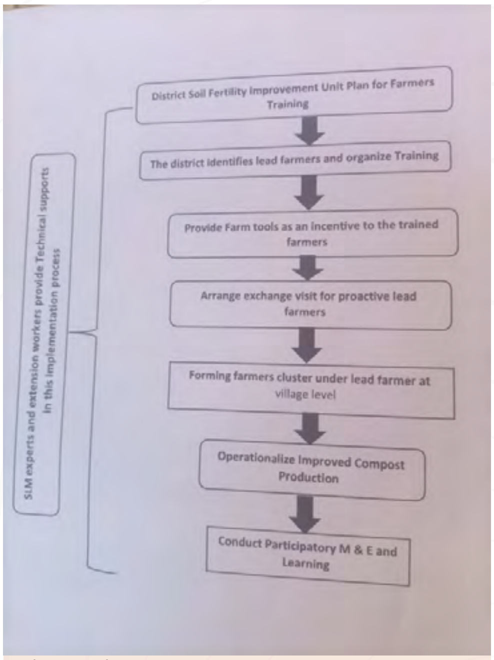
What stakeholders / implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	Farmers	Collective learning and labor sharing.
SLM specialists/ agricultural advisers	Woreda SLM experts and Kebele extension workers.	Technical support and provision of advisory service.
NGO	FC Ethiopia	Arranged experience exchange visit for few farmers.

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

	none	passive	external support	interactive	self-mobilization	
initiation/ motivation				✓		SLM experts and extension workers provide technical support, and a group of farmers jointly learn and implement the technology.
planning				✓		Extension workers engage in the planning process.
implementation					✓	Farmers are keen to learn and implement the technology via group steering and self-mobilization.
monitoring/ evaluation				✓		Woreda SLM experts, extension workers, and farmers engaged in participatory evaluation and learning in a cluster.

Flow chart

Process of implementing cluster-based improved compost production.



Author: Gerba Leta

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
- [ ] evaluation of well-documented SLM knowledge (evidence-based decision-making)
- [x] 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

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

Subjects covered

Improving soil fertility using organic fertilizers, acid soil management, crop residue management, crop rotation, etc.

Advisory service

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

Advisory service is often given at Farmers Training Center (FTC) and complemented by field visit and provision of on- the- spot technical support and counseling services.

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.

Farmers cluster (soil fertility improvement group). Member farmers jointly learn the technique of producing organic fertilizers, SLM practices, and sharing labor during the time of applying the fertilizer to the farm.

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

Further details

Monitoring and evaluation

The monitoring and evaluation are conducted by Woreda SLM experts and seldom with member of the woreda administration and the land users.

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component

- [ ] < 2,000
- [x] 2,000-10,000
- [ ] 10,000-100,000
- [ ] 100,000-1,000,000
- [ ] > 1,000,000

Precise annual budget: n.a.

Actually, specific data for operational data is not available at the level of the compost production cluster since the training and exchange visits were organized by the woreda office of Agriculture and an NGO. Of course, there are huge labor costs spent by land users to access the feedstock. Also, materials/accessories and farm tools cost for compost production was not precisely accounted for.

The following services or incentives have been provided to land users

- [x] Financial/ material support provided to land users
- [ ] Subsidies for specific inputs
- [ ] Credit
- [x] Other incentives or instruments

Financial/ material support provided to land users

Material support during the training such as farm tools (spade/fork) only.

Other incentives or instruments

The woreda SLM/Soil Fertility Improvement unit sometimes purchase surplus organic fertilizer produced by land users to promote them consistently produce and use to restore their soil fertility and address threat of degradation.

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? It brings land users residing in a village together and collectively learn and share labor.			✓	
Did the Approach enable evidence-based decision-making? It assists in learning from practical application and the remarkable response of the treated soil to the crop.			✓	
Did the Approach help land users to implement and maintain SLM Technologies? Restoration of the degraded soil owing to the application of improved compost inspired the land users to take up and sustain the technology.				✓
Did the Approach improve coordination and cost-effective implementation of SLM? It brings farmers together by cluster and promotes joint learning and acting.		✓		
Did the Approach mobilize/ improve access to financial resources for SLM implementation? Not yet mobilized the resources for the implementation of the SLM.	✓			
Did the Approach improve knowledge and capacities of land users to implement SLM? It improves land users knowledge through joint learning and exchange visit.			✓	
Did the Approach improve knowledge and capacities of other stakeholders? It allows other stakeholders to learn from the pilot activities.		✓		
Did the Approach build/ strengthen institutions, collaboration between stakeholders?		✓		
Did the Approach empower socially and economically disadvantaged groups? It is believed that economically marginalized groups learn to produce improved compost for sell and generate income.		✓		
Did the Approach improve gender equality and empower women and girls? It increases women's participation in the production process.			✓	
Did the Approach encourage young people/ the next generation of land users to engage in SLM? t enables the young generation to build trust in the technology for restoring soil fertility and arresting further degradation.			✓	
Did the Approach lead to improved food security/ improved nutrition? It increases the quantity and quality of produce by application of organic fertilizer, and compost.			✓	
Did the Approach improve access to markets? Land users learn to produce surplus compost for sale.			✓	
Did the Approach lead to improved access to water and sanitation? Conceptually yes, as a long-term impact.	✓			

Did the Approach lead to more sustainable use/ sources of energy?	✓ (1 of 4)
Did the Approach improve the capacity of the land users to adapt to climate changes/ extremes and mitigate climate related disasters? The treated soil holds moisture and allows an extended grain-filling period of the crop and allows it to escape the moisture deficit period.	✓ (2 of 4)
Did the Approach lead to employment, income opportunities? It creates an opportunity to work on improved compost production during the off-season. Also, surplus production generated income.	✓ (3 of 4)

Main motivation of land users to implement SLM

- [x] increased production
- [x] 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
- [x] environmental consciousness
- [ ] customs and beliefs, morals
- [x] 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
- [x] yes
- [ ] uncertain

Farmers enjoy the benefit accrued from the production and use of improved compost. It improves soil fertility and mitigates the effects of soil acidity on the best use of synthetic fertilizers. Also, land users are enjoying the sale of surplus production. At least about 0.5 tons of compost is harvested from a pile which increases the cumulative production of as many heaps as possible.

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- The approach is based on preliminary training, exchange visit, motivation, and technical support.
- It promotes mutual learning at the local level and allows other stakeholders to learn from the pilot activities.
- As it is less labor-demanding and matured shortly compared to conventional compost making, it has a high rate of scaling opportunity.

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

- It is an inspiring initiative in the middle of adversity relating to soil degradation so that land users learn from one another, and arrest the ongoing soil degradation.
- The technology can be easily scaled up as the district is located in high biomass production areas that serve as a source of feedstock to produce more compost as compared to the other part of the country where there is huge competition for multiple uses of crop residue as an ingredient for compost making.
- Farmer clusters promote collective learning, labor sharing, and transferring knowledge and skills to other land users as peer learning has groundbreaking effects over centralized advisory services associated with conceptual than practical showcasing.

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

- All members of the cluster do not actively participate in collective action. Promote the active participation of the member of the cluster by strengthening ties and labor-sharing traditions. Also, to engage family labor to cover the gaps.

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

- Limited stakeholders participation as it is not project-based and is being derived from the motivation and goodwill of Woreda soil fertility improvement unit experts and the model farmers who are members of the cluster. Create more awareness of the approach. Also, the woreda needs to acknowledge and institutionalize such a beneficial approach that strives to promote collective action against the growing issues of land degradation.

REFERENCES

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Date of documentation: Feb. 14, 2023

Last update: April 27, 2023

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Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/approaches/view/approaches_6653/

Linked SLM data
Technologies: Improved Compost https://qcat.wocat.net/en/wocat/technologies/view/technologies_6649/

Documentation was faciliated by

Institution
- CIAT International Center for Tropical Agriculture (CIAT International Center for Tropical Agriculture) - Kenya

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

Key references
- CLUSTER FARMING AS NEW APPROACH IN ETHIOPIA. Dejene Mamo. 2019. Conference: Academic presentation: https://www.researchgate.net/publication/347976115_CLUSTER_FARMING_AS_NEW_APPROACH_IN_ETHIOPIA

Links to relevant information which is available online
- Collective Action in Rural Communities: https://resources.uwcc.wisc.edu/Research/AFRI_final_report_full.pdf

Green manures grown for production of seed to allow its distribution for use at larger scale. (Gerba Leta)

Green Manures (Ethiopia)

Xa'oo Magarisaa

DESCRIPTION

Green manures are fast-growing legumes sown in a field, weeks or even months before the main crop is planted. These are plants that are deliberately grown for incorporation into the soil to improve fertility and organic matter content.

Green manures are grown with the prime purpose of building up as much biomass as possible. However, they also play a role in covering the ground and protecting it from solar radiation and soil erosion. These are plants that are deliberately grown for incorporation into the soil to improve soil fertility and organic matter content. They are generally fast-growing legumes sown in a field several weeks or months before the main crop is planted. Legumes are chosen due to their ability to fix atmospheric nitrogen, their drought tolerance, quick growth, and adaptation to adverse conditions. Green manures have the potential to restore soil fertility and have an ameliorating effect on climate change via the sequestration of atmospheric carbon.
Green manures supply the soil with great amounts of fresh biomass. After incorporation into the soil, the biomass is decomposed by soil organisms within a few weeks under humid and warm conditions. Most nutrients are then readily available to a new crop. A small proportion is also transformed into stable soil organic matter, contributing to better soil structure, better aeration, improved drainage, increased soil water and nutrient holding capacity, and reduced erodibility of the soil by wind or water. Soil microbial activity is increased, as is the availability of macro and micronutrients in forms that the plants can use. They also have a root system that holds the soil in place.

Green manures are often applied to degraded land that demands management interventions. The purpose of introducing the technology reported here is primarily to multiply seeds for the scaling out of the technology. Among the common green manure crops which are being used in Ethiopia are lupin and lablab. Land users benefit from the sale of the seed itself as well as the fact that green manures increase production and help to changes unproductive and abandoned land into productive assets. This technology has been distributed to virtually all Integrated Soil Fertility Management project (ISFM+) intervention woredas/regions as a component of intervention technologies/practices.

LOCATION

Location: Mirga Mute, Bedele district, Oromia, Ethiopia

No. of Technology sites analysed: 2-10 sites

Geo-reference of selected sites
- 36.34407, 8.48284

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

In a permanently protected area?: No

Date of implementation: 2020

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

A lupin crop grown as green manure right before its incorporation into the soil. (GERBA LETA)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [x] improve production
- [x] reduce, prevent, restore land degradation
- [x] 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: No

Cropland

- Annual cropping

Number of growing seasons per year: 1
Is intercropping practiced? No
Is crop rotation practiced? No

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

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

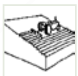
physical soil deterioration - Pc: compaction

biological degradation - Bc: reduction of vegetation cover, Bl: loss of soil life

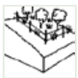
SLM group

- integrated crop-livestock management
- improved ground/ vegetation cover
- integrated soil fertility management

SLM measures



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



management measures - M5: Control/ change of species composition

TECHNICAL DRAWING

Technical specifications

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology area (size and area unit: **1.5 Sanga**; conversion factor to one hectare: **1 ha = 1ha = 8**

Most important factors affecting the costs

Cost is highly volatile in Ethiopia. It could be attributed to global and national economic crises and price changes.

sanga)
- Currency used for cost calculation: **ETB**
- Exchange rate (to USD): 1 USD = 53.12 ETB
- Average wage cost of hired labour per day: 200

Establishment activities
1. Land preparation (Timing/ frequency: Dry season)
2. Planting (Timing/ frequency: Sow the green manure seeds during the short rainy season in March/April, about 45-60 days before planting the main crop.)
3. Slash and plowing over (Timing/ frequency: Plow in the green manure about 2 weeks before planting the main crop, i.e. in June/July.)

Establishment inputs and costs (per 1.5 Sanga)

Specify input	Unit	Quantity	Costs per Unit (ETB)	Total costs per input (ETB)	% of costs borne by land users
Labour					
Land preparation	PDs	3.0	200.0	600.0	100.0
Slashing and plow over	PDs	1.5	200.0	300.0	100.0
Planting	PDs	1.5	200.0	300.0	100.0
Plant material					
Green manure seed	kg	37.5	8.0	300.0	
Total costs for establishment of the Technology				**1'500.0**	
Total costs for establishment of the Technology in USD				*28.24*	

Maintenance activities
1. Labor for land preparation, planting, and slashing over. (Timing/ frequency: Before planting the main crop.)

Maintenance inputs and costs (per 1.5 Sanga)

Specify input	Unit	Quantity	Costs per Unit (ETB)	Total costs per input (ETB)	% of costs borne by land users
Labour					
Land preparation, planting, slashing and plow over	PDs	4.5	200.0	900.0	100.0
Plant material					
Seeds	PDs	37.5	8.0	300.0	100.0
Total costs for maintenance of the Technology				**1'200.0**	
Total costs for maintenance of the Technology in USD				*22.59*	

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
Receives rainfall with a summer maximum. January to March is a dry season. The area receives short rains from March to April and maximum rain from June to September.
Name of the meteorological station: Bedele

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)

Is salinity a problem?
- ☐ Yes
- ☑ No

Occurrence of flooding

- [ ] unusable

Water quality refers to: surface water

- [ ] 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
- [x] 10-50% of all income
- [ ] > 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
- [ ] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [ ] women
- [x] men

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

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [x] 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
- [x] small-scale
- [ ] medium-scale
- [ ] large-scale

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

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

Water use rights
- [x] open access (unorganized)
- [ ] communal (organized)
- [x] 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
None	poor			✓	good

Comments

Apart from electricity, the land user is closer to other public facilities and services.

IMPACTS

Socio-economic impacts

Crop production	decreased					✓			increased	
crop quality	decreased					✓			increased	
product diversity	decreased					✓			increased	
land management	hindered						✓		simplified	It improves the organic matter content of the soil.
drinking water availability	decreased				✓				increased	
drinking water quality	decreased				✓				increased	
expenses on agricultural inputs	increased					✓			decreased	
farm income	decreased					✓			increased	

Socio-cultural impacts

food security/ self-sufficiency	reduced					✓			improved	
health situation	worsened				✓				improved	
SLM/ land degradation knowledge	reduced						✓		improved	As it is evidence based practice, it improves land users knowledge about SLM.

Ecological impacts

water quantity	decreased				✓				increased
water quality	decreased				✓				increased
surface runoff	increased					✓			decreased
excess water drainage	reduced					✓			improved

Impact										Comment
groundwater table/ aquifer	lowered				✓				recharge	There is no facts to validate regarding the status of groundwater table.
soil moisture	decreased							✓	increased	
soil cover	reduced						✓		improved	
soil loss	increased						✓		decreased	
soil accumulation	decreased					✓			increased	
soil crusting/ sealing	increased					✓			reduced	
soil compaction	increased					✓			reduced	
nutrient cycling/ recharge	decreased						✓		increased	It improves soil nutrient cycling through adding more nutrients including by fixing atmospheric nitrogen.
soil organic matter/ below ground C	decreased						✓		increased	
acidity	increased					✓			reduced	
vegetation cover	decreased					✓			increased	
biomass/ above ground C	decreased					✓			increased	
plant diversity	decreased					✓			increased	
beneficial species (predators, earthworms, pollinators)	decreased				✓				increased	
habitat diversity	decreased				✓				increased	
pest/ disease control	decreased				✓				increased	
emission of carbon and greenhouse gases	increased						✓		decreased	Part of the plow over, remains undecomposed in the soil system and contributes to carbon sequestration.

Off-site impacts

Impact										Comment
water availability (groundwater, springs)	decreased					✓			increased	Off-site water availability is expected to increase but the assumption needs long-term data and documentation.
reliable and stable stream flows in dry season (incl. low flows)	reduced				✓				increased	
downstream siltation	increased					✓			decreased	
impact of greenhouse gases	increased						✓		reduced	

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 technology needs land users knowledge and skills and less of financial expenses.

CLIMATE CHANGE

Gradual climate change

annual temperature increase	not well at all			✓			very well
annual rainfall decrease	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

- Improve soil fertility.
- Reduce soil acidity.
- Increase grain yield.

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

- It stops the soil from being carried away by wind and rain by providing ground cover during early season when flash rain/wind causes erosion.
- Increases soil microbial activity, and the availability of macro and micronutrients in forms that the plants can use.
- After the plow over, most nutrients are then readily available to a new crop.

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

- Labor demanding for establishment and maintenance. Continues awareness raising work regarding the indirect benefits generated from the technology in terms of amending the soil fertility and reducing issues of soil acidity.
- Lack of tangible benefit as most farmers expect yield. Convince the land users about the indirect benefit accrued from using green manure.

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

- Farmers may be unwilling to put in the labor or buy the seed needed. Advocate the sustainable benefits triggered by using green manures so that the mindset of the land users would be changed.
- Lack of awareness of green manuring as a soil fertility management option since it is a recent innovation in Ethiopia. Create more awareness and institutionalize its benefit in the mainstream agricultural extension system to reach out to large number of beneficiaries.
- Many farmers look for an immediate economic product, such as grains, from any crop that is grown. Again, this need familiarizing the land users to the in kind benefits accrued from the application of green manure. Demonstrating the technology and arranging experience exchange visit is pivotal to scale out the technology/practice.

REFERENCES

Compiler
GERBA LETA

Editors
Noel Templer
Julia Doldt
Kidist Yilma

Reviewer
William Critchley
Rima Mekdaschi Studer

Date of documentation: Feb. 6, 2023

Last update: April 27, 2023

Resource persons
Anbese Gebremedhin - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6645/

Linked SLM data
Approaches: Farmers Research and Extension Group (FREG) https://qcat.wocat.net/en/wocat/approaches/view/approaches_6629/
Approaches: Integrated Soil Fertility Management (ISFM) https://qcat.wocat.net/en/wocat/approaches/view/approaches_6732/

Documentation was faciliated by

Institution

- CIAT International Center for Tropical Agriculture (CIAT International Center for Tropical Agriculture) - Kenya

Project

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

Key references

- Managing Land: A practical guidebook for development agents in Ethiopia. 26. RELMA & MARD. 2005.: It is public resource.

Links to relevant information which is available online

- Green Manures: https://www.daera-ni.gov.uk/articles/green-manures#

Application and mixing of lime into soil affected by soil acidity. (Birhanu Itana)

Treating acid soils with lime (Ethiopia)

Biyyoo dhangagaa'e nooratiin haakiimu

DESCRIPTION

Acidic soils deprive crops of their full nutrient absorption capacity. Lime application to these soil makes them less acidic. It breaks the barrier that fixes nutrients and ensures crops access to vital soil nutrients that unleash their productivity potential.

Acidic soils deprive crops of their full nutrient absorption capacity. The farm under the assessment has soil with a pH below 5.0. Lime application to these soil (liming) makes them less acidic. It breaks the barrier that fixes nutrients and ensures crops access to vital soil nutrients that unleash their productivity potential. Soil amendment with lime needs to be at least a month in advance of planting the intended crop. It requires thoroughly mixing the lime powder into the soil. The crop response from the treated soil is gradually visible, particularly during the second cropping season. Lime application takes place after the soil is pulverized very well. Most small cereals (for example "tef", Eragrostis tef, wheat and barley) need tillage at least four times to create a good environment for the small seeds to emerge and quickly compete effectively with the weeds.

Treating exhausted acidic soils enhances the availability of nutrients that otherwise remain fixed by non-leaching mineral elements in the soil. Application of lime along with organic fertilizers improves soil structure, soil pore space, and soil infiltration capacity. Treating acid soil increases crop production and productivity of the soil. It reduces labour costs relative to output, since it leads to a relatively high yield from a small area. The practice helps to stop land being converted from cropping to grazing. Even when this conversion occurs, the grazing land itself is poor because of the acidity and may be abandoned and simply become unproductive degraded land.

However, availability and accessibility of lime, transportation, and manual application to the farmland are challenging. Based on the degree of soil acidity, the amount of lime required can be high. Apart from the large quantity required (4 or more tonnes per ha), the price per unit is discouraging to smallholder farmers. The high price, poor supply, and delays in delivery are the main challenges to effectively address the prevailing issues of soil acidity.

LOCATION

Location: Gechi district, Gito kebele, Oromia, Ethiopia

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 36.43964, 8.30947

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

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
- [x] through projects/ external interventions
- [x] Bureau/office of agriculture

Wheat crops grown on degraded soil with pH 4.94 after treating with lime. (GERBA LETA)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [x] improve production
- [x] reduce, prevent, restore land degradation
- [x] 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: No

Cropland

- Annual cropping: cereals - maize, cereals - millet, cereals - wheat (spring)

Number of growing seasons per year: 1
Is intercropping practiced? No
Is crop rotation practiced? Yes

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, Wo: offsite degradation effects

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

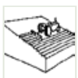
physical soil deterioration - Pc: compaction, Ps: subsidence of organic soils, settling of soil

biological degradation - Bc: reduction of vegetation cover, Bq: quantity/ biomass decline, Bs: quality and species composition/ diversity decline, Bl: loss of soil life, Bp: increase of pests/ diseases, loss of predators

SLM group

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

SLM measures



agronomic measures - A2: Organic matter/ soil fertility, A7: Others

other measures - It is a topsoil treatment or management by incorporating lime into the soil.

TECHNICAL DRAWING

Technical specifications

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs	Most important factors affecting the costs

- Costs are calculated: per Technology area (size and area unit: **Sanga 4**; conversion factor to one hectare: **1 ha = 1 ha = 8 Sanga**)
- Currency used for cost calculation: **ETB**
- Exchange rate (to USD): 1 USD = 53.12 ETB
- Average wage cost of hired labour per day: 400

Global increment of Fuel prices influences the corresponding increase in the price of inputs and other services costs in addition to the prevailing economic crisis and persistently rising inflation.

Establishment activities

1. Land preparation (Timing/ frequency: In advance of the main planting season.)
2. Lime transportation to the farm (Timing/ frequency: One month in advance)
3. Lime application (Timing/ frequency: 1 month before planting.)

Establishment inputs and costs (per Sanga 4)

Specify input	Unit	Quantity	Costs per Unit (ETB)	Total costs per input (ETB)	% of costs borne by land users
Labour					
Land preparation	PDs	8.0	400.0	3200.0	100.0
Lime transportation	PDs	10.0	100.0	1000.0	100.0
Lime application	PDs	4.0	400.0	1600.0	100.0
Fertilizers and biocides					
Lime	ton	2.0	5000.0	10000.0	
Total costs for establishment of the Technology				**15'800.0**	
Total costs for establishment of the Technology in USD				*297.44*	

Maintenance activities

1. Land preparation (Timing/ frequency: 2-3 times before lime application)
2. Lime application (Timing/ frequency: A month before planting the crop.)

Maintenance inputs and costs (per Sanga 4)

Specify input	Unit	Quantity	Costs per Unit (ETB)	Total costs per input (ETB)	% of costs borne by land users
Labour					
Land preparation	PDs	8.0	400.0	3200.0	100.0
Lime application	PDs	4.0	400.0	1600.0	100.0
Fertilizers and biocides					
Lime	ton	2.0	5000.0	10000.0	50.0
Total costs for maintenance of the Technology				**14'800.0**	
Total costs for maintenance of the Technology in USD				*278.61*	

NATURAL ENVIRONMENT

Average annual rainfall

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

Agro-climatic zone

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

Specifications on climate

n.a.

Slope

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

Landforms

- [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.
- [ ] 1,501-2,000 m a.s.l.
- [x] 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

- [x] 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%)
- [ ] medium (1-3%)
- [x] low (<1%)

Groundwater table

- [ ] on surface

Availability of surface water

- [ ] excess

Water quality (untreated)

- [ ] good drinking water

Is salinity a problem?

- [ ] Yes

- [ ] < 5 m
- [x] 5-50 m
- [ ] > 50 m

- [x] good
- [ ] medium
- [ ] poor/ none

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

Water quality refers to: ground water

- [x] No

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

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

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

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

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- [x] mixed (subsistence/ commercial)
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- [ ] Semi-nomadic
- [ ] Nomadic

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- [ ] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

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- [x] men

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

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- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [x] 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
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- [ ] medium-scale
- [ ] large-scale

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

Land use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] 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
drinking water and sanitation	poor	✓			good
financial services	poor			✓	good

IMPACTS

Socio-economic impacts

Crop production	decreased							✓	increased	Quantity before SLM: 0.4 ton Quantity after SLM: 4 tons Highly increased. With proper application of lime to acid soil crop production increased from about 0.4 to 4 tons on a hectare of land.
crop quality	decreased							✓	increased	Significantly increases as compared to crop production without liming the farm.
fodder production	decreased					✓			increased	As liming increases biomass production, it contributes to fodder production through the supply of surplus crop residue.
fodder quality	decreased					✓			increased	
animal production	decreased					✓			increased	The attributes converge with the availability of quality fodder.
risk of production failure	increased						✓		decreased	
product diversity	decreased					✓			increased	

Impact	Negative end	Rating (−3 to +3)	Positive end	Comment
land management	hindered	+3	simplified	Land management is simplified as liming promotes high biomass production in combination with the use of organic and inorganic fertilizers.
expenses on agricultural inputs	increased	+1	decreased	As it improves crops absorption of the available nutrients by releasing the nutrients that are otherwise fixed in the soil, it reduces the investment in more inputs/fertilizers.
farm income	decreased	+2	increased	
diversity of income sources	decreased	+1	increased	
workload	increased	−3	decreased	Lime transporting and application demands a large number of labor.

Socio-cultural impacts

Impact	Negative end	Rating (−3 to +3)	Positive end	Comment
food security/ self-sufficiency	reduced	+2	improved	
health situation	worsened	+1	improved	It converges with good harvest and access to nutritious food.
community institutions	weakened	0	strengthened	
SLM/ land degradation knowledge	reduced	+3	improved	Improved through evidence based practical learning.

Ecological impacts

Impact	Negative end	Rating (−3 to +3)	Positive end	Comment
surface runoff	increased	+1	decreased	
excess water drainage	reduced	+1	improved	
groundwater table/ aquifer	lowered	0	recharge	No facts supporting this particular claim.
evaporation	increased	+1	decreased	
soil moisture	decreased	+1	increased	
soil cover	reduced	+1	improved	
soil loss	increased	+1	decreased	
soil accumulation	decreased	+1	increased	
soil crusting/ sealing	increased	+2	reduced	
soil compaction	increased	+2	reduced	
nutrient cycling/ recharge	decreased	+3	increased	Liming unfix the available nutrients in the soil system and newly applied ones.
acidity	increased	+3	reduced	Soil acidity highly reduced by the application of appropriate amount of lime.
vegetation cover	decreased	+1	increased	
biomass/ above ground C	decreased	+1	increased	
plant diversity	decreased	+1	increased	
invasive alien species	increased	−1	reduced	
animal diversity	decreased	0	increased	
beneficial species (predators, earthworms, pollinators)	decreased	0	increased	
habitat diversity	decreased	+1	increased	
pest/ disease control	decreased	0	increased	
emission of carbon and greenhouse gases	increased	+1	decreased	

Off-site impacts

Impact	Negative end	Rating (−3 to +3)	Positive end	Comment
water availability (groundwater, springs)	decreased	0	increased	As the intervention is a recent one, this estimation is more conceptual than the actual one.
reliable and stable stream flows in dry season (incl. low flows)	reduced	0	increased	As the intervention is a recent one, this estimation is more conceptual than the actual one.
downstream flooding (undesired)	increased	0	reduced	
downstream siltation	increased	0	decreased	
groundwater/ river pollution	increased	+1	reduced	The growth of dense biomass reduces soil movement which causes pollution.
buffering/ filtering capacity (by soil, vegetation, wetlands)	reduced	+1	improved	
damage on neighbours' fields	increased	+2	reduced	

impact of greenhouse gases — increased / reduced (✓ on scale)

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns — very negative / very positive (✓ on scale)
Long-term returns — very negative / very positive (✓ on scale)

Benefits compared with maintenance costs

Short-term returns — very negative / very positive (✓ on scale)
Long-term returns — very negative / very positive (✓ on scale)

CLIMATE CHANGE

Gradual climate change

annual temperature increase — not well at all / very well (✓ on scale)
annual rainfall decrease — not well at all / very well (✓ on scale)

ADOPTION AND ADAPTATION

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

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

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

- [x] 0-10%
- [ ] 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

- Fix problem of soil acidity.
- Increases crop production from a given land unit.
- Increase biomass production and improve soil structure.

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

- Improve land users understanding of SLM.
- Motivate farmers to share cost for accessing the inputs or purchase it by their own.

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

- Demands a relatively higher amount to effectively treat a given land unit. The land users need to treat their land on a gradual basis.
- Difficult to transport large size of lime to the farm. Need to mainstream well the cost-benefit of using lime to the land users.
- Cost per 100 kg is high (about 500 ETB) More subsidy is demanded from the government.

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

- Low amount, and untimely supply of the inputs. Serving providing organizations/governments need to increase the quantity of supply in time wanted by the land users.

REFERENCES

Compiler
GERBA LETA

Editors
Noel Templer
Julia Doldt
Kidist Yilma

Reviewer
William Critchley
Rima Mekdaschi Studer

Date of documentation: Feb. 4, 2023

Last update: April 27, 2023

Resource persons
Mohammed Benti - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6641/

Linked SLM data
Approaches: Farmers Research and Extension Group (FREG) https://qcat.wocat.net/en/wocat/approaches/view/approaches_6629/
Approaches: Integrated Soil Fertility Management (ISFM) https://qcat.wocat.net/en/wocat/approaches/view/approaches_6732/

Documentation was faciliated by

Institution
- CIAT International Center for Tropical Agriculture (CIAT International Center for Tropical Agriculture) - Kenya

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

Key references

- Soil Acidity and its Management Options in Ethiopia: A Review. Golla, A. S. 2019. DOI:10.18535/ijsrm/v7i11.em01: https://www.ijsrm.in › index.php › ijsrm
- Leta, G., Schulz, S., Alemu, G. 2020. Agricultural extension approach: evidence from an Integrated Soil Fertility Management project in Ethiopia. Frontiers of Agricultural Science and Engineering, 7(4): 1-13. DOI: 10.15302/J-FASE-2020331: http://journal.hep.com.cn/fase

Links to relevant information which is available online
- SUSTAINABLE LAND MANAGEMENT PROGRAM (SLMP) TRAINING SERIES: FIELD GUIDE TECHNICAL IMPLEMENTATION INTEGRATED SOIL FERTILITY MANAGEMENT: www.slmethiopia.info.et

Vermicompost production house of a farmer, Degu Dinka in Bido Kebele of Gechi District. (Gerba Leta)

Vermicomposting (Ethiopia)

Komposti Ramo

DESCRIPTION

Vermicompost is the product of the decomposition process using various species of earthworms. It is a form of humus and is produced through worms digesting and excreting organic in their casts. Vermicompost has been shown to be an effective organic soil amendment, reducing the need for inorganic fertilizers.

Vermicomposting is the process by which worms convert organic materials (usually wastes) into a humus-like material known as vermicompost. The process is an aerobic, bio-oxidation, non-thermophilic process of organic decomposition that depends upon earthworms to fragment, mix and promote microbial activity. In making vermicompost, earthworms are very good at transforming dead plant material, and livestock droppings into excellent manure. The excrement of the worms has high nutrient levels and a growth-promoting effect on plants. Earthworms are very sensitive to changes in moisture and temperature. They need a continuous food supply and protection from ants, birds, and chickens. Compared to ordinary compost making, it needs maximum care. For optimum management practices, vermicompost production must be located close to the homestead where livestock barns are usually located. Livestock droppings (especially those of horses and donkeys) are the best sources of feed in addition to plant biomass and other household refuses. Vermicompost production needs a bin in which the worms live. This holds the bedding and food scraps, regulates the amount of moisture and temperature in the bedding, and blocks light which is harmful to the nocturnal worms. Worm bins can be made from plastic or wooden materials. In Ethiopia, wooden boxes are preferred because they are more absorbent and provide better insulation.
Vermicompost reduces farmers' investment costs on chemical fertilizers. It also has a sustainable role in restoring soil fertility, ameliorating soil acidity and rehabilitating degraded farmland – all of which are problems in the southwestern part of Ethiopia. In the farm where vermicompost is applied, newly transplanted seedlings, in the case of vegetables, remain green and resilient as the compost improves not only the nutrients but also the moisture content of the soil. According to the land users, annual and perennial crops such as horse beans (Vicia faba), wheat, cabbages and avocados grown under vermicompost do very well. Under ideal conditions, 1,000 earthworms can convert 45kg of wet biomass per week into about 25kg of vermicompost. Therefore, the size of production depends on the number of worms, supply of foods, availability of boxes, and associated management practices. In rows and spot application of vermicompost during planting the crop allows efficient and effective uses of the products.

Currently (2023) the government in the southwestern zones of Oromia Region is promoting vermicompost as a vital organic fertilizer. This signals a change in the public sector's and end-users' mindset in the use of organic fertilizer as a reliable soil amendment, particularly in acid-prone areas. In general, compost restores soil fertility, increases crop production and improves the livelihood of the end users. While the initial cost of constructing the house and installing bins and worms is high, there is potential for the use of local materials. However, it demands considerable household labour for upkeep.

LOCATION

Location: Gechi district, Oromia, Buno-Bedele Zone, Ethiopia

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 36.44966, 8.23228

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

In a permanently protected area?: No

Date of implementation: 2020; less than 10 years ago (recently)

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

Vermiworms in operation inside vermicompost production box. (Gerba Leta)

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
- [ ] 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: No

Cropland
- Annual cropping: cereals - wheat (spring), legumes and pulses - beans, vegetables - root vegetables (carrots, onions, beet, other)

Number of growing seasons per year: 1
Is intercropping practiced? No
Is crop rotation practiced? Yes

Water supply
- [ ] rainfed
- [x] 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

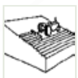
chemical soil deterioration - Cn: fertility decline and reduced organic matter content (not caused by erosion), Ca: acidification

physical soil deterioration - Pc: compaction, Ps: subsidence of organic soils, settling of soil, Pu: loss of bio-productive function due to other activities

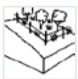
biological degradation - Bc: reduction of vegetation cover, Bh: loss of habitats, Bq: quantity/ biomass decline, Bs: quality and species composition/ diversity decline, Bl: loss of soil life

SLM group
- integrated crop-livestock management
- integrated soil fertility management
- integrated pest and disease management (incl. organic agriculture)

SLM measures



agronomic measures - A2: Organic matter/ soil fertility, A3: Soil surface treatment, A4: Subsurface treatment



management measures - M2: Change of management/ intensity level

TECHNICAL DRAWING

Technical specifications

The box is also made with wooden pegs supported with thin horizontal bars and plastered by mud made of soil and water mixed with straw of teff (Eragrostis tef). The box is usually 3 meters long, 60 cm wide, and 50 cm deep, with a total capacity of carrying 0.9 m3 of worms and feedstock at a time. This is a manageable size with 50 cm wide between the structure to allow mobility of the caregivers for effective management of vermicompost.


Author: Gerba Leta

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology unit (unit: **House, boxes, worms, labor...** volume, length: **The preferred box size is 3m (L) x 50cm (W) x 30cm (H) with holes (0.5cm diameter).**)
- Currency used for cost calculation: **ETB**
- Exchange rate (to USD): 1 USD = 53.12 ETB
- Average wage cost of hired labour per day: 200

Most important factors affecting the costs

The cost is consistently changing. It might be attributed to the economic crisis and the growing inflation.

Establishment activities

1. Constructing house or huts. (Timing/ frequency: Anytime, preferable before the main cropping season.)
2. Build or purchase the worm bin/ boxes/structure with same function. (Timing/ frequency: Anytime, preferable before the main cropping season.)
3. Purchase and/or introduce the worms. (Timing/ frequency: Anytime, preferable before the main cropping season.)
4. Add the food and water to the box/structure. (Timing/ frequency: Regularly, through monitoring the status of the worms in the bin/box.)
5. Monitor the surround from the predators and aerate the structure. (Timing/ frequency: Regular monitoring is commendable.)
6. Harvest and dry the vermicompost for use. (Timing/ frequency: When the worms feed on the feedstock and cast the compost (brown humus).)

Establishment inputs and costs (per House, boxes, worms, labor...)

Specify input	Unit	Quantity	Costs per Unit (ETB)	Total costs per input (ETB)	% of costs borne by land users
Labour					
Labor	PDs	183.0	200.0	36600.0	100.0
Equipment					
Boxes	number	14.0	250.0	3500.0	100.0
Other					
House with corrugated iron sheet	Lump sum	1.0	25000.0	25000.0	100.0
Worms	kg	12.0	500.0	6000.0	
Total costs for establishment of the Technology				**71'100.0**	
Total costs for establishment of the Technology in USD				*1'338.48*	

Maintenance activities

1. Labour to supply feedstock and provision of other related management practices. (Timing/ frequency: It needs follow-up and supplying the feedstock throughout the year.)

Maintenance inputs and costs (per House, boxes, worms, labor...)

Specify input	Unit	Quantity	Costs per Unit (ETB)	Total costs per input (ETB)	% of costs borne by land users
Labour					
Labor for follow-up and related practices	PDs	183.0	200.0	36600.0	100.0
Total costs for maintenance of the Technology				**36'600.0**	
Total costs for maintenance of the Technology in USD				*689.01*	

NATURAL ENVIRONMENT

Average annual rainfall

- < 250 mm
- 251-500 mm
- 501-750 mm
- 751-1,000 mm

Agro-climatic zone

- humid
- ✓ sub-humid
- semi-arid
- arid

Specifications on climate

Name of the meteorological station: Bedele

- [ ] 1,001-1,500 mm
- [x] 1,501-2,000 mm
- [ ] 2,001-3,000 mm
- [ ] 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
- [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)
- [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
- [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: ground 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
- [x] 10-50% of all income
- [ ] > 50% of all income

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

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

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

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

Gender
- [ ] women
- [x] men

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

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [ ] 2-5 ha
- [x] 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
- [x] small-scale
- [ ] medium-scale
- [ ] large-scale

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

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

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

IMPACTS

Socio-economic impacts

Crop production	decreased	□□□□□✓□	increased	Quantity before SLM: Abandoned for faba beans Quantity after SLM: 1.2 tons/ha The yield of Faba bean increased from negligible yield where a farmer abandoned it to over 1 ton per hectare.
crop quality	decreased	□□□□✓□□	increased	It was not scientifically measured but the farmer communicated the harvest of good seed size with better tastes as compared to the harvest without using vermicompost.
fodder production	decreased	□□□□✓□□	increased	There is an assumption and evidence that validate that compost favors the growth of diverse wild species. Also, it increases biomass production that associates with fodder or feed production.
product diversity	decreased	□□□□✓□□	increased	The use of vermicompost enables to regain of the lost crop species because of soil degradation.
land management	hindered	□□□□□✓□	simplified	As it added organic matter to the soil, it improves soil structure and other attributes of the soil that improve the land.
expenses on agricultural inputs	increased	□□□□✓□□	decreased	It reduces investment on synthetic fertilizers and allows to harvest organic products.
farm income	decreased	□□□□✓□□	increased	As most of the distinctions between the treatments with SLM technology vs without technology are not properly documented by the land users, it is difficult to quantify them. However, the evidence from the demonstration plots shows the yield increments by more than quadruple per unit of land. Since then the technology is applied recently, and promoting documentation of the yield difference by the land users themselves is commendable to ensure access to reliable data.

Socio-cultural impacts

food security/ self-sufficiency	reduced	□□□□✓□□	improved	Generally, it added value to the efforts of ensuring food as well as nutrition security.
health situation	worsened	□□□□✓□□	improved	Health situation is converging with ensured food and nutrition security.
SLM/ land degradation knowledge	reduced	□□□□□✓□	improved	Increased through exchange visit and participatory learning of the effect of the technology on the farm.
situation of socially and economically disadvantaged groups (gender, age, status, ehtnicity etc.)	worsened	□□□□✓□□	improved	Slightly improved with access and use of the technology.

Ecological impacts

surface runoff	increased	□□□□✓□□	decreased	This is with the assumption that vermicompost improve soil structure via the addition of organic matter and improves water infiltration than favoring runoff.
excess water drainage	reduced	□□□□✓□□	improved	
soil moisture	decreased	□□□□✓□□	increased	
soil cover	reduced	□□□□✓□□	improved	
soil loss	increased	□□□□✓□□	decreased	
soil accumulation	decreased	□□□□✓□□	increased	
soil crusting/ sealing	increased	□□□✓□□□	reduced	
soil compaction	increased	□□□✓□□□	reduced	
nutrient cycling/ recharge	decreased	□□□□□✓□	increased	
soil organic matter/ below ground C	decreased	□□□✓□□□	increased	
acidity	increased	□□□□✓□□	reduced	
vegetation cover	decreased	□□□□✓□□	increased	
biomass/ above ground C	decreased	□□□□✓□□	increased	

plant diversity	decreased	✓ (neutral/slightly positive)	increased
animal diversity	decreased	✓ (neutral/slightly positive)	increased
beneficial species (predators, earthworms, pollinators)	decreased	✓ (neutral/slightly positive)	increased
habitat diversity	decreased	✓ (neutral/slightly positive)	increased
emission of carbon and greenhouse gases	increased	✓ (neutral/slightly positive)	decreased

Off-site impacts

water availability (groundwater, springs)	decreased	✓ (neutral/slightly positive)	increased
reliable and stable stream flows in dry season (incl. low flows)	reduced	✓ (neutral)	increased
downstream flooding (undesired)	increased	✓ (neutral/slightly positive)	reduced
downstream siltation	increased	✓ (neutral/slightly positive)	decreased

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns	very negative	✓ (slightly negative)	very positive
Long-term returns	very negative	✓ (very positive)	very positive

Benefits compared with maintenance costs

Short-term returns	very negative	✓ (positive)	very positive
Long-term returns	very negative	✓ (very positive)	very positive

CLIMATE CHANGE

Gradual climate change

annual rainfall decrease	not well at all	✓ (well)	very well	
seasonal rainfall decrease	not well at all	✓ (moderately)	very well	Season: summer

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)
- ☑ Produced the boxes from local materials such as mud and posts.

The land users and the district ISFM+ project focal person modified the boxes by building with a bunch of sticks plastered with mud to replace the priceless boxes made up of timbers.

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Reduce investment costs on chemical fertilizers.
- Partly replace the role of chemical fertilizers.
- Improve soil fertility and reduces soil acidity.

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

- Rehabilitate the degraded land and improve the biodiversity of flora and fauna.
- Reduce risks of crop failure.
- Creat employment opportunity

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

- Labor demanding. Engage family labor.
- Shortage of biomass to supply feedstock. Improve access to biomass supply and improve practical uses of crop residue and animal excreta.

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

- Lack of proper documentation by the land users inline with such comprehensive questions. Promote the capacity of land users to document the various facets of the technology on land management, production, and other multiple pros and cons.

REFERENCES

Compiler
GERBA LETA

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Rima Mekdaschi Studer

Date of documentation: Feb. 6, 2023

Last update: April 13, 2023

Resource persons
Degu Dinqa - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6643/

Linked SLM data
Approaches: Farmers Research and Extension Group (FREG) https://qcat.wocat.net/en/wocat/approaches/view/approaches_6629/
Approaches: Integrated Soil Fertility Management (ISFM) https://qcat.wocat.net/en/wocat/approaches/view/approaches_6732/

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Institution
- CIAT International Center for Tropical Agriculture (CIAT International Center for Tropical Agriculture) - Kenya

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

Key references
- Organic Exchange. 2009. Soil Fertility Management: An introductory Fact-Sheet for Farmers and Projects.: Free online
- MoA. 2016. Technical Manual: Integrated Soil Fertility Management. SLMP Training Series 14. Addis Ababa, Ethiopia.: Free online

Links to relevant information which is available online
- Vermicomposting: https://composting.ces.ncsu.edu/vermicomposting-2/

Improved compost production by individual farmer in Kersa District of Jimma Zone, Oromia (Gerba Leta)

Improved Compost (Ethiopia)

Kompoosti Fooyya'a

DESCRIPTION

Improved compost making using "static pile" systems transforms organic material from plants and/or animals into high-value, rich organic compost. It demands less labour, and less time to reach maturity than conventional systems as it thoroughly mixes the ingredients at the beginning which precludes the need to turn the heap later.

Improved composting using static pile systems transforms organic material from plants and/or animals into high-value, rich organic compost. This compost can be prepared in a heap form, where the ingredients are thoroughly mixed and wrapped within a polyethylene sheet. Notably, white polyethylene has the role of intercepting sunlight and improving the solarization effects on weed seeds or wild species arbitrarily used as biomass for improved compost production. This technique accelerates the breakdown of the organic materials faster because it heats up the compost as part of the decomposition process. Accordingly, the compost reaches maturity in 60-70 days. Compost provides the crop with balanced nutrients and helps to increase the soil's organic matter content. It has long-term, and short-term effects on plant nutrition as nutrients are continuously released. It is an organic matter resource with the unique ability to improve soils' chemical, physical and biological properties. Improved compost is applied in rows for vegetables and small cereal crops but spot application (planting holes) is employed for large cereal crops such as maize. The application is on an incremental basis year and again to reach out to the large size of lands. In principle, as the nutrients are slowly released, they may not need a continuous application like chemical fertilizers.

Improved compost-making requires 12-15 wooden pegs 1m high each supported by horizontal bars/string, to form a round structure. The interior is lined with plastic sheeting, then thoroughly mixed ingredients, including coffee hulls, ash, livestock manure, crop residues, livestock urine, water, and chaff are mixed and piled before being sealed in the structure. Unlike the mainstream heaps or pits types of composting, it doesn't need turning. Therefore, this technique reduces labour requirement, and is liked by the users who have been piloting the technology. The relatively short maturity date also enables it to be produced at least twice a year during the offseason. Compost is prepared around the homestead – which allows closer attention - using livestock urine, manure, and house refuse.

In most of Ethiopia's central and western highlands, soil degradation is a severe issue. Soil acidity has become a growing problem challenging the livelihoods of smallholders. Thus, countering the negative effect of degradation and acidity through producing and using organic fertilizers is a key strategy. However, it is essential that the resources of biomass, family labour, skills and motivation, are combined to ensure sustainable land for crop production. From end users' observations and analysis, improved compost restores soil fertility. It increases yield as well as grain quality: this has been proved by testing the grain compared with the harvest where only chemical fertilizers have been applied. Farmers prefer the simplicity of preparing improved compost to the conventional method, and appreciate its role in improving yield and grain quality as well as reducing the labour demand.

LOCATION

Location: Babo kebele of Kersa district, Jimma zone, Oromia, Ethiopia

No. of Technology sites analysed: 2-10 sites

Geo-reference of selected sites
- 36.92973, 7.69544

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

In a permanently protected area?: No

Date of implementation: 2022

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

A farmer measures the diameter, circumference and height of the improved compost heaps (piles) (Gerba Leta)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [x] improve production
- [x] reduce, prevent, restore land degradation
- [x] 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: No

Cropland

- Annual cropping: cereals - maize, cereals - wheat (spring), legumes and pulses - beans, Hot pepper
- Perennial (non-woody) cropping: banana/plantain/abaca, sugar cane
- Tree and shrub cropping: avocado

Number of growing seasons per year: 1
Is intercropping practiced? Yes
Is crop rotation practiced? Yes

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

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

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

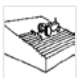
biological degradation - Bc: reduction of vegetation cover, Bh: loss of habitats, Bs: quality and species composition/ diversity decline, Bl: loss of soil life

water degradation - Hs: change in quantity of surface water, Hp: decline of surface water quality

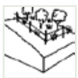
SLM group

- integrated crop-livestock management
- integrated soil fertility management

SLM measures



agronomic measures - A2: Organic matter/ soil fertility, A3: Soil surface treatment (A 3.3: Full tillage (< 30% soil cover))



management measures - M2: Change of management/ intensity level, M5: Control/ change of species composition

TECHNICAL DRAWING

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs
- Costs are calculated: per Technology unit (unit: **Compost production structure** volume, length: **6-7m3**)
- Currency used for cost calculation: **ETB**
- Exchange rate (to USD): 1 USD = 53.12 ETB
- Average wage cost of hired labour per day: 100

Most important factors affecting the costs
Material prices are also variable because of economic instability and price fluctuation. In general, the cost is inconsistent because of inflation.

Establishment activities
1. Select site and constructing the structure. (Timing/ frequency: During the off-season particularly right after harvest when adequate biomass is available.)
2. Collecting ingredients for compost making. (Timing/ frequency: During crop harvest)
3. Thoroughly combine the ingredients and seal. (Timing/ frequency: After materials are ready to make the heap.)
4. Harvest/open and dry the compost on open air. (Timing/ frequency: Six to seven weeks after piling the compost.)

Establishment inputs and costs (per Compost production structure)

Specify input	Unit	Quantity	Costs per Unit (ETB)	Total costs per input (ETB)	% of costs borne by land users
Labour					
Labor	PDs	5.0	100.0	500.0	100.0
Equipment					
Spade	number	1.0	300.0	300.0	
Reck	number	1.0	160.0	160.0	100.0
Machete	number	1.0	1000.0	1000.0	100.0
Sickle	number	1.0	500.0	500.0	100.0
Construction material					
Posts for peg making	number	2.0	50.0	100.0	100.0
Horizontal bars	number	5.0	10.0	50.0	100.0
Strings	meter	12.0	10.0	120.0	100.0
Polyethylene sheet	meter	14.0	50.0	700.0	100.0
Total costs for establishment of the Technology				**3'430.0**	
Total costs for establishment of the Technology in USD				*64.57*	

Maintenance activities
n.a.

Maintenance inputs and costs (per Compost production structure)

Specify input	Unit	Quantity	Costs per Unit (ETB)	Total costs per input (ETB)	% of costs borne by land users
Labour					
Labor	PDs	5.0	100.0	500.0	100.0
Construction material					
Plastic sheet	meter	14.0	50.0	700.0	100.0
Posts	number	2.0	50.0	100.0	100.0
Total costs for maintenance of the Technology				**1'300.0**	
Total costs for maintenance of the Technology in USD				*24.47*	

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

Specifications on climate
The site receives high rainfall in summer maximum (June to September). From January to May, it is the dry season with short showers in March/April.
Name of the meteorological station: Jimma

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

Landforms
- [x] 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.
- [ ] 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.

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

- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

Soil depth
- [x] 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%)
- [ ] medium (1-3%)
- [x] 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: surface water

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

Occurrence of flooding
- [ ] Yes
- [ ] 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
- [x] less than 10% of all income
- [ ] 10-50% of all income
- [ ] > 50% of all income

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

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

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

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

Gender
- [ ] women
- [x] men

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

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [x] 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
- [x] small-scale
- [ ] medium-scale
- [ ] large-scale

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

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

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

As the farmland is closer to all-weather roads and the district town, the farmer can easily access almost all of the facilities in the area.

IMPACTS

Socio-economic impacts

Crop production

decreased						✓		increased

Quantity before SLM: 2 tons/hectare
Quantity after SLM: 2.8 tons/hectare
Maize yield has immensely increased during the first harvest with compost as compared to the plot with NSP fertilizer at the rate of 100 kg/ha. As nutrients from organic fertilizers gradually available, it is expected to increase in the coming years.

Impact	Negative								Positive	Comment
crop quality	decreased					✓			increased	Land users communicated the positive effects of using compost on grain size and overall quantity of production.
fodder production	decreased					✓			increased	As biomass production is increasing, the part of crop residue that is used for livestock feed is also increasing.
product diversity	decreased					✓			increased	
land management	hindered						✓		simplified	Farmlands where improved compost applied increases soil aggregate stability as compared to the farmland where only chemical fertilizers is applied.
expenses on agricultural inputs	increased						✓		decreased	Using organic fertilizer (improved compost) reduces land users investment on chemical fertilizers.
farm income	decreased					✓			increased	It correlates with increasing production per unit of land.
diversity of income sources	decreased					✓			increased	The farmer also generate income from the sale of compost itself.
Socio-cultural impacts										
food security/ self-sufficiency	reduced					✓			improved	
health situation	worsened					✓			improved	Convergent to food and nutrition security.
community institutions	weakened					✓			strengthened	Farmer group formation is promoted for peer learning.
Ecological impacts										
water quantity	decreased					✓			increased	
water quality	decreased					✓			increased	Ground cover contributes to filtering the downslope runoff and siltation.
surface runoff	increased					✓			decreased	
excess water drainage	reduced					✓			improved	The organic matter in the improved compost improve soil structure and simplify water drainage down in soil horizon.
soil moisture	decreased					✓			increased	
soil cover	reduced						✓		improved	Improved compost increase biomass production and soil cover.
soil loss	increased					✓			decreased	
soil accumulation	decreased						✓		increased	
soil crusting/ sealing	increased					✓			reduced	Improved compost promotes soil aggregate stability.
soil compaction	increased					✓			reduced	
nutrient cycling/ recharge	decreased						✓		increased	
soil organic matter/ below ground C	decreased					✓			increased	Salinity is uncommon in the district.
acidity	increased					✓			reduced	
vegetation cover	decreased				✓				increased	
biomass/ above ground C	decreased						✓		increased	
plant diversity	decreased					✓			increased	Compost promotes the growth of wild species and/or promotes the succession of some lost species.
animal diversity	decreased					✓			increased	
beneficial species (predators, earthworms, pollinators)	decreased					✓			increased	
habitat diversity	decreased					✓			increased	
pest/ disease control	decreased		✓						increased	
drought impacts	increased					✓			decreased	
emission of carbon and greenhouse gases	increased					✓			decreased	It increases surface and subsurface biomass production and sequester soil carbon.
micro-climate	worsened					✓			improved	

Off-site impacts

water availability (groundwater, springs)	decreased	✓ (slightly increased)	increased	Slightly increases as it improves the soil infiltration potential.
reliable and stable stream flows in dry season (incl. low flows)	reduced	✓ (no change)	increased	
downstream flooding (undesired)	increased	✓ (slightly reduced)	reduced	
downstream siltation	increased	✓ (slightly decreased)	decreased	It positively associate with reduction of the runoff due to good ground cover.
groundwater/ river pollution	increased	✓ (slightly reduced)	reduced	
impact of greenhouse gases	increased	✓ (no change)	reduced	Such impact can be achieved in the long-term.

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns	very negative	✓ (slightly positive)	very positive
Long-term returns	very negative	✓ (positive)	very positive

Benefits compared with maintenance costs

Short-term returns	very negative	✓ (slightly positive)	very positive
Long-term returns	very negative	✓ (positive)	very positive

The benefits accrued from the application of technology (improved compost) increases overtime as the rate of nutrient adsorption or release of the elements is on a gradual basis as compared to chemical fertilizers. The return remains positive despite variations in temporal and the degrees.

CLIMATE CHANGE

Gradual climate change

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

Other climate-related consequences

extended growing period	not well at all	✓ (very well)	very well

ADOPTION AND ADAPTATION

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

- [ ] single cases/ experimental
- [x] 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%
- [x] 91-100%

Number of households and/ or area covered

About five farmers were adopted in one village. It is spreading in a similar manner over the other areas.

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

- Improve soil fertility and reduce acidity on gradual basis.
- Increase grain and biomass yield and quality of the crop.
- Generate income from the sale of compost.

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

- It reduces the investment cost on chemical fertilizers.
- Shortly mature compared to conventional compost making, enabling more composts to be produced.
- It reduces labor costs as an overturning operation is exempted.

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

- Intensive labour during planting (transport to the farm and implement row or spot application) depending on the crop types. Promote labour-sharing arrangements with neighboring peers, engage family labor, and use necessary farm tools such as wheelbarrows to transport to the nearby farms.

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

- Introduction of the technology is steered by soil fertility improvement department of the district office on piecemeal basis. Need popularization via the extension system. This demands institutionalizing the technology as the best technology/practice.

REFERENCES

Compiler
GERBA LETA

Editors
Noel Templer
Julia Doldt
Kidist Yilma

Reviewer
William Critchley
Rima Mekdaschi Studer

Date of documentation: Feb. 9, 2023

Last update: April 13, 2023

Resource persons
Mohammed Abdulqadir - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6649/

Linked SLM data
Approaches: Soil Fertility Improvement Cluster https://qcat.wocat.net/en/wocat/approaches/view/approaches_6653/

Documentation was faciliated by

Institution
- CIAT International Center for Tropical Agriculture (CIAT International Center for Tropical Agriculture) - Kenya

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

Key references
- Soil Fertility Management: An introductory Fact-Sheet for Farmers and Projects.Organic Exchange. 2009: free online

Links to relevant information which is available online
- Making and Using Compost for Organic Farming: https://eorganic.org/node/2880

Livestock urine collection chamber, storage jerrycan and locally made spraying tool (Gerba Leta)

Livestock Urine Collection and Use (Ethiopia)

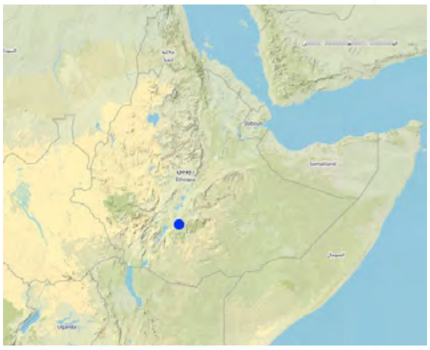
Yeshint Madaberya

DESCRIPTION

Collection of livestock urine allows resource-poor farmers to capture nutrient-rich livestock waste and use it to substitute urea fertilizer. It is a liquid organic product that restores soil fertility and pest management.

Enset, the "false banana", is a perennial that grows well under the supply of organic fertilizers (farmyard manure, urine, compost and other household refuse). In the enset farming system, farmers traditionally shelter their livestock behind a partition within the main house. They construct a sloping floor in the livestock stall to allow the urine to drain into a narrow channel that leads to nearby enset and vegetable plots. However, construction of a collection chamber on the outlet side is an innovative approach which allows for better use of the urine. The collected urine fertilizes annual crops such as barley, maize, and vegetables - notably kale, carrots, and onions, via foliar and basal applications. Land users collect and preserve the urine for about 15 days before applying it to the target crops for the intended purposes. The urine is also used for pest management such as aphids and cutworms. According to the land user interviewed about 20 litres a day can be collected from six cattle. This implies the potential to collect about 7 cubic metres a year by a farmer: a considerable resource that should not be lost when there is an urgent need to restore soil fertility given ongoing and severe problems with land degradation. Therefore, urine collection and storage can be a way of reducing substantial investment in chemical fertilizers. To learn and showcase the benefits of urine as a replacement for urea fertilizer, a farmer sprayed 80 litres of urine twice onto 600 m2 of a ISFM+ barley demonstration plot. The sprayed amount replaced the equivalent of 6 kg urea that currently costs about 300 ETB.
Housing animals enables the collection of a reasonable quantity of urine to restore the soil fertility at the homestead and on the farm. Locally available bamboo helps to construct partitions and stall floors for the livestock as well as serving as a pipeline to drain the urine into a collection chamber. The benefits of applying urine goes beyond simply urea replacement, and its potential is merely limited by land users knowledge, skills, and motivation. These can be acquired via training, demonstration, exchange visit, and social learning. Land users like the role of urine in restoring soil fertility and boosting production. Furthermore, urine serves as integrated pest management via targeted application, deterring insects. However, the smell of the urine is unpleasant and may deter farmers from its use as they do not have safety clothes or masks to use when spraying the crop.

LOCATION



Location: Tuticha Kebele 01, Sidama, Ethiopia

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 38.62276, 6.64419

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

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

The floor of the cattle stall drains the urine straight to the collection chamber set outside the house. (Gerba Leta)

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: No

Cropland

- Annual cropping: cereals - barley, fodder crops - grasses, legumes and pulses - peas, root/tuber crops - potatoes, vegetables - leafy vegetables (salads, cabbage, spinach, other)
- Perennial (non-woody) cropping

Number of growing seasons per year: 2
Is intercropping practiced? No
Is crop rotation practiced? Yes

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

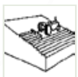
chemical soil deterioration - Cn: fertility decline and reduced organic matter content (not caused by erosion)

biological degradation - Bq: quantity/ biomass decline, Bp: increase of pests/ diseases, loss of predators

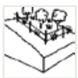
SLM group

- integrated crop-livestock management
- integrated soil fertility management
- integrated pest and disease management (incl. organic agriculture)

SLM measures



agronomic measures - A2: Organic matter/ soil fertility



management measures - M7: Others

TECHNICAL DRAWING

Technical specifications

The urine collection chamber is set up adjacent to the rural house on the side of livestock stalls. It receives urine that drains out of the sloping floor intentionally constructed using stone or bamboo to drain the liquid wastes through conduit directly to the collection chambers. A ditch that is placed adjacent to the outlet also takes the slurry to the nearby farm/garden. The dimension of the collection chamber and the types of materials used to establish the technology varies depending on resource availability or the number of livestock held by the land user. Other materials such as concrete pits or pits lined by google membranes can be used. Furthermore, jerrican or clay pots are the other alternative tools to collect urine. The different local materials replace the use of expensive materials. Small protective caps over the chamber is recommendable to protect the collected urine from rain and the heat of the sun that triggers the volatilization loss of urea. It is also possible to note additional information from the associated keys to describe the sketch.

Author: Gerba Leta

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology unit
- Currency used for cost calculation: **ETB**
- Exchange rate (to USD): 1 USD = 53.6283 ETB
- Average wage cost of hired labour per day: 500

Most important factors affecting the costs

Economic crisis, spiking inflation, and overall labour and material market cost instability.

Establishment activities

1. Construct collection chamber (Timing/ frequency: Dry season)
2. Construct hats or covering lid for the chamber/collection pit (Timing/ frequency: Dry season)
3. Lining drainage line heading to the pit with concrete (Timing/ frequency: Dry season)
4. Storage vessels/barrel (Timing/ frequency: Anytime)
5. Supplying safety clothes (wear, boots, gloves and mask) (Timing/ frequency: In advance)

Establishment inputs and costs

Specify input	Unit	Quantity	Costs per Unit (ETB)	Total costs per input (ETB)	% of costs borne by land users
Labour					
Casual labor	no.	4.0	250.0	1000.0	100.0
Carpentering	no.	1.0	1000.0	1000.0	50.0
Equipment					
Safety wears (shirt & trousers, gloves, mask, boots)	Lump sum	1.0	3000.0	3000.0	
Watering cane	no.	1.0	1000.0	1000.0	
Fertilizers and biocides					
Effective Micro Organism	Litre	2.0	100.0	200.0	50.0
Construction material					
Cement	kg	100.0	20.0	2000.0	50.0
Stone	m3	1.0	2000.0	2000.0	100.0
Corrugated iron	pcs	2.0	1000.0	2000.0	50.0
Posts and nails	Lump sum	1.0	1000.0	1000.0	50.0
Total costs for establishment of the Technology				**13'200.0**	
Total costs for establishment of the Technology in USD				*246.14*	

Maintenance activities

1. Effective Microorganisms (Timing/ frequency: Throughout collection and application)

Maintenance inputs and costs

Specify input	Unit	Quantity	Costs per Unit (ETB)	Total costs per input (ETB)	% of costs borne by land users
Labour					
EMO	Litre	6.0	100.0	600.0	100.0
Family labor	no.	52.0	100.0	5200.0	100.0
Total costs for maintenance of the Technology				**5'800.0**	
Total costs for maintenance of the Technology in USD				*108.15*	

NATURAL ENVIRONMENT

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

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

Specifications on climate
Receive bimodal rainfall with a summer maximum.
The rainfall distribution is nearly consistent. The temperature is cold typical of highland weather conditions.

Slope
- [ ] flat (0-2%)
- [ ] gentle (3-5%)
- [ ] moderate (6-10%)
- [x] 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.
- [ ] 1,501-2,000 m a.s.l.
- [ ] 2,001-2,500 m a.s.l.
- [x] 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)
- [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
- [x] 5-50 m
- [ ] > 50 m

Availability of surface water
- [ ] excess
- [ ] good
- [x] 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
- [ ] medium
- [x] 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
- [ ] > 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
- [x] Sedentary
- [ ] Semi-nomadic
- [ ] Nomadic

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

Gender
- [ ] women
- [x] men

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

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [x] 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
- [x] small-scale
- [ ] medium-scale
- [ ] large-scale

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

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

Comments

technical assistance	poor			✓	good	Although they mentioned the quality of both ground and surface water is good in the preceding section, the level of sanitation is not significant as the resident use water from the springs for drink and other household activities.
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: 70 kg from 0.12 hectare of land. Quantity after SLM: 400 kg from the same land. With the application of ISFM+ approach and urine as a replacement for Urea, a substantial yield increment was achieved.
crop quality	decreased					✓			increased	As the technology is at its early stage of implementation where documentation is not well organized, it was impossible to quantify the harvest and quality of the crop.
land management	hindered						✓		simplified	
expenses on agricultural inputs	increased					✓			decreased	As urine complement urea fertilizer, other nutrients from Sulfur, Phosphorus and other micro nutrients remain important.
farm income	decreased					✓			increased	

Socio-cultural impacts

food security/ self-sufficiency	reduced					✓			improved	
health situation	worsened		✓						improved	
cultural opportunities (eg spiritual, aesthetic, others)	reduced				✓				improved	
SLM/ land degradation knowledge	reduced						✓		improved	Crop response to urine application is an evidence based for adoption of the SLM technology.

Ecological impacts

soil moisture	decreased					✓			increased	
soil cover	reduced					✓			improved	
soil loss	increased				✓				decreased	
soil accumulation	decreased					✓			increased	
soil organic matter/ below ground C	decreased				✓				increased	Not practically measured and documented. Besides, the technology is at earlier phase to judge the real impacts.
acidity	increased					✓			reduced	
vegetation cover	decreased					✓			increased	
biomass/ above ground C	decreased					✓			increased	
habitat diversity	decreased				✓				increased	
pest/ disease control	decreased							✓	increased	It has tangible impacts on managing pests.
emission of carbon and greenhouse gases	increased			✓					decreased	As a foliar application of urine to the target crops might be subjected to evaporation, if not good hours of the day are not identified, there is a likelihood of emission. However, its amount is very insignificant as the little amount used for foliar feeding.

Off-site impacts

downstream flooding (undesired)	increased				✓				reduced	
downstream siltation	increased				✓				decreased	
groundwater/ river pollution	increased				✓				reduced	The impact has not yet measured.
impact of greenhouse gases	increased				✓				reduced	

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 (rated positive)

Long-term returns — very negative ✓ very positive (rated very positive)

Post-establishment, the maintenance costs are believed to be very low. This shows the technology is cost-effective to resource-poor farmers.

CLIMATE CHANGE

Gradual climate change

seasonal rainfall decrease — not well at all / very well: moderately — Season: wet/ rainy season

Climate-related extremes (disasters)

drought — not well at all / very well — Answer: not known

Other climate-related consequences

extended growing period — not well at all / very well: well

reduced growing period — not well at all / very well: moderately

ADOPTION AND ADAPTATION

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

- [ ] single cases/ experimental
- [x] 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%
- [x] 51-90%
- [ ] 91-100%

Number of households and/ or area covered

Forty-four (44) farmers are currently piloting this technology. Of these, 30 farmers are innovative and adopted the technology on their own using locally available materials to collect and spray urine as a complement to urea fertilizer to the target crops.

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

- [x] Yes
- [ ] No

To which changing conditions?

- [ ] climatic change/ extremes
- [ ] changing markets
- [ ] labour availability (e.g. due to migration)
- [x] Unavailability of the right kits/materials

Land users use locally available materials to collect, store and spray the urine on the target crops. Meaning the concept is introduced in a way it matches or complements conventional uses of livestock wastes to improve the fertility of soil on which Enset, a perennial crop is growing. Otherwise, standard designs or types of materials and safety precautions kits have not been associated with the technology. Despite the unavailability of the necessary kits for the establishment of the technology, farmers forge their mechanisms to collect and use urine. This indicates the innovativeness of the land/technology users.

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Reduce costs spent on chemical fertilizer.
- Increase yield per unit of land and land users' income in general. Furthermore, it increases the number of tillers per plant and overall biomass yield.
- Manage insect pests such as cutworms and aphids.

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

- It seems a good substitute for chemical fertilizer, urea. It improves farmers' access to wasted resources without being used.
- It restores the fertility of the soil and improves production and productivity, and species diversity which improves ecological benefits on top of the high return from the most minor investment in fertilizer.

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

- Bad smell of the urine when sprayed on the target crops. By ensuring access to necessary tools. Otherwise, they will not give up on using it since the benefit outweighs the loss.
- Lack of spraying materials. If not accessed spraying tools, the farmer committed to using locally forged ones.

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

- Stinking of the urine while applying to the crop. Try to test whether using Effective Micro Organism (EMO) can improve urine smell before using it in the field.
- Lack of safety wear and associated necessary kits. Improving access to the necessary materials, knowledge, and skills to use the available resources or materials effectively.

REFERENCES

Compiler
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Date of documentation: Jan. 21, 2023

Last update: April 13, 2023

Resource persons
Wachara Shone - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6623/

Linked SLM data
Approaches: Farmer-Research-Extension Group (FREG) https://qcat.wocat.net/en/wocat/approaches/view/approaches_2496/
Approaches: Farmers Research and Extension Group (FREG) https://qcat.wocat.net/en/wocat/approaches/view/approaches_6629/
Approaches: Integrated Soil Fertility Management (ISFM) https://qcat.wocat.net/en/wocat/approaches/view/approaches_6732/

Documentation was faciliated by

Institution
- CIAT International Center for Tropical Agriculture (CIAT International Center for Tropical Agriculture) - Kenya

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

Key references

- Use of Cow Urine in the Field of Agriculture. Singh, R. 2022: http://www.pashudhanpraharee.com/use-of-cow-urine-in-the-field-of-agriculture/
- Utilization of urine waste to produce quality cauliflower. Khanal, A., Shakya , S. M., Shah, S. C., Sharma, M. D. 2011.: https://www.nepjol.info (Free access)

Links to relevant information which is available online
- Nitrogen concentration in the urine of cattle, sheep and deer grazing a common ryegrass/cocksfoot/white clover pasture. Doi.org/10.1080/00288233.2010.499899: https://www.tandfonline.com

Bioslurry structure with feedstock from livestock manure and human toilet. (Gerba Leta)

Bioslurry (Ethiopia)

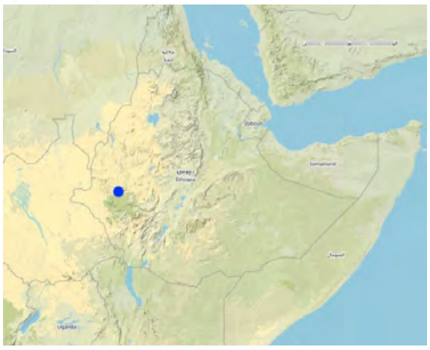
Siico biogaazi

DESCRIPTION

Bioslurry is a byproduct of the anaerobic process used for production of methane (biogas). It is derived from the manure used to feed the biodigester. Bioslurry is an organic fertilizer that serves as a replacement for chemical fertilizers, and also plays a pesticidal role.

Bioslurry is a byproduct of the anaerobic process used for production of methane (biogas). It is derived from the manure and other organic materials used to feed the biodigester – which is central to a biogas plant. The biodigester is fed with thoroughly mixed livestock manure and water. For instance, a biodigester with a capacity of 8m3 requires manure from 8 cattle mixed with 20 litres of water daily. This allows consistent production of biogas, and bioslurry as a byproduct.
Bioslurry is used as an organic soil amendment that serves as an alternative to chemical fertilizers. It can also play a pesticidal role. Increasing the use of organic fertilizer can reduce the money spent on inorganic fertilizer by at least half. It also improves soil structure via the addition of organic matter. Essentially, the organic matter content of bioslurry is about 20-30%. Appropriate application of the bioslurry as organic fertilizer leads to more moisture retention in the root zone and improves crop resilience to adverse conditions. Usually, bioslurry is applied around homesteads where the biogas plant is sited where it produces energy and light for the household. The main functions of bioslurry are improving soil fertility, increasing crop production, and deterring invasion by various insects. Applying filtered liquid bioslurry to the crop supplies available liquid nutrients and manages crop infestation such as by fall armyworms and maize stalk borer.
Bioslurry is a replacement for chemical fertilizers. It is applied in two forms: liquid and dry forms. The liquid form is mainly used around the homestead, using a watering can or bucket. The dried form can more easily be carried to fields for application. Bioslurry as organic fertilizer is applied to vegetables and other perennial crops around the homestead, once during the growing season. The overall application rate by smallholders is not necessarily based on the recommendation rate per hectare but on the availability of the by-product. Row application is the efficient and effective use of resources in short supply. The rate of application to the specific parcel is on a decremental basis. The end users are pleased by its merit of increasing production, reducing investment costs on chemical fertilizers, improving soil structure and associated properties. They also like the way it makes constructive use of a byproduct that needs to be disposed of. Nevertheless, bioslurry is only available to those who invest in costly biogas plants which also require intensive labour input to collect cattle manure and fetch water.

LOCATION



Location: Adale-Bise Kebele, Mattu district, Oromia, Ethiopia

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 35.48012, 8.32526

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

In a permanently protected area?: No

Date of implementation: 2020

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 composting and drying bioslurry for use in remote farmland. (Gerba Leta)

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
- [ ] 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: No

Cropland
- Annual cropping: cereals - maize, cereals - sorghum, Wheat
- Tree and shrub cropping: avocado

Number of growing seasons per year: 1
Is crop rotation practiced? Yes

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

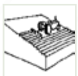
soil erosion by water - Wt: loss of topsoil/ surface erosion

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

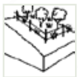
physical soil deterioration - Ps: subsidence of organic soils, settling of soil, Pu: loss of bio-productive function due to other activities

SLM group
- integrated crop-livestock management
- integrated soil fertility management
- integrated pest and disease management (incl. organic agriculture)

SLM measures



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

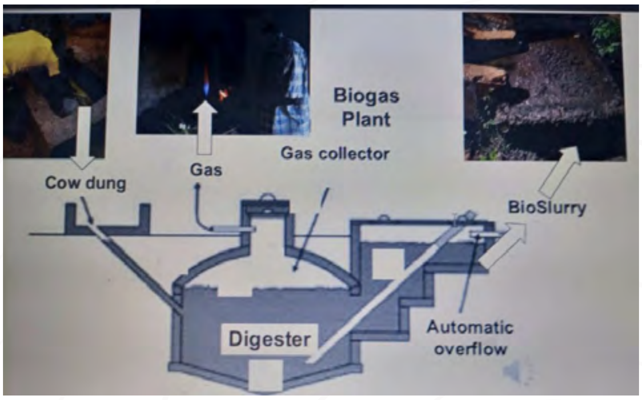


management measures - M2: Change of management/ intensity level, M5: Control/ change of species composition

TECHNICAL DRAWING

Technical specifications

The Photo clearly portrays where the feedstock is added; the biodigester produces methane gas; gas collection and energy production points, and the final collection pits for bioslurry are located. The photo is adopted from W. Critchley PPT presentation. The dimension of the different parts is variable based on the supply of feedstock and financial resources the land users have for investment.



ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology unit (unit: **Biogas structure** volume, length: **Structure with 8m3 digester**)
- Currency used for cost calculation: **ETB**
- Exchange rate (to USD): 1 USD = 53.12 ETB
- Average wage cost of hired labour per day: 200

Most important factors affecting the costs

Economic crisis and price volatility of the labor and materials.

Establishment activities

1. Constructing biogas structure (Timing/ frequency: Anytime wanted)
2. Supplying feedstock to the digester (Timing/ frequency: On dial basis)
3. Collect bioslurry via collection pits (Timing/ frequency: when collection pits are filled and try to compost to transport the dry to remote farmlands.)
4. Apply the slurry to the crop or the farm either in liquid or dry forms. (Timing/ frequency: During planting and other time of the season depending, on the types of crop.)

Establishment inputs and costs (per Biogas structure)

Specify input	Unit	Quantity	Costs per Unit (ETB)	Total costs per input (ETB)	% of costs borne by land users
Labour					
Labor	PDs	10.0	200.0	2000.0	100.0
Technician	Lump sum	1.0	10000.0	10000.0	
Equipment					
PBC, Gate valve, plastic pipes, stove, bulbs	Lump sum	1.0	6000.0	6000.0	
Spade	Nnumber	1.0	300.0	300.0	100.0
Wheel barrow	Number	1.0	1600.0	1600.0	
Construction material					
Cement	ton	1.0	10000.0	10000.0	
Stone	m3	2.0	1500.0	3000.0	100.0
Sand	m3	8.0	500.0	4000.0	100.0
Total costs for establishment of the Technology				**36'900.0**	
Total costs for establishment of the Technology in USD				*694.65*	

Maintenance activities

1. Labor for collection of livestock drops, supply water, and drying the outputs. (Timing/ frequency: Throughout)
2. Maintenance of the malfunctioning structure and supply of biogas accessories. (Timing/ frequency: Throughout)

Maintenance inputs and costs (per Biogas structure)

Specify input	Unit	Quantity	Costs per Unit (ETB)	Total costs per input (ETB)	% of costs borne by land users
Labour					
Family labor to supply feedstock and collect the product.	PDs	365.0			100.0
Equipment					
Accessories	Lump sum	5.0	200.0	1000.0	50.0
Total costs for maintenance of the Technology				**1'000.0**	
Total costs for maintenance of the Technology in USD				*18.83*	

NATURAL ENVIRONMENT

Average annual rainfall

- ☐ < 250 mm
- ☐ 251-500 mm
- ☐ 501-750 mm

Agro-climatic zone

- ☐ humid
- ☑ sub-humid
- ☐ semi-arid

Specifications on climate

Dry season: January to March, and wet season: June to September.
Name of the meteorological station: Mettu

- [ ] 751-1,000 mm
- [ ] 1,001-1,500 mm
- [x] 1,501-2,000 mm
- [ ] 2,001-3,000 mm
- [ ] 3,001-4,000 mm
- [ ] > 4,000 mm

- [ ] arid

Slope
- [ ] flat (0-2%)
- [ ] gentle (3-5%)
- [x] moderate (6-10%)
- [x] 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.
- [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)
- [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
- [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: surface water

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

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

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

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

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
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- [x] mixed (subsistence/ commercial)
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- [x] rich
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Level of mechanization
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- [x] Sedentary
- [ ] Semi-nomadic
- [ ] Nomadic

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

Gender
- [ ] women
- [x] men

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

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [ ] 2-5 ha
- [x] 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
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- [x] individual, titled

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

Water use rights
- [x] 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	poor			✓	good

IMPACTS

Socio-economic impacts

Crop production	decreased					✓			increased	The farmer observed a significant increase in crop yield per unit of land post the application of bioslurry. According to the farmer, the yield increment amounts to more than double the harvest that used to be gained via the use of chemical fertilizers.
crop quality	decreased					✓			increased	A farmer communicated the improvement in the taste of the maize grain harvested from the farmland treated with bioslurry.
fodder production	decreased					✓			increased	It increases biomass production and feed availability from crop residues.
fodder quality	decreased					✓			increased	
risk of production failure	increased					✓			decreased	
land management	hindered						✓		simplified	According to the land user, tilling the farmland treated by bioslurry is lighter than the other soil. Furthermore, it forms an aggregate that otherwise remains dusty on tillage without the use of organic fertilizer or the bioslurry.
expenses on agricultural inputs	increased					✓			decreased	
farm income	decreased					✓			increased	

Socio-cultural impacts

food security/ self-sufficiency	reduced					✓			improved
health situation	worsened					✓			improved
SLM/ land degradation knowledge	reduced						✓		improved

Ecological impacts

water quantity	decreased				✓				increased	
water quality	decreased				✓				increased	
surface runoff	increased					✓			decreased	
excess water drainage	reduced					✓			improved	
groundwater table/ aquifer	lowered				✓				recharge	Not yet empirically measured.
evaporation	increased					✓			decreased	As it promotes the growth of diverse plant species, it has positive effects on reducing evoration.
soil moisture	decreased					✓			increased	
soil cover	reduced					✓			improved	
soil loss	increased						✓		decreased	
soil accumulation	decreased					✓			increased	
soil compaction	increased					✓			reduced	
nutrient cycling/ recharge	decreased					✓			increased	
soil organic matter/ below ground C	decreased				✓				increased	
acidity	increased					✓			reduced	
vegetation cover	decreased						✓		increased	
biomass/ above ground C	decreased					✓			increased	
plant diversity	decreased					✓			increased	
emission of carbon and greenhouse gases	increased					✓			decreased	

Off-site impacts

water availability (groundwater, springs)	decreased					✓			increased	
reliable and stable stream flows in dry season (incl. low flows)	reduced				✓				increased	As the technology is not widely adopted and measured its impact is negligible in this regard.
downstream flooding (undesired)	increased					✓			reduced	
downstream siltation	increased					✓			decreased	Reduces the runoff of soil and water because of good ground cover and high biomass production.

damage on neighbours' fields

increased ✓ reduced

As it arrest the downstream runoff, it reduces the damage it may imposes on the adjacent fields.

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

During the establishment phase, the farmer hesitates to engage as the cost is on the higher side.

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

annual rainfall decrease — not well at all ✓ very well

seasonal rainfall decrease — not well at all ✓ very well — Season: summer

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?

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

Number of households and/ or area covered

The technology piloted by three farmers in a kebele.

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

- Improve soil fertility
- Increase production per unit of land
- The process allows for cleaning the environment, as cattle manure and urine are collected and safely disposed of or used as feedstock to the biogas structure.

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

- Allows the farm to retain moisture and nutrients, keep the crop vigorous, and become resilient to adverse conditions.
- It creates employment opportunities for the member of the family farmers.
- Liquid slurry deters insect pests from the farm and the crop.

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

- Labor-intensive technology for its production and application to the farm. Aware of family members and engaged them in the production and uses of slurry.

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

- High initial investment cost. Provide support via the project as well as relevant government organizations such as water and energy, also through strengthening cost sharing with the end user.
- As the production per structure is relatively low, the rate and frequency of application have not yet worked out. Need follow-up, documentation, and defining the right amount and frequency of application to crop and the farm.

REFERENCES

Compiler
GERBA LETA

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Date of documentation: Feb. 7, 2023

Last update: April 13, 2023

Resource persons
Tamiru Tolessa - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6646/

Linked SLM data
Approaches: Farmers Research and Extension Group (FREG) https://qcat.wocat.net/en/wocat/approaches/view/approaches_6629/
Approaches: Integrated Soil Fertility Management (ISFM) https://qcat.wocat.net/en/wocat/approaches/view/approaches_6732/

Documentation was faciliated by

Institution
- CIAT International Center for Tropical Agriculture (CIAT International Center for Tropical Agriculture) - Kenya

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

Key references

- Bioslurry: A supreme fertilizer. Warnass, L. 2014. ISBN: 978-90-70435-07-3: https://www.academia.edu/83905083/Bioslurry_A_Supreme_Fertilizer

Links to relevant information which is available online
- Bioslurry = Brown Gold? A review of scientific literature on co-product of biogas production.: https://www.fao.org/3/i3441e/i3441e.pdf

Agroforestry practices developed by land user's initiative but complemented by training, technical support and supplies of seedling by development actors. (GERBA LETA)

Integrated Agroforestry System (Ethiopia)

Mitikarsamino Ersha

DESCRIPTION

The integrated agroforestry system is a self-initiated approach by a land user to implement agroforestry as part of an indigenous practice and has evolved over the years through technical support, training, and supplies of coffee and tree seedlings by the Office of Agriculture and Coffee Improvement Project. Had there been a participatory process throughout it would have helped in design and also in scaling up.

The integrated agroforestry system was independently initiated by land users during the Derg regime (1974-91). During the regime, farmers were failed by two distinct and polar development approaches: socialist and the mainstream local approaches. The earlier one involved the communist approach of communal production and sharing the output according to contribution. The latter ones employed a conventional approach and included non-members of the so-called Farmers Producer Cooperatives. As a non-member of the earlier one, the land user had to develop his farm alone. The solitary agroforestry initiative described here has gradually evolved to a fully-fledged system that currently serves as a model SLM practice for scaling up across similar agroecological and farming system. Thus, there was little participation involved during the early intensification of agroforestry in Ethiopia. Rather, it is considered an indigenous practice that now receives publicity as a form of "regenerative agriculture" with ecological, economic, and social benefits. As it has global significance in terms of emission reduction and sequestration of carbon, it is the favourite technology among the government and other development practitioners.
The farmer started agroforestry by planting enset and coffee. Over time, with emerging technical support, access to training, and supply of coffee seedlings by the agriculture and coffee improvement project offices, the land user has continued intensification of the agroforestry around the homestead by adopting the correct planting space for coffee and enset, and other companion fruit, fodder crops, and shade trees. The former Ministry of Coffee and Tea, and the current Ministry of Agriculture have had an immense contribution by supplying technical support, training, and inputs (notably coffee and tree seedlings), and by ensuring access to fertilizers. The latter was supplied to the farmers on a credit basis through the then Service Cooperative.
As the initiative was the farmer's own, the tendency to plant incompatible crops was not uncommon. Even so, the agroforestry trees and shrubs still had immense ecological and economic value. They ameliorate the extreme temperature experienced during the dry season, improve the microclimate, recharge the surface and groundwater via improving water infiltration, and reduce runoff losses. Improving soil fertility and soil health are among other benefits. Despite the substantial benefit the technology confers on land users, the lack of a participatory approach in planning, implementation, monitoring, and evaluation at the community level restricts the adoption and scaling up of this beneficial approach. Despite the achievements of the land user, earlier engagement of other smallholders and institutionalizing the approach decades ago might have positively influenced the design as

LOCATION

Location: Shoye kebele (Kebele - lower administrative level)., Sidama, Ethiopia

Geo-reference of selected sites
- 38.43817, 6.77315

Initiation date: 1980

Year of termination: n.a.

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

well as wider-scale adoption and application of the technology. However, regardless of any limitations, the technology is evidence-based and inspirational.

The photo portrays the diverse components of the agroforestry system (GERBA LETA)

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims / objectives of the approach

A traditional approach was initiated to change the land use/ land cover and optimize the benefit of the degraded land by reducing the negative effects of overgrazing and its consequence.

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

- **Social/ cultural/ religious norms and values**: The long-standing tradition of the society promotes planting and preserving trees.
- **Availability/ access to financial resources and services**: Access to in-kind credit services such as fertilizers from farmers' cooperatives enables the land users to effectively implement the practice.
- **Collaboration/ coordination of actors**: Foster farmers access to training, technical support, exchange visit...
- **Legal framework (land tenure, land and water use rights)**: Enables the development of a sense of ownership and accountability to properly implement and manage the practice.
- **Knowledge about SLM, access to technical support**: Promote effective implementation, management, and use of the return from the practice.
- **Markets (to purchase inputs, sell products) and prices**: The availability of a fair and subsidized market enables the approach.
- **Workload, availability of manpower**: The availability of manpower enables one to accomplish the job without pressure.

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

- **Institutional setting**: The lack of institutional setting might have influenced the rate of scaling the technology.
- **Markets (to purchase inputs, sell products) and prices**: Lack of reliable market compels to change the approach to another income-generating practice/approach.
- **Workload, availability of manpower**: Shortage of manpower disables effective implementation of the practice.

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	Land users and local communities	Plan and implement the technology, and sharing labor, skills and knowledge.
SLM specialists/ agricultural advisers	Development agents (DAs) and district experts	Provide training, and technical support, facilitate land users' access to inputs such as seedlings and fertilizers, monitor and evaluate, and documentation of successful practices for pervasive application and use.
researchers	Regional Agricultural Research Institute, and under/graduate students.	Generate supportive specific and relevant technologies, learn the lesson, and recommend best-fit technologies/practices.
local government	District administration and colleagues	Acknowledge the farmers/technology adopters as a model to showcase their experience and encourage the scaling out of the initiative.

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

	none	passive	external support	interactive	self-mobilization	
initiation/ motivation					✓	Land user: Initiated coffee and enset plantation little by little and accessed training and technical support from DAs and Woreda office of Agriculture experts.
planning					✓	Land user and development agent: In consultation with DAs, the land users plan based on available labor and capital every other year.
implementation					✓	Land users and family member. They involved in various implementation/management activities.
monitoring/ evaluation		✓				Government development agents, and experts coordinate mobilization of the communities to visit and learn from the ongoing practice.

Flow chart

A flow chart depicting the evolution of practice from self-initiative indigenous coffee planting practices to a multistorey agroforestry system with the participation and support of public organization agents and farmers' primary cooperative.

Author: Gerba Leta

Decision-making on the selection of SLM Technology

Decisions were taken by

- [x] 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
- [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
- [ ] Institution strengthening (organizational development)
- [ ] Monitoring and evaluation
- [ ] Research

Capacity building/ training

Training was provided to the following stakeholders

- [x] land users
- [ ] field staff/ advisers
- [x] Development agents

Form of training

- [ ] on-the-job
- [ ] farmer-to-farmer
- [ ] demonstration areas
- [x] public meetings
- [ ] courses
- [x] Training and visit

Subjects covered

Coffee production and management such as preparation of planting pits, refilling the soil back to the pit, planting space, fertilizer application, weeding, mulching, planting shade trees, etc.

Advisory service

Advisory service was provided

- [x] on land users' fields
- [x] at permanent centres

The training used to be given in permanent centers such as development stations in the past and Farmers Training Center since recent a decade ago and was associated with a visit to a farmers field.

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component

- [x] < 2,000
- [ ] 2,000-10,000
- [ ] 10,000-100,000
- [ ] 100,000-1,000,000
- [ ] > 1,000,000

Precise annual budget: n.a.

Only in kind support such as coffee seedlings and technical support such as advisory service was provide by the government agricultural office through development/extension agents. Otherwise, it is privately financed

The following services or incentives have been provided to land users

- [x] Financial/ material support provided to land users
- [x] Subsidies for specific inputs
- [ ] Credit
- [ ] Other incentives or instruments

business with main expense geared toward supplying seedlings and agricultural inputs such as fertilizers.

Financial/ material support provided to land users

In the past (during Derg regime) there was subsidy for fertilizers as a country which is entirely removed in the recent years.

	partly financed	fully financed
Fertilizer In the past, the government import and supply fertilizer on subsidized basis. The trend was changed over the last a couple of decades.	✓	

Labour by land users was

- [x] 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? The approach was mainly based on self initiative. The assistance that came in later on was top-down where farmers were urged to plant coffee and companion tree crops. However, later it has evolved into agroforestry and SLM that empower local land users to join.		✓		
Did the Approach enable evidence-based decision-making? It is not entirely the approach but the outcome of intensifying the technology that eventually enables land users and other stakeholders to make an evidence-based decision.			✓	
Did the Approach help land users to implement and maintain SLM Technologies? The prevailing system compels farmers to integrate land management practices such as soil bunds, food and non-food tree species into the farm that enable land users to adopt and uphold SLM technology.			✓	
Did the Approach improve coordination and cost-effective implementation of SLM?		✓		
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? Through public meetings and social learning from peers and better-off farmers, land users' knowledge and skills to implement the technology have been improved.			✓	
Did the Approach improve knowledge and capacities of other stakeholders? Virtually through social learning and labor sharing.		✓		
Did the Approach build/ strengthen institutions, collaboration between stakeholders? It was a solitary approach but later adopted by numerous land users.		✓		
Did the Approach mitigate conflicts?	✓			
Did the Approach empower socially and economically disadvantaged groups? It doesn't deliberate about gender disparity and equity as it was an indigenous initiative in the long past.	✓			
Did the Approach improve gender equality and empower women and girls?	✓			
Did the Approach encourage young people/ the next generation of land users to engage in SLM? The established technology built youths trust in SLM.			✓	
Did the Approach improve issues of land tenure/ user rights that hindered implementation of SLM Technologies?	✓			
Did the Approach lead to improved food security/ improved nutrition? Actually, implementing the agroforestry improved food and nutrition security of the family farmers.				✓
Did the Approach improve access to markets? Harvest from the integrated system improved farmer's access to market.			✓	
Did the Approach lead to improved access to water and sanitation?	✓			
Did the Approach lead to more sustainable use/ sources of energy? Through promoting biogas technology in mixed tree-crop-livestock system.		✓		

Did the Approach improve the capacity of the land users to adapt to climate changes/ extremes and mitigate climate related disasters?
Again, it is not the approach but the applied technology has improved farmers adaptation to climate change/climate variability.

Did the Approach lead to employment, income opportunities?
It creates all year round employment opportunity for family labor and other casual laborers.

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
- [x] prestige, social pressure/ social cohesion
- [ ] affiliation to movement/ project/ group/ networks
- [x] environmental consciousness
- [ ] customs and beliefs, morals
- [x] 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
- [x] yes
- [ ] uncertain

Despite the implementation approach employed by the land user, the technology is highly commended by the land users and the public at large. The income generated from the sale of crops adequately supports the livelihoods of family farmers as well as effectively finances the maintenance of the system. However, the new beginners need external support to make sure the technology is properly implemented and scaled out for wider application and use.

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Enables improved crop production and productivity and reduces risks of crop failure due to climate change/variability.
- Motivate farmers to reduce soil erosion and land degradation and improve soil fertility.
- The approach creates an enabling environment to intensify agroforestry and improve the microclimate of the area and ensure sustainability of the system.
- Increased land users' status in the community to feel confident as local elites and friendliness to the environment.

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

- The agroforestry system creates economic, ecological, and social benefits for the family farm.
- It ensures sustainable land management becomes in place as well as improves land users' understanding of SLM.
- Ensure productivity and product stability, and serve as a permanent source of income and insurance for a family farmer.

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

- Failure to promote collective action that end up with shortage of labor with increasing size/ areas of technology. Establish and promote collective action and labor-sharing techniques.
- Lack of participatory planning and decision make to put in place proper trees-crops integration. Promote participation that enables to select and plant trees and crops with desirable characteristics to the agroforestry system.
- Lack of active women participation with clear role and their share of the benefit from the system. Improve women's participation and share of the benefit.

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

- Lower level of mainstreaming the approach and the technology at earlier stage that led to land users lower level of understanding of the multi-storey agroforestry system. Improve land users understanding of Agroforestry and the SLM through capacity building and exchange visits.
- The solitary approach led to relatively lower adoption of the technology. Improve participation, access to training, technical support, and credit services to optimize the benefit of land users at scale.
- Evolving the approach from solitary approach to large mass of land users constrained by shortage of farmland. Promote intensification through introduction of high - value crops and optimize the return from the smaller holdings.

REFERENCES

Compiler
GERBA LETA

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Date of documentation: Jan. 19, 2023

Last update: April 27, 2023

Resource persons
Afra Gabiba (+251 934 73 5738) - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/approaches/view/approaches_6622/

Linked SLM data
Technologies: Multistorey agroforestry https://qcat.wocat.net/en/wocat/technologies/view/technologies_6621/

Documentation was faciliated by

Institution
- CIAT International Center for Tropical Agriculture (CIAT International Center for Tropical Agriculture) - Kenya

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

Key references
- An Agroforestry Guide for Field Practitioners. 2013. ISBN 978-92-9059-333-1: https://www.worldagroforestry.org

Links to relevant information which is available online
- SUSTAINABLE LAND USE FORUM: http://publication.eiar.gov.et

A multistory agroforestry system (GERBA LETA)

Multistorey agroforestry (Ethiopia)

Mitikarsamino Ersha

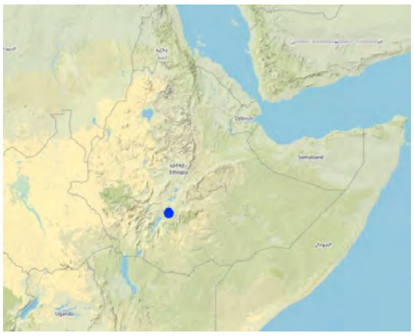
DESCRIPTION

Multistorey agroforestry is the intentional mixing of trees/shrubs with crops, pastures, and livestock. The practice creates environmental, economic, and social benefits for the end users.

Multistorey agroforestry is the intentional mixing of trees/shrubs with crops and pasture at different levels ("storeys" or heights) and the livestock. The practice creates environmental, economic, and social benefits for the end users. Agroforestry practices provide opportunities to integrate productivity and profitability with environmental stewardship resulting in healthy and sustainable agricultural systems that can be passed on to future generations. Tree litter increases soil organic matter and reduces soil chemical and biological degradation. Tree cover can reduce soil erosion and evaporation from the soil surface. The technology is applied close to the homestead as it demands close follow-up and steady management practices, and that is where tree-crop-livestock integration can be best applied. The farmer whose practice is described here used to be very poor four decades ago. He has planted coffee gradually over the years under shade trees. As a staple perennial food crop, enset was planted also in the mixture. Livestock were also integrated. Eventually, numerous multipurpose tree species, food and fodder crops, and physical structures with productive barriers were integrated into the farming system. As a consequence, a multistorey agroforestry system has been established over years.

The purpose of the technology is to ensure ecological, economic, and social benefits. The rolling landscape of the area necessitates permanent ground cover to reduce the effect of erosive rainfall that degrades the soil. Once established, the technology needs management practices including pruning/stumping of coffee trees, managing other trees, weed control, enrichment planting with coffee and enset, and fertilization of annual and perennial crops. The livelihood of the respondent farmer has been completely changed. He has made a significant accumulation of wealth from producing and sale of tons of unprocessed coffee, avocado fruits and some indigenous bananas. This form of agroforestry creates year-round employment opportunities for proactive farmers. However, subsistence farmers with small parcels give priority entirely to the mono-cropping of cereals and other fast-maturing crops to meet their urgent demand for food. Shortage of land, capital, and a general lack of awareness about the sustainable benefits of the technology are reasons for lack of adoption of the technology.

LOCATION



Location: Shoye kebele (Kebele - lower administrative level), Sidama, Ethiopia

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 38.43817, 6.77315

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

In a permanently protected area?: No

Date of implementation: 1980; 10-50 years ago

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

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

Land use

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

Cropland
- Annual cropping: cereals - maize, Legumes - Haricot beans and other climbing species, Pumpkin and root crops/tuber potato and yam.

- [ ] 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

- Perennial (non-woody) cropping: banana/plantain/abaca, fodder crops - grasses, herbs, chili, capsicum, Enset/false banana
- Tree and shrub cropping: avocado, coffee, shade grown, mango, mangosteen, guava

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

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


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


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

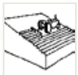

physical soil deterioration - Pc: compaction, Pw: waterlogging, Ps: subsidence of organic soils, settling of soil


biological degradation - Bc: reduction of vegetation cover, Bh: loss of habitats, Bq: quantity/ biomass decline, Bs: quality and species composition/ diversity decline, Bl: loss of soil life, Bp: increase of pests/ diseases, loss of predators

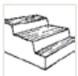
SLM group

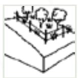
- agroforestry
- integrated crop-livestock management
- integrated soil fertility management

SLM measures


agronomic measures - A1: Vegetation/ soil cover, A2: Organic matter/ soil fertility


vegetative measures - V1: Tree and shrub cover

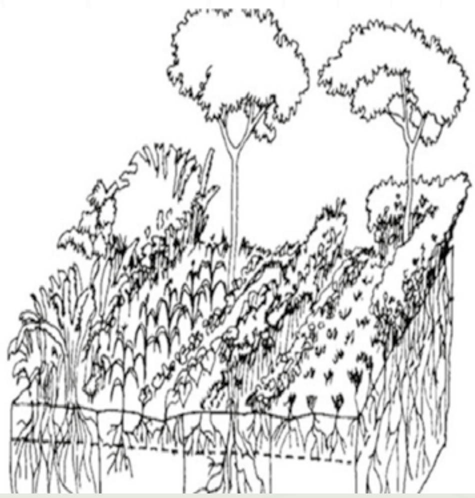

structural measures - S2: Bunds, banks


management measures - M1: Change of land use type, M2: Change of management/ intensity level

TECHNICAL DRAWING

Technical specifications

An adopted technical drawing/specification of the classification of tree-crop arrangement in the multistorey agroforestry system.



Author: Xu J, Mercado A, He J., Dawson I (eds.) (2013); ISBN 978-92-9059-333-1

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology area (size and area unit: **4Timad**; conversion factor to one hectare: **1 ha = 4 Timad = 1 ha**)
- Currency used for cost calculation: **Ethiopian Birr**

Most important factors affecting the costs

Economic crisis and the prevailing inflation in the country, and global changes in price of petroleum and other commodities such as chemical fertilizers.

- Exchange rate (to USD): 1 USD = 53.12 Ethiopian Birr
- Average wage cost of hired labour per day: In rural area wage rate vary by type of work: coffee harvest-80 ETB/day, weeding 60 ETB/day. About 70 birr/day, on average.

Establishment activities

1. Land preparation (Timing/ frequency: Before and during Belg (short rain) and Meher (long rain) season.)
2. Enset and Coffee planting (Timing/ frequency: In Belg and Meher season, respectively.)
3. Planting beans (annual crops) (Timing/ frequency: In Belg season)
4. Fodder and other Multipurpose trees planting (Timing/ frequency: In Meher (main rainy season).)

Establishment inputs and costs (per 4Timad)

Specify input	Unit	Quantity	Costs per Unit (Ethiopian Birr)	Total costs per input (Ethiopian Birr)	% of costs borne by land users
Labour					
Land preparation	Oxen plow	16.0	200.0	3200.0	100.0
Planting annual crops	Oxen plow	4.0	200.0	800.0	100.0
Planting perennial crops	PDs	20.0	70.0	1400.0	100.0
Planting fodder crops and trees	PDs	5.0	70.0	350.0	100.0
Equipment					
Spade	Number	1.0	400.0	400.0	100.0
Hoe	Number	1.0	600.0	600.0	100.0
Digging fork	Number	1.0	500.0	500.0	100.0
Plant material					
Coffee seedling	number	2500.0	10.0	25000.0	100.0
Enset seedling	number	6000.0	5.0	30000.0	100.0
Tree seedling	number	1500.0	2.0	3000.0	50.0
Beans seed	kg	50.0	42.0	2100.0	100.0
Fertilizers and biocides					
NSP fertilizer	kg	100.0	44.0	4400.0	
Urea fertilizer	kg	50.0	44.0	2200.0	
Total costs for establishment of the Technology				**73'950.0**	
Total costs for establishment of the Technology in USD				*1'392.13*	

Maintenance activities

1. Inputs (Timing/ frequency: Before the onset of short/long rain.)
2. Management (Timing/ frequency: Throughout the year depending on the management types.)
3. Farm tools (Timing/ frequency: During off-season.)

Maintenance inputs and costs (per 4Timad)

Specify input	Unit	Quantity	Costs per Unit (Ethiopian Birr)	Total costs per input (Ethiopian Birr)	% of costs borne by land users
Labour					
Enrichment/replacement planting	PDs	5.0	70.0	350.0	100.0
Fertilization	PDs	40.0	70.0	2800.0	100.0
Weeding	PDs	40.0	70.0	2800.0	100.0
Equipment					
Hoes	number	4.0	600.0	2400.0	100.0
Digging fork	number	4.0	500.0	2000.0	100.0
Spade	number	4.0	400.0	1600.0	100.0
Plant material					
Coffee seedling for replacement	number	250.0	10.0	2500.0	100.0
Fertilizers and biocides					
NSP	kg	100.0	44.0	4400.0	
Urea	kg	50.0	44.0	2200.0	
Total costs for maintenance of the Technology				**21'050.0**	
Total costs for maintenance of the Technology in USD				*396.27*	

NATURAL ENVIRONMENT

Average annual rainfall

- [ ] < 250 mm
- [ ] 251-500 mm
- [ ] 501-750 mm
- [ ] 751-1,000 mm
- [x] 1,001-1,500 mm

Agro-climatic zone

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

Specifications on climate

The area receive adequate rainfall.
Name of the meteorological station: Awassa Meteorology center
The climate is virtually consistent except during the season of El Nino and cyclical shortage that happens once in years.

- [ ] 1,501-2,000 mm
- [ ] 2,001-3,000 mm
- [ ] 3,001-4,000 mm
- [ ] > 4,000 mm

Slope
- [ ] flat (0-2%)
- [ ] gentle (3-5%)
- [x] moderate (6-10%)
- [x] 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)
- [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
- [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: ground water

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

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

Species diversity
- [x] high
- [ ] 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
- [x] less than 10% of all income
- [ ] 10-50% of all income
- [ ] > 50% of all income

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

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

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

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

Gender
- [ ] women
- [x] men

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

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [x] 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
- [x] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [ ] individual, not titled
- [x] individual, titled

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

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

Tap water is accessible some distance away. The deep well the farmer has is not clean for drinking by the household but for cattle and cleaning goods and clothes.

IMPACTS

Socio-economic impacts

Crop production	decreased [ ][ ][ ][ ][ ][✓][ ] increased	It is difficult to guess the increment by weight of perennial crops such as Enset. Of course, the performance is much better in the agroforestry system with intensive management and application of organic fertilizers. The integration also ameliorates the microclimate of the area and makes the situation ideal for the crops.
crop quality	decreased [ ][ ][ ][ ][ ][✓][ ] increased	In the agroforestry system, a combination of livestock manure, tree litter, and a mixed cropping system contributes to soil fertility and soil health which improves crop quality.
fodder quality	decreased [ ][ ][ ][ ][ ][✓][ ] increased	Increased with improved soil fertility and soil healthy.
animal production	decreased [ ][ ][ ][ ][ ][✓][ ] increased	Livestock access to feed during the dry spell when communal grazing land is denuded of grass. Furthermore, agroforestry promotes a cut-and-carry feeding system that strengthens reliance on one's feed reserves at disposal. This goes with the intensification of livestock production.
risk of production failure	increased [ ][ ][ ][ ][ ][✓][ ] decreased	The practices rather improve the resilience of the crop as it creates an ambient environment.
product diversity	decreased [ ][ ][ ][ ][ ][✓][ ] increased	The integration increase product diversity.
production area (new land under cultivation/ use)	decreased [ ][ ][ ][✓][ ][ ][ ] increased	
land management	hindered [ ][ ][ ][ ][ ][✓][ ] simplified	
energy generation (e.g. hydro, bio)	decreased [ ][ ][ ][ ][✓][ ][ ] increased	Cattle manure is used for the production of heat and light energy through the application of biogas technology.
water availability for livestock	decreased [ ][ ][ ][ ][ ][✓][ ] increased	Agroforestry's contribution to drinking water availability and water quality was not measured and was beyond the scope of respondents to comprehend and address the questions except the merely conceptual reflection. Of course, the technology reduces runoff and recharges the ground water which directly contributes to the availability of surface water for livestock.
expenses on agricultural inputs	increased [ ][ ][ ][ ][ ][✓][ ] decreased	Fertilizer supply changed more to organic than chemical fertilizer. The foliage of tree litter and in situ decomposition of organic matter added substantial value to the restoration of soil fertility.
farm income	decreased [ ][ ][ ][ ][ ][✓][ ] increased	
diversity of income sources	decreased [ ][ ][ ][ ][ ][✓][ ] increased	
workload	increased [✓][ ][ ][ ][ ][ ][ ] decreased	Increased management demand with gradual increase of the integration of tree crops and the overall size of the land is remarked by the farmer.

Socio-cultural impacts

food security/ self-sufficiency	reduced [ ][ ][ ][ ][ ][✓][ ] improved	Land users generate reasonable income from the integration of different perennial and annual crops as well as livestock.
health situation	worsened [ ][ ][ ][ ][ ][✓][ ] improved	
land use/ water rights	worsened [ ][ ][ ][ ][ ][✓][ ] improved	
SLM/ land degradation knowledge	reduced [ ][ ][ ][ ][ ][ ][✓] improved	The technology immensely contributed to SLM by covering the farmland with perennial trees and crops and by incorporating the physical structure into the practice.

Ecological impacts

harvesting/ collection of water (runoff, dew, snow, etc)	reduced [ ][ ][ ][ ][✓][ ][ ] improved	

Impact	Negative	Rating	Positive	Comment
surface runoff	increased	□□□□□✓□	decreased	
excess water drainage	reduced	□□□□□✓□	improved	
groundwater table/ aquifer	lowered	□□□□✓□□	recharge	The groundwater table is estimated to increase as the ground cover promotes the infiltration and vertical movement of the intercepted rain on a gradual basis.
evaporation	increased	□□□□✓□□	decreased	As some tree species such as avocados consume large amounts of water for transpiration needs, the degree of evaporation reduction of the practices is counterbalanced by the integration of the high-consumers with low-consumer species. Overall, agroforestry has a positive impact on evaporation reduction.
soil moisture	decreased	□□□□□✓□	increased	
soil cover	reduced	□□□□□✓□	improved	
soil loss	increased	□□□□□✓□	decreased	
soil accumulation	decreased	□□□□□✓□	increased	
soil compaction	increased	□□□□✓□□	reduced	
nutrient cycling/ recharge	decreased	□□□□□✓□	increased	Nutrient cycling is highly improved because different tree species may penetrate the impervious soil layer and bring the nutrient to the surface via tree litter, fix atmospheric nitrogen, and add to the soil.
soil organic matter/ below ground C	decreased	□□□□□□✓	increased	Highly increase, though not measured for this particular farm.
acidity	increased	□□□□✓□□	reduced	The cause of soil acidity can be diverse including the soil parent materials. However, agroforestry has positive acidity-reducing factors by improving soil fertility and soil health.
vegetation cover	decreased	□□□□□✓□	increased	
biomass/ above ground C	decreased	□□□□□✓□	increased	
plant diversity	decreased	□□□□□□✓	increased	Highly increased because of the combination of trees/shrubs with food crops and fodder crops.
invasive alien species	increased	□□□□□□✓	reduced	
animal diversity	decreased	□□□□✓□□	increased	
beneficial species (predators, earthworms, pollinators)	decreased	□□□□□□✓	increased	
habitat diversity	decreased	□□□□□✓□	increased	
pest/ disease control	decreased	□□□□✓□□	increased	Agroforestry hosts the predators and prey and creates balanced food chains that reduce the degrees of pest development.
drought impacts	increased	□□□□□✓□	decreased	
emission of carbon and greenhouse gases	increased	□□□□□□✓	decreased	It is a climate-smart agriculture by its virtue that increase carbon sequestration as a regenerative agriculture.
wind velocity	increased	□□□□□✓□	decreased	
micro-climate	worsened	□□□□□✓□	improved	

Off-site impacts

Impact	Negative	Rating	Positive	Comment
water availability (groundwater, springs)	decreased	□□□□✓□□	increased	
reliable and stable stream flows in dry season (incl. low flows)	reduced	□□□□✓□□	increased	
downstream flooding (undesired)	increased	□□□□□✓□	reduced	
downstream siltation	increased	□□□□□✓□	decreased	
groundwater/ river pollution	increased	□□□□✓□□	reduced	Even if the impact of agroforestry plays a positive reduction role in pollution, the overall impact is compromised by the total farmland covered by a combination of tree crops.
buffering/ filtering capacity (by soil, vegetation, wetlands)	reduced	□□□□□✓□	improved	Agroforestry has a filtering capacity of polluted air with dust and adverse temperature such as during dry and hot days.
wind transported sediments	increased	□□□□□✓□	reduced	Intercepted by leaves of trees and shrubs.
damage on neighbours' fields	increased	□□□□□✓□	reduced	

damage on public/ private infrastructure	increased	☐ ☐ ☐ ☐ ✓ ☐ ☐	reduced	
impact of greenhouse gases	increased	☐ ☐ ☐ ☐ ☐ ☐ ✓	reduced	It highly contributes to carbon absorption and storage above and below the ground.

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

Climate-related extremes (disasters)

drought	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

About 30% of resident farmers have adopted the technology. The prevailing farming system necessitate change in the approach, and outshined farmers motivated the others to follow suit.

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

- ☑ Yes
- ☐ No

Raising coffee prices motivated farmers to refocus on the crop which years back discouraged to shift of the coffee farm to eucalyptus plantation.

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

- Increase production per unit of land and improve livelihoods of family farmers.
- Reduce land/soil degradation because of permanent soil cover.
- Ensure sustainable production, reduce risks and improve the biodiversity. Also, increase the family farmers income and their status in the society. It enables them to feel as valuable elite in the community.

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

- Agroforestry improves total production earned from a farmland and improve the wellbeing of the adopted farmers. Implies, it has substantial economic benefits.
- It reduces soil erosion and land degradation. Also has immense ecological benefits and improves the microclimate of the surrounding.
- It reduces risks of crop failure owing to climate variability. Also, boost the biodiversity of trees, crops, and habitat diversity that host various living creature in the biosphere as well pedosphere. This is related to carbon sequestration, emission reduction, proper ecosystem function, and overall ecological contribution.

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

- Demand intensive management, and there is shortage of labor. Identify and established trees and crops that requires minimum labor for planting, maintenance & propagation.
- Incompatible tree species to the essence of proper integration in Agroforestry. Select and adopt trees and crops with desirable characteristics to be integrated in the technology and responsive to management practices.
- Inconsistent product prices for the farm products such as coffee beans and avocado fruits on the local market. Link farmers to free and fair market which is consistent and sustainable.

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

- Failure to select tree species with desirable characteristics Trees/shrubs with the following desirable characteristics need to be considered:
  - Deep root system to draw water & nutrients.
  - Easy to propagate, & high biomass producers, palatable, provide more green manure, & high survival percentage.
  - Adaptable to close spacing like in hedgerows.
  - Good sprouting & positive response to pruning.
  - High coppicing and pollarding capacity.

- Highly dense in some areas and slightly sparse in some part of the farm. Try to maintain the spacing and distribution of suitable species composition.
- Trees and shrubs less used as livestock feed except during the shortage period Promote feeding the diverse fodder trees to the livestock to ensure their access and benefited from trees/shrubs as well than rely only on grass family.

REFERENCES

Compiler
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Date of documentation: Jan. 15, 2023

Last update: April 27, 2023

Resource persons
Afra Gabiba - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6621/

Linked SLM data
Approaches: Integrated Agroforestry System https://qcat.wocat.net/en/wocat/approaches/view/approaches_6622/

Documentation was faciliated by

Institution
- CIAT International Center for Tropical Agriculture (CIAT International Center for Tropical Agriculture) - Kenya

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

Key references

- World Agroforestry Centre. 2008. Annual Report 2007-2008: Agroforestry for food security and healthy ecosystems. Nairobi, Kenya: World Agroforestry Centre (ICRAF). ISSN 1995-6851: www.worldagroforestry.org
- Agroforestry System for Ecological Restoration: How to reconcile conservation and production options for Brazil's Cerrado and Caatinga Biomes. Miccolis, Peneiveirok Marques et al. 2016. ISBN: 978-85-63288-18-9: http://apps.worldagroforestry.org/downloads/Publications/PDFS/B19034.pdf
- Indigenous Agroforestry Practices and their Implications on Sustainable Land Use and Natural Resources Management: The Case of Wonago Woreda. Sustainable Land Use Forum (SURF), 2006. Research Report No 1, Addis Ababa: www. devinet.org/sluf

Links to relevant information which is available online
- The Center for Subtropical Agroforestry (CSTAF): http://www. cstaf.ifas.ufl.edu/
- World Agroforestry (ICRAF): https://www.worldagroforestry.org; https://www.cgiar.org/research/center/world-agroforestry-centre/

Relay intercropping of field peas within the maize crop. Field peas are planted when the main crop maize has nearly reached physiological maturity. (Abiyot Kebede)

Relay Intercropping (Ethiopia)

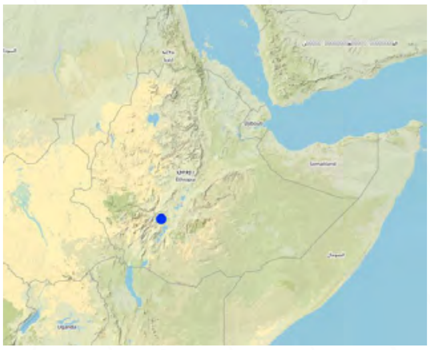
Kurcheta

DESCRIPTION

Intercropping is the growing of two or more crops on the same piece of land at the same time or in temporal sequence. Relay intercropping usually involves planting a legume into an established cereal crop. This farming practice has multiple benefits and is a popular among smallholders in Wolaita zone of SNNPR.

Intercropping systems in Sodo Zuria of Waraza-Lasho kebele are characterized by relay intercropping. Under relay intercropping a second crop is planted alongside a growing crop, typically when it has reached its reproductive stage of growth. The practice enables efficient use of available space. In this kebele (lower administrative unit), field peas and haricot beans are commonly intercropped within maize. The seeds of these legumes are either sown in no particular pattern, or simply broadcast, under the main crop, maize. They are planted when the maize comes close to physiological maturity. Intercropping of cereals with legumes improves soil fertility through nitrogen fixation: this system extracts fewer nutrients from the soil than do monocrops. The practice also avoid risks of crop failure, improves effective use of available land, generates additional income and ensures food and nutrition security of the family farmers. Making the right choices about crops and timing of relay planting is crucial. Furthermore, good intercropping demands improved varieties of cereals and legumes. Adequate and timely labour is required also. Conventionally, the farmers till the land up to five times before planting the main crop. In relay intercropping further more land cultivation is essential to plant the companion crop.
Various researchers have reported considerably higher yields from intercropping compared with a pure stand. This can be measured through the "land equivalent ratio" which describes the relative land area required under sole cropping to produce the same yield as under intercropping. Intercropping has been regarded by many farmers as a technique that reduces risk in crop production. It improves carbon sequestration since it enhances biomass accumulation both above and below the surface of the soil. Intercropping is also a form of climate change adaptation strategy as it spreads risks and allows opportunistic use of extra moisture. However, relay intercropping can subject the land to compaction because the companion crops demand extra field operations. These include harvesting the main crops, or sometimes stripping the leaves to reduce the shading effects for the low growing companion crops. There is also extra labour required for weeding and harvesting of the intercrop.

LOCATION



Location: Sodo Zuria, SNNPR, Ethiopia

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 37.71336, 6.92262

Spread of the Technology: evenly spread over an area (approx. 0.1-1 km2)

In a permanently protected area?: No

Date of implementation: more than 50 years ago (traditional)

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

Haricot beans intercropped under the main crop maize when the latter reached physiological maturity. (Abiyot Kebede)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

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

Land use

Land use mixed within the same land unit: Yes

Cropland

- Annual cropping: cereals - maize, legumes and pulses - beans

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

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

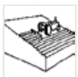
chemical soil deterioration - Cn: fertility decline and reduced organic matter content (not caused by erosion)

biological degradation - Bc: reduction of vegetation cover, Bl: loss of soil life

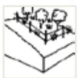
SLM group

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

SLM measures



agronomic measures - A2: Organic matter/ soil fertility, A5: Seed management, improved varieties, A6: Residue management (A 6.3: collected)



management measures - M5: Control/ change of species composition, M6: Waste management (recycling, re-use or reduce)

TECHNICAL DRAWING

Technical specifications

Soybean intercropped with wheat. Adopted from https://www.no-tillfarmer.com/articles/4084-lessons-learned-from-2014-modified-relay-intercropping.

Author: Ohio State University

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology area (size and area unit: **4 Timad**; conversion factor to one hectare: **1 ha = 4 Timad = 1ha**)
- Currency used for cost calculation: **Ethiopia Birr (ETB)**
- Exchange rate (to USD): 1 USD = 53.6283 Ethiopia Birr (ETB)
- Average wage cost of hired labour per day: 400

Most important factors affecting the costs

Usually, the cost is influenced by the economic crisis and high inflation rate experienced in the last few years in Ethiopia. It is also related to global fuel and fertilizer prices as well as other crises which are the potential causes.

Establishment activities

n.a.

Maintenance activities

1. Land preparation (Timing/ frequency: Before and during planting of companion crop.)
2. Planting (Timing/ frequency: During the long rain for associated crop.)
3. Weeding (Timing/ frequency: Three weeks after emergency of companion crops seedling onwards.)
4. Harvesting (Timing/ frequency: At the end of harvest season.)

Maintenance inputs and costs (per 4 Timad)

Specify input	Unit	Quantity	Costs per Unit (Ethiopia Birr (ETB))	Total costs per input (Ethiopia Birr (ETB))	% of costs borne by land users
Labour					
Land preparation	PDs	8.0	400.0	3200.0	100.0
Planting	PDs	4.0	400.0	1600.0	100.0
Weeding	PDs	8.0	100.0	800.0	100.0
Harvesting	PDs	8.0	100.0	800.0	100.0
Plant material					
Haricot beans/field peas seeds	kg	40.0	60.0	2400.0	100.0
Fertilizers and biocides					
NSP fertilizer	kg	50.0	45.0	2250.0	100.0
Total costs for maintenance of the Technology				**11'050.0**	
Total costs for maintenance of the Technology in USD				*206.05*	

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: 1452.0
Bimodal rainfall is intercepted in the area with a summer maximum from June to September.
Name of the meteorological station: Sodo Center Meteorology
High temperature is experienced from December to February.

Slope

- ☐ flat (0-2%)
- ☑ gentle (3-5%)
- ☐ moderate (6-10%)
- ☐ rolling (11-15%)
- ☐ hilly (16-30%)

Landforms

- ☑ plateau/plains
- ☐ ridges
- ☐ mountain slopes
- ☐ hill slopes
- ☐ footslopes

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.

Technology is applied in

- ☐ convex situations
- ☐ concave situations
- ☑ not relevant

- [ ] steep (31-60%)
- [ ] very steep (>60%)

- [ ] valley floors

- [ ] 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.

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
- [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: ground water

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

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

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

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

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

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

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

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

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

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

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

Gender
- [ ] women
- [x] men

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

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [x] 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
- [x] small-scale
- [ ] medium-scale
- [ ] large-scale

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

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

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

Note: in the table above the printed scale has three boxes: poor ☐ ☐ ☐ good; the ✓ marks the box: health, education, technical assistance, markets, energy, roads and transport, financial services — third box; employment — first box; drinking water and sanitation — second box.

Comments

There is a high unemployment rate. Of course, the area is highly populated. As the site is located closer to the zonal capital they have good financial services particularly access to Bank services such as for saving.

IMPACTS

Socio-economic impacts

Crop production

decreased ☐ ☐ ☐ ☐ ☐ ✓ ☐ increased

Increases as the technology best use the available space and surplus moisture in the soil system.

crop quality

decreased ☐ ☐ ☐ ☐ ✓ ☐ ☐ increased

Increases as the arrangement allows the relay crop to enjoy the space and available residual nutrients at disposal.

Impact		1	2	3	4	5	6	7		Comment
product diversity	decreased						✓		increased	Relay intercropping increases the number of crops harvested per unit of land in one season.
production area (new land under cultivation/ use)	decreased				✓				increased	
land management	hindered					✓			simplified	Combining cereal with legumes improves land management by increasing biomass production and combining cereal with nitrogen-fixing legumes that contribute to land management.
drinking water availability	decreased				✓				increased	
drinking water quality	decreased				✓				increased	
farm income	decreased					✓			increased	Combining two different types of crop on a farm diversify farm income.
diversity of income sources	decreased					✓			increased	
economic disparities	increased				✓				decreased	
workload	increased		✓						decreased	Workload increases as it demands additional labor for land preparation, planting, weeding, and harvesting two crops grown in temporal sequences.
Socio-cultural impacts										
food security/ self-sufficiency	reduced						✓		improved	Relay intercropping allows ensuring the food and nutrition security of family farmers.
health situation	worsened					✓			improved	
SLM/ land degradation knowledge	reduced						✓		improved	
Ecological impacts										
water quantity	decreased					✓			increased	
water quality	decreased					✓			increased	
soil moisture	decreased			✓					increased	Soil moisture can exhaustively be used by the companion crop.
soil cover	reduced					✓			improved	
soil loss	increased					✓			decreased	
soil compaction	increased		✓						reduced	Frequent farm operation for two different crops increases the pressure that leads to soil compaction.
nutrient cycling/ recharge	decreased						✓		increased	
vegetation cover	decreased					✓			increased	
biomass/ above ground C	decreased					✓			increased	
plant diversity	decreased					✓			increased	
drought impacts	increased				✓				decreased	
emission of carbon and greenhouse gases	increased						✓		decreased	Ground cover by two different crops on a temporal basis increases the absorption and storage of carbon.
micro-climate	worsened					✓			improved	
Off-site impacts										
water availability (groundwater, springs)	decreased				✓				increased	No actual data to forecast the potential off-site impacts.
reliable and stable stream flows in dry season (incl. low flows)	reduced				✓				increased	
impact of greenhouse gases	increased					✓			reduced	Land covered by crops for extended part of a season contributes to carbon sequestration and reduction of greenhouse gases.

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Benefits compared with maintenance costs

Returns		1	2	3	4	5	6	7	
Short-term returns	very negative						✓		very positive
Long-term returns	very negative							✓	very positive

Maintenance cost for intercropping limited largely to labor and agricultural inputs such as seed and fertilizers.

CLIMATE CHANGE

Gradual climate change

annual temperature increase	not well at all ☐ ☐ ✓ ☐ ☐ very well	
annual rainfall decrease	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

- Improve family farmers diet from the perspective of food and nutrition security.
- Generate income from the sale of companion legume crops.
- Improve soil fertility and management of the land

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

- Improve effective resource utilization such as land, labor, and inputs.
- Insure against total crop failure under unfavorable weather conditions, and pest outbreaks.
- Improve and maintain soil fertility as the combination is mostly cereal with legumes.
- Increase total biomass and crop production per unit of land.
- Pest levels are often lowered in intercrops, as the diversity of plants hampers the movement of certain pest insects and in some cases encourages beneficial insect populations.
- Reduce soil erosion, lower soil surface evaporation & reduce weed infestation.

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

- Demand more labor. Overlay planting season, and promote row intercropping to simplify the management practices.
- Relay intercropping triggers soil compaction, Promote row intercropping for effective utilization of space and reduction of soil compaction.
- Shortage of best fitting varieties of legume crops for relay intercropping. Facilitate and improve land users access to suitable companion crops from the nearby research institutes.

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

- It is time-consuming as it requires more attention and thus increases intensive management. Promote row intercropping and overlay planting season to avoid giving separate management practices.
- There is reduced efficiency in planting, weeding and harvesting which may add to the labor costs of these operations, especially if the practice is at a larger scale. Plant the main and companion crops simultaneously and apply optimum management practices.

REFERENCES

Compiler
GERBA LETA

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Date of documentation: Jan. 31, 2023

Last update: April 27, 2023

Resource persons
Goa Sankura - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6630/

Linked SLM data
Approaches: Farmers Research and Extension Group (FREG) https://qcat.wocat.net/en/wocat/approaches/view/approaches_6629/
Approaches: Integrated Soil Fertility Management (ISFM) https://qcat.wocat.net/en/wocat/approaches/view/approaches_6732/

Documentation was faciliated by

Institution
- CIAT International Center for Tropical Agriculture (CIAT International Center for Tropical Agriculture) - Kenya

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

Key references

- Guidelines for Intercropping. Mohler, C. L. and Stoner, K. A. 2009.: EBook for $24 (https://www.sare.org/publications/crop-rotation-on-organic-farms/guidelines-for-intercropping/)
- Raza, M.A. et al. 2019. Growth and development of soybean under changing light environments in relay intercropping system. DOI: 10.7717/Peerji.7262.: Free online from Research gate

Links to relevant information which is available online

- Intercropping: What it is, what it isn't and why we do it.: https://www.permaculturenews.or/2016/08/12
- Intercropping Agriculture System: https://fscluster.org/gaziantep
- Intercropping: Ergonomic and Efficient Farming: https://eos.com/blog/intercropping/

Maize stover retained on farmers field (GERBA LETA)

Crop Residue Management (Ethiopia)

Hafte Midhani

DESCRIPTION

Crop residue management involves leaving stover and other trash from cereal crops (including tef, wheat and maize), as well as haulms of legumes, in the field. Crop residues keep the soil covered, retain organic matter and moisture in the soil, and help to ensure better production.

Crop residue management involves leaving stover and other trash from cereal crops (including tef, wheat and maize), as well as haulms of legumes, in the field. Crop residue (CR) management is integral to soil health: it yields multiple benefits such as mitigating the risks of soil loss to water erosion, reducing the decomposition of organic matter and storing extra carbon. It also increases the fertility status of degraded soils and helps to improve soil structure and moisture properties. Degraded soils are at risk of tillage, water, and wind erosion. Soils degrade quickly when not covered and when no effort is made to increase organic matter levels or improve soil structure. Crop residue management plays an important role in arresting soil degradation and improving soil properties, and eventually increasing crop production. Therefore, it has positive economic and ecological functions. The aim of applying this technology is to improve soil fertility, reduce soil acidity and demands for synthetic fertilizers. Overall, crop residue management allows land users to sustainably use their land over a long period without losing its productive potential. In this part of Ethiopia, land users used to leave maize and millet stover in the fields but this is challenged by the prevalence of free (open access) grazing. Thus, controlling grazing is one prerequisite to ensuring adoption of the technology. Monocropping also reduces biomass production. Land users appreciate the extra grain yields from crop residue-rich farms. CR management also retains moisture and enables early tillage operations. In summary, the application of appropriate CR management provides multiple benefits. It mitigates the risks of erosion, reduces excessive mining of CR, reduces the rate of decomposition of organic matter, increases the fertility status of degraded soils, and increases crop production and sustainable productivity.

LOCATION

Location: Oromia, Ethiopia

No. of Technology sites analysed: 10-100 sites

Geo-reference of selected sites
- 36.33893, 8.50204

Spread of the Technology: evenly spread over an area (approx. 0.1-1 km2)

In a permanently protected area?: No

Date of implementation: 2015; less than 10 years ago (recently)

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

Tef straw harvested 30 cm high to retain crop residue on the farm. (GERBA LETA)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [x] improve production
- [x] reduce, prevent, restore land degradation
- [x] 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: No

Cropland

- Annual cropping: cereals - maize, cereals - millet, cereals - wheat (spring), cereals - Tef

Number of growing seasons per year: 1
Is intercropping practiced? No
Is crop rotation practiced? Yes

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

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

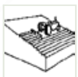
physical soil deterioration - Pc: compaction, Ps: subsidence of organic soils, settling of soil

biological degradation - Bc: reduction of vegetation cover, Bq: quantity/ biomass decline, Bs: quality and species composition/ diversity decline, Bl: loss of soil life

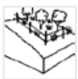
SLM group

- integrated crop-livestock management
- improved ground/ vegetation cover
- integrated soil fertility management

SLM measures



agronomic measures - A2: Organic matter/ soil fertility, A3: Soil surface treatment (A 3.3: Full tillage (< 30% soil cover)), A6: Residue management (A 6.4: retained), A7: Others



management measures - M2: Change of management/ intensity level

TECHNICAL DRAWING

Technical specifications

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

Most important factors affecting the costs

- Costs are calculated: per Technology area (size and area unit: **4 sanga**; conversion factor to one hectare: **1 ha = 1ha**)
- Currency used for cost calculation: **ETB**
- Exchange rate (to USD): 1 USD = 53.12 ETB
- Average wage cost of hired labour per day: n.a

Change of the cost is related to the inflation and economic instability.

Establishment activities
1. Mowing the crop by leaving some proportion on the ground. (Timing/ frequency: Harvesting)
2. Keep of livestock grazing (Timing/ frequency: Dry season)
3. Plow over the crop residue early on. (Timing/ frequency: Late in the dry season.)

Maintenance activities
1. Keep the farm with crop residue intact from livestock (Timing/ frequency: During off-season.)

Total maintenance costs (estimation)
2500.0

NATURAL ENVIRONMENT

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

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

Specifications on climate
Average annual rainfall in mm: 1947.0
The area received summer maximum rainfall.
Name of the meteorological station: Bedele
The uniform distribution of rainfall is helpful to incorporate the residue in time.

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

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

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- [ ] 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: 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
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- [ ] very rich

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- [x] animal traction
- [ ] mechanized/ motorized

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

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

Gender
- [ ] women
- [x] men

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

Area used per household

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- [x] 0.5-1 ha
- [ ] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
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- [ ] medium-scale
- [ ] large-scale

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- [ ] company
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- [ ] group
- [ ] individual, not titled
- [x] individual, titled

Land use rights

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

Water use rights

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

Access to services and infrastructure

		1	2	3	
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

Land users are benefited from various financial institutions to access credit and other services. Various credit institutions and revolving funds were mentioned my the land users.

IMPACTS

Socio-economic impacts

		1	2	3	4	5	6	7		
Crop production	decreased					✓			increased	
crop quality	decreased					✓			increased	
fodder production	decreased				✓				increased	The purpose is to use less of crop residue for soil amendment than as fodder.
fodder quality	decreased				✓				increased	The purpose is to reduces
animal production	decreased				✓				increased	
risk of production failure	increased					✓			decreased	As it improves soil structure, moisture retention capacity, etc., the practice reduces risks of crop failure.
product diversity	decreased				✓				increased	
production area (new land under cultivation/ use)	decreased				✓				increased	
land management	hindered					✓			simplified	
drinking water availability	decreased				✓				increased	
drinking water quality	decreased				✓				increased	
expenses on agricultural inputs	increased					✓			decreased	
farm income	decreased					✓			increased	
diversity of income sources	decreased				✓				increased	

Socio-cultural impacts

		1	2	3	4	5	6	7		
food security/ self-sufficiency	reduced					✓			improved	
health situation	worsened					✓			improved	The health condition is convergent with considerable harvest and food security.
SLM/ land degradation knowledge	reduced							✓	improved	

Ecological impacts

		1	2	3	4	5	6	7		
water quantity	decreased					✓			increased	
water quality	decreased					✓			increased	
surface runoff	increased					✓			decreased	
excess water drainage	reduced						✓		improved	
groundwater table/ aquifer	lowered				✓				recharge	The health condition is convergent with considerable harvest and food security.
evaporation	increased						✓		decreased	The ground cover by crop residues inevitably contributes to the reduction of evaporation.
soil moisture	decreased						✓		increased	
soil cover	reduced						✓		improved	
soil loss	increased					✓			decreased	
soil accumulation	decreased					✓			increased	
soil crusting/ sealing	increased					✓			reduced	
soil compaction	increased					✓			reduced	

nutrient cycling/ recharge	decreased	increased	Improves on a gradual basis.
soil organic matter/ below ground C	decreased	increased	
acidity	increased	reduced	
vegetation cover	decreased	increased	
biomass/ above ground C	decreased	increased	
beneficial species (predators, earthworms, pollinators)	decreased	increased	
habitat diversity	decreased	increased	
pest/ disease control	decreased	increased	Crop residue may host some insects but obstruct the movement of others.
drought impacts	increased	decreased	Increasing the moisture retention capacity of the soil improves crops' resilience to droughts and other adversity.
emission of carbon and greenhouse gases	increased	decreased	Accumulation of crop residue increases carbon storage via the reduction of emissions.

Off-site impacts

water availability (groundwater, springs)	decreased	increased	No facts are available to support the allegation. Besides, it needs long-term observation and documentation.
reliable and stable stream flows in dry season (incl. low flows)	reduced	increased	
downstream flooding (undesired)	increased	reduced	
downstream siltation	increased	decreased	
impact of greenhouse gases	increased	reduced	Impact of greenhouse gases reduced with accumulation of crop residues.

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Benefits compared with maintenance costs

Short-term returns	very negative	very positive
Long-term returns	very negative	very positive

Actually, the technology demands only labor costs for the protection of the farmland from grazing the leftover and to avoid illegal burning of crop residues.

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
annual rainfall decrease	not well at all	very well	

Climate-related extremes (disasters)

epidemic diseases	not well at all	very well	Answer: not known
insect/ worm infestation	not well at all	very well	

Other climate-related consequences

extended growing period	not well at all	very well
reduced growing period	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%
- [ ] 11-50%
- [ ] 51-90%
- [x] 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

- It improves soil fertility on gradual basis.
- It assists to reduce soil acidity.
- Increases production and productivity.

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

- Absorbs and retain soil moisture for the crop to rely on for growth and grain filling as a coping mechanism to the unpredictable distribution of rainfall.
- It reduces soil temperature and smother the weeds.
- Sequesters carbon, a beneficial for climate change/variability.

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

- Create tillage inconvenience as mechanization is less common among smallholders. Using the excessive residue as trash line support the purpose of soil and water conservation.
- Free grazing system and multiple uses of crop residue challenges retention of crop residue. Institutionalizing controlled grazing system is of paramount important.

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

- Less fodder available for the livestock and other multiple uses of crop residues. Limit the amount of crop residue to be retained on the farm to 15 to 30 percent of the total non-grain biomass produced in the farm.

REFERENCES

Compiler
GERBA LETA

Editors
Noel Templer
Julia Doldt
Kidist Yilma

Reviewer
William Critchley
Rima Mekdaschi Studer

Date of documentation: Feb. 6, 2023

Last update: April 27, 2023

Resource persons
Habtamu Woyessa - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6644/

Linked SLM data
Approaches: Farmers Research and Extension Group (FREG) https://qcat.wocat.net/en/wocat/approaches/view/approaches_6629/
Approaches: Integrated Soil Fertility Management (ISFM) https://qcat.wocat.net/en/wocat/approaches/view/approaches_6732/

Documentation was faciliated by

Institution

- CIAT International Center for Tropical Agriculture (CIAT International Center for Tropical Agriculture) - Kenya

Project

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

Key references

- Renard, C. 1997. Crop Residues in Sustainable Mixed Crop/Livestock Farming Systems. CAB International, Walingford. ISBN 0 851991777: https://core.ac.uk › download ›
- IIRR and ACT. 2005. Conservation Agriculture. A manual for farmers and extension workers in Africa. International Institute of Rural Agriculture, Nairobi; African Conservation Tillage Network, Harare.: http://www.act-africa.org ›

Links to relevant information which is available online

- Best management practices: residue management: http://omaf.gov.on.ca/english/environment/bmp/AF179.pdf

Desmodium as a cover crop in maize field in Kuto Sorfela Kebele of Sodo Zuria district (Abiyot Kebede)

Cover crops (Ethiopia)

Yeshifan Sebil (in Amharic)

DESCRIPTION

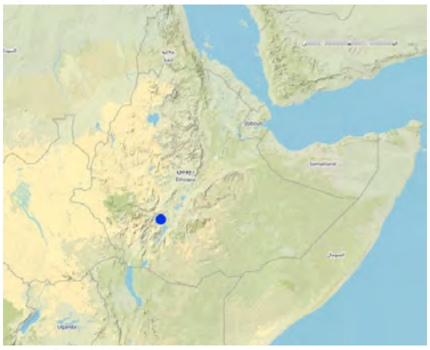
Cover crops are crops grown on bare, fallow farmland or under a main crop to cover and conserve the soil by protecting it from exposure to the sun, wind, and direct impact of rain. It fixes nitrogen (if a legume), improves soil fertility, supplies livestock fodder, and helps manage both pests and weeds.

Cover crops are planted to conserve the soil on bare, fallow farmland or under a main crop. They can be grown on their own or between rows of annual and perennial crops such as maize, coffee, and fruits. The main purposes of growing cover crops are to cover the soil with low-growing vegetation, protect the soil from exposure to sun and rain, suppress weeds, improve soil fertility, supply livestock feed, and manage insect pests. Cover crops may be nitrogen fixing (if legumes), and they make productive use of spaces between crop rows, as well as controlling wind and water erosion. They also have the potential to restore soil fertility and help in climate change adaptation, as well as sequestration of atmospheric carbon above and below soil surface. Furthermore, cover crops can be fed to livestock, helping to bridge periods of shortage of feed when grazing lands are not available – which is an increasing problem because of growing population pressure and expansion of croplands. Land users give huge credit for its role as a pesticide by deterring armyworm and stalk borer when used as a border, and stopping their advance into the maize crop.

Desmodium is an example of a leguminous cover crop, improving soil fertility via fixing atmospheric nitrogen, increasing infiltration and productive use of soil moisture, and catering for livestock via a "cut-and-carry" fodder system. Desmodium is planted between rows of maize crops as well as between grass hedgerows around the farm. For its establishment, access to desmodium seed is essential. Once established, it remains to serve as a permanent source of planting material. Nevertheless, there are some disadvantages of desmodium: seed collection is difficult, it may trap honey bees and it can compete with the crop for light and space if allowed to grow too tall. Thus, efficient management of desmodium is essential.

Nevertheless, as part of an agro-ecological intervention, cover crops like desmodium deliver multiple benefits to resource-poor farmers and can be viewed as an investment in improving soil fertility as well as soil health. Overall, cover crops improve productivity, and help ensure yield stability and contribute to a healthier ecosystem.

LOCATION



Location: Kuto Sorfela kebele, Sodo Zuria, SNNPR, Ethiopia

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 37.69179, 6.90513

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
- [x] through projects/ external interventions

Desmodium (cover crop) grown between hedgerows of grass at the periphery of maize plot to serve as push-and-pull technology against insect pests. (GERBA LETA)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [x] improve production
- [x] reduce, prevent, restore land degradation
- [x] 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
- [x] create beneficial social impact

Land use

Land use mixed within the same land unit: Yes

Cropland

- Annual cropping: cereals - maize, Desmodium. Cropping system: Maize/sorghum/millet intercropped with legume

Number of growing seasons per year: 2

Is intercropping practiced? Yes

Is crop rotation practiced? Yes

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

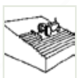
chemical soil deterioration - Cn: fertility decline and reduced organic matter content (not caused by erosion)

physical soil deterioration - Pc: compaction

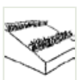
SLM group

- integrated crop-livestock management
- integrated soil fertility management
- integrated pest and disease management (incl. organic agriculture)

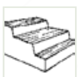
SLM measures



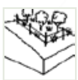
agronomic measures - A2: Organic matter/ soil fertility



vegetative measures - V2: Grasses and perennial herbaceous plants



structural measures - S4: Level ditches, pits

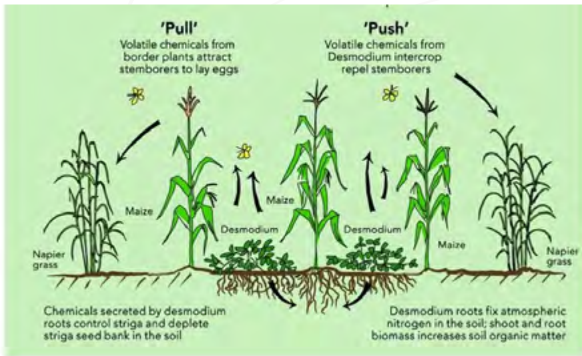


management measures - M2: Change of management/ intensity level

TECHNICAL DRAWING

Technical specifications

Desmodium and the grass (Brachiaria species) serving as push-pull technology to the pest. Adopted from https://www.linkedin.com/pulse/desmodium-legume-cover-crop-solution-food-insecurity-africa-ndiritu/. In this particular case, Brachiaria play the "pull" function on the periphery of the maize farm.



Author: Africa Sustainable Agriculture Biweekly Newsletter, ICIPE Push Pull Project

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology area (size and area unit: **Timad = 0.25 ha**; conversion factor to one hectare: **1 ha = 1 ha = 4 Timad**)
- Currency used for cost calculation: **ETB**
- Exchange rate (to USD): 1 USD = 53.6283 ETB
- Average wage cost of hired labour per day: 250

Most important factors affecting the costs

The prevailing economic crisis and rising of inflation in the country contributes to inputs and other services price uncertainty.

Establishment activities

n.a.

Maintenance activities

1. Land preparation and planting (Timing/ frequency: Before and at planting)
2. Cutting desmodium to use as feed for cattle (Timing/ frequency: During the growing season)
3. Harvesting desmodium biomass and /or seed (Timing/ frequency: At harvest maturity)
4. Access to planting materials, if newly started (Timing/ frequency: Anytime in the offseason)

Maintenance inputs and costs (per Timad = 0.25 ha)

Specify input	Unit	Quantity	Costs per Unit (ETB)	Total costs per input (ETB)	% of costs borne by land users
Labour					
Land preparation	PDs	4.0	500.0	2000.0	100.0
Cutting for use as feed	PDs	8.0	250.0	2000.0	100.0
Harvesting total biomass and /or seed	PDs	5.0	250.0	1250.0	100.0
Plant material					
Desmodium seed	kg	3.0	120.0	360.0	
Total costs for maintenance of the Technology				**5'610.0**	
Total costs for maintenance of the Technology in USD				*104.61*	

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

Rainfall distribution is uniform except in El Nino cases or recurrent drought experienced in the country and the region.

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)

Soil texture (topsoil)

- ☐ coarse/ light (sandy)

Soil texture (> 20 cm below surface)

Topsoil organic matter content

- ☐ high (>3%)

- ☐ shallow (21-50 cm)
- ☑ moderately deep (51-80 cm)
- ☐ deep (81-120 cm)
- ☐ very deep (> 120 cm)

- ☐ medium (loamy, silty)
- ☑ fine/ heavy (clay)

- ☐ coarse/ light (sandy)
- ☐ medium (loamy, silty)
- ☑ fine/ heavy (clay)

- ☑ 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
- ☐ 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 land user accessed electricity in rural areas. She also used biogas for energy production.

IMPACTS

Socio-economic impacts

Crop production

crop production	decreased	☐	☐	☐	☐	☑	☐	☐	increased	Increase with proper management of the companion crops on a gradual basis.
crop quality	decreased	☐	☐	☐	☐	☑	☐	☐	increased	Simultaneously increase with good harvest per unit of land as the integration allows to combat against pests.
fodder production	decreased	☐	☐	☐	☐	☐	☑	☐	increased	Desmodium gives high biomass production. So it supplies more fodder if timely trimmed and supplied to the livestock.
fodder quality	decreased	☐	☐	☐	☐	☑	☐	☐	increased	Believed to increase with the application of appropriate management practices.
animal production	decreased	☐	☐	☐	☐	☑	☐	☐	increased	

Impact		1	2	3	4	5	6	7		Comment
land management	hindered						✓		simplified	Desmodium fixes atmospheric nitrogen that improves the fertility of the soil in addition to the production of large biomass that supplies organic matter to the soil.
drinking water availability	decreased				✓				increased	
expenses on agricultural inputs	increased					✓			decreased	Slightly decrease as desmodium fix atmospheric nitrogen in the long run and partly complements urea fertilizer.
farm income	decreased					✓			increased	
workload	increased		✓						decreased	It demands follow-up and frequently monitors and manages the growth of desmodium to reduce its competition with the main crops.

Socio-cultural impacts

Impact		1	2	3	4	5	6	7		Comment
food security/ self-sufficiency	reduced					✓			improved	
SLM/ land degradation knowledge	reduced						✓		improved	As it creates evidence-based learning, it improves land user's SLM knowledge.

Ecological impacts

Impact		1	2	3	4	5	6	7		Comment
water quantity	decreased					✓			increased	
surface runoff	increased						✓		decreased	High biomass production and the ground covering traits of desmodium assist to slow down surface runoff and promote infiltration deep into the soil.
soil moisture	decreased					✓			increased	
soil cover	reduced						✓		improved	
soil loss	increased						✓		decreased	
soil crusting/ sealing	increased					✓			reduced	
nutrient cycling/ recharge	decreased						✓		increased	As the companion crop fixes atmospheric nitrogen, it improves nutrient cycling.
vegetation cover	decreased					✓			increased	
biomass/ above ground C	decreased						✓		increased	
pest/ disease control	decreased							✓	increased	Land users suggested the pesticidal role of desmodium as compared to the hidden contribution to the improvement of soil fertility through its natural traits of fixing atmospheric nitrogen.
flood impacts	increased					✓			decreased	
emission of carbon and greenhouse gases	increased						✓		decreased	It increases biomass production that absorbs carbon above and below the surface of the soil.

Off-site impacts

Impact		1	2	3	4	5	6	7		Comment
water availability (groundwater, springs)	decreased					✓			increased	Contributes to groundwater recharge by reducing surface runoff.
reliable and stable stream flows in dry season (incl. low flows)	reduced				✓				increased	Facts are not available to complement this allegation since the implementation is on smaller areas of farmland.
downstream flooding (undesired)	increased					✓			reduced	It breaks the speed of flood that overflow and damage neighboring areas.

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

		1	2	3	4	5	6	7	
Short-term returns	very negative						✓		very positive
Long-term returns	very negative							✓	very positive

Benefits compared with maintenance costs

		1	2	3	4	5	6	7	
Short-term returns	very negative						✓		very positive
Long-term returns	very negative							✓	very positive

The benefit from desmodium can be made in the short term. Its high biomass production to enrich grass fodder and suppression of weeds and pests are promptly seen as compared to some other SLM technologies.

CLIMATE CHANGE

Gradual climate change

seasonal temperature increase — not well at all / very well — Season: dry season Answer: not known

Climate-related extremes (disasters)

heatwave — not well at all / very well — Answer: not known

Other climate-related consequences

extended growing period — not well at all / very well (✓ very well)

reduced growing period — not well at all / very well (✓ second box)

ADOPTION AND ADAPTATION

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

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

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

- [x] 0-10%
- [ ] 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

- The technology improves soil fertility.
- It manages insect pests and stops their advance and negative consequence they might causes on the main crops.
- Supply protein-rich feed to the animals.

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

- Cover crops provide multiple benefits to the family farmers such as the best uses of land between the rows of maize crops.
- It smothers weeds and improves soil fertility and crop productivity which have a positive contribution to the livelihoods of family farmers.
- Cover crops and the practice itself have a beneficial role in agroecology intervention and improvement of the ecosystem functioning.

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

- Fast growing and overwhelming the main crops (competition for space). Applying intensive management such as cutting and feeding to the animals.
- Feeding the animals with fresh harvest is not friendly to the livestock. As it is a protein-rich fodder crop the harvest must be slightly dry and mixed with grass fodder that reduces the adverse effects of either bloating or diarrhea.

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

- Difficulty to manage and harvesting desmodium seeds. 1. Intensify the management of desmodium and reduce harvesting inconvenience on main crop.
  2. Replace desmodium with other farmer's friendly legume species such as Dolichos lablab...as cover crops.
- Hooky nature of the seed that sticks to the clothes. -Wear nylon wears/clothes that reduces the effects of hooky seeds.
  - Produce seeds on separate plots.
- Quick growth and climbing traits that dominate the main crops. - Apply intensive management and use the above-ground parts as fodder for the livestock by adopting cut-and-carry feeding system. Also, needs to keep the green parts under frequent management practices.

REFERENCES

Compiler
GERBA LETA

Editors
Julia Doldt
Kidist Yilma
Noel Templer

Reviewer
William Critchley
Rima Mekdaschi Studer

Date of documentation: Jan. 26, 2023

Last update: April 27, 2023

Resource persons
Fanaye Falaha - land user

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6628/

Linked SLM data
Approaches: Farmers Research and Extension Group (FREG) https://qcat.wocat.net/en/wocat/approaches/view/approaches_6629/
Approaches: Integrated Soil Fertility Management (ISFM) https://qcat.wocat.net/en/wocat/approaches/view/approaches_6732/

Documentation was faciliated by

Institution
- CIAT International Center for Tropical Agriculture (CIAT International Center for Tropical Agriculture) - Kenya

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

Key references

- Cover Crops for Sustainable Crop Rotations. Clark, Andy. 2015: https://www.sare.org/resources/cover-crops/

Links to relevant information which is available online
- Greenleaf desmodium. A Fact sheet index describing about the cover crop: https://keys.lucidcentral.org/keys/v3/pastures/Html/Greenleaf_desmodium.htm

Farmers group meeting on joint planning exercise for the implementation of ISFM+/Agro ecology projects. (Abiyot Kebede)

Farmers Research and Extension Group (FREG) (Ethiopia)

FREG

DESCRIPTION

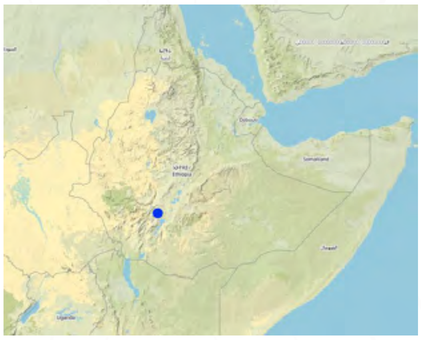
A Farmers Research and Extension Group (FREG) engages about 50 or more farmers in a kebele (lower administrative unit), with three sub groups of 17-20 each who live in a homogenous landscape. It is a local institution established for joint learning, piloting, and evaluating soil improvement technologies across the intervention regions.

Farmers Research and Extension Groups (FREGs) are the approach used to test and spread Integrated Soil and Fertility Management (ISFM+)/Agroecology project best practices in Ethiopia. These technologies include livestock urine collection and use, cover crops, intercropping, vermicompost, acid soil treatment by liming, green manures, crop residue management, and bioslurry. A FREG employs a participatory approach, whereby joint investigation and learning is implemented. Farmers' group members use participatory planning and peer learning from one another. The approach is gender inclusive: one-third of the members in a FREG are women. There is also a mix of social categories. FREGs are populated by proactive model farmers who adopt and demonstrate technologies for scaling up. After the first year, the best-performing model farmer serves as an ambassador for knowledge and skills transfer to the indirect beneficiaries.

Collective investigation, learning, adoption, and then promotion of proven technologies are the key features of the approach. Member of the FREG jointly identify soil fertility/acidity-related issues, participate in training and demonstrate the technologies. The ISFM+/ Agroecology projects equip the target groups with implementation skills and knowledge. Site and participant selection are made with participation of woreda and kebele representative partners and the target farmers. Then soil-related issues are jointly identified with the support of laboratory analysis by the Regional Research Institute. This demonstrates that the intervention is implemented by the public research and development actors with technical, financial and/or inputs supply from the projects. The approach tends to mobilize the communities living in similar agroecology and farming systems who are subjected to the same SLM-related issues.

Identifying proactive model farmers and establishing demonstration plots for different technologies and crop types are the basis of collective learning. The demonstration is employed as an experimental and learning plot by showcasing and inspiring farmer groups and indirect beneficiaries in the area. Organizing field days and exchange visits further enables the demonstration of technologies for scaling out. Experience shows that where ISFM+ technologies have been piloted, farmers have built up new agroecology technologies such as cover cropping, intercropping and woodlots development over and above those previously adopted. Target farmers have piloted at least three or more technologies/practices on their plots. The woreda office of agriculture through the assigned project focal person gives closer follow-up for the proper implementation of the technologies. Provision of technical support and advisory service via the development agents (DAs) are among many other services.

LOCATION



Location: Sodo Zuria district, Kuto-Sarfela kebele, Southern Nations, Nationalities and People Region (SNNPR), Ethiopia

Geo-reference of selected sites
- 37.69077, 6.90482

Initiation date: 2022

Year of termination: n.a.

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

Refreshment moment during the expert interviews with SLM experts and regional advisor on the implementation approach of the cover crops. (Gerba Leta)

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims / objectives of the approach

To promote participatory implementation and peer-to-peer learning by increasing its scope from plot based to landscape scale. The approach capacitates the farmers' group and stimulates the scaling of the approach at a larger scale.

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

- **Social/ cultural/ religious norms and values**: Increasing soil degradation, growing infrequent moisture stress, and farmers' willingness to manage their land can be considered enabling factors.
- **Institutional setting**: The establishment of FREG at local level promotes the implementation of the technology. The involvement of public research and development actors support to implement evidence based and problem solving practices.
- **Collaboration/ coordination of actors**: Woreda focal person, development agents, and farmers' group are supporting participatory planning, implementation, and evaluation. The involvement of different actors promotes collaboration and collective action.
- **Legal framework (land tenure, land and water use rights)**: The availability of a legal framework builds farmers' confidence to invest in their land.
- **Policies**: Support the SLM initiative via the green legacy.
- **Knowledge about SLM, access to technical support**: It facilitates effective implementation of technologies/approaches.

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

- **Social/ cultural/ religious norms and values**: Giving priority to food crops due to shortage of farmland, climbing traits of the companion/cover crop that may cause harvesting inconvenience if not managed very well.
- **Workload, availability of manpower**: Shortage of labor and costs are hindering appropriate implementation.

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

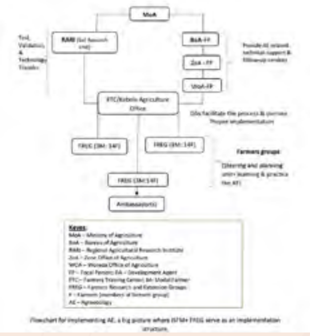
What stakeholders / implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	Members of farmers group	Participate in participatory planning, implementation, and evaluation of the intervention.
SLM specialists/ agricultural advisers	Woreda Natural Resource Management experts or project focal person and development agents.	Facilitate farmers' group meetings during participatory planning, implementation, and participatory evaluation of the activities. Also, provide technical support to the implementers at the various stages of project implementation.
local government	Kebele administration	Assist in technology scaling up/out via mobilizing the community to learn and adopt from the pilot activities.
national government (planners, decision-makers)	Ministry of Agriculture	Establish an agreement with the project and support it in steering the institutionalization of proven technologies for scaling out via policy support.
international organization	GIZ	Provide financial, technical and material support to the partner organizations and the end users of the project intervention via the public line offices.

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

Phase	none	passive	external support	interactive	self-mobilization	
initiation/ motivation			✓			Farmers' group involved in participatory planning, experience exchange visit, and evaluation of the activities. Agricultural experts, development agents, and project staff oversee the implementation of activities and provide technical support/advisory services.
planning			✓			Target farmers and development agents involved in problem identification/assessment and planning.
implementation			✓			Farmers who are members of the FREG are involved in implementing the technology with technical support from the woreda focal person and the DAs.
monitoring/ evaluation			✓			

Flow chart

Agroecology/ISFM+ implementation flow chart that ran from the Ministry of Agriculture to the local level institution, the FREG. The role of stakeholders at different levels are briefly described in the flow chart.



Author: Gerba Leta

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

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

Subjects covered

The concepts of agroecology, integrated soil fertility management and overall benefits of cover cropping and related crops such as Desmodium.

Advisory service

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

The advisory service is face-to-face on demonstration plots at various crop stages including for split application of Urea fertilizer, disease/pest management time, harvesting, and post-harvesting.

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.
FREG has three model farmers leading the group. They mobilize their followers, demonstrate technologies, and steer collective action. Farmers' groups along with agricultural experts and project staff support the selection of technologies and replacement of the existing ones if the need emerges.

Type of support

- ☐ financial
- ☐ capacity building/ training
- ☐ equipment
- ☑ Facilitation/mobilization

Further details

Monitoring and evaluation

Participatory monitoring and evaluation are part of the FREG approach. Essentially, beginning and end-season evaluation is the approach employed in the implementation of new technologies.

Research

Research treated the following topics

- ☐ sociology
- ☐ economics / marketing
- ☐ ecology
- ☑ technology

Research is part of the introduced technologies. Problem identification is the entryway to introducing a new technology/practice. Regional Agricultural Research Institute involves in the assessment and identification of problems, evaluation, and issuance of appropriate recommendations that make the intervention evidence-based.

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.

The budget is generally allocated to support woreda's operational cost and to supply necessary inputs for the implementation of ISFM+ and the Agroecology projects.

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

For best-performing farmers, incentives such as solar panels, energy-saving cooking stoves, wheelbarrows, etc., are offered to further motivate the farmers and enable them to properly implement the technology and become a very good advocator for scaling the beneficial practices.

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? Land users are decision makers on selection of technologies.				✓
Did the Approach enable evidence-based decision-making? Through piloting and learning from the technologies.				✓
Did the Approach help land users to implement and maintain SLM Technologies?				✓
Did the Approach improve coordination and cost-effective implementation of SLM?			✓	
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?			✓	
Did the Approach improve knowledge and capacities of other stakeholders?			✓	
Did the Approach build/ strengthen institutions, collaboration between stakeholders?			✓	
Did the Approach mitigate conflicts?	✓			
Did the Approach empower socially and economically disadvantaged groups?			✓	
Did the Approach improve gender equality and empower women and girls?			✓	
Did the Approach encourage young people/ the next generation of land users to engage in SLM?			✓	
Did the Approach improve issues of land tenure/ user rights that hindered implementation of SLM Technologies?	✓			
Did the Approach lead to improved food security/ improved nutrition?				✓

Did the Approach improve access to markets?	☐ ☐ ☑ ☐
Did the Approach lead to improved access to water and sanitation?	☑ ☐ ☐ ☐
Did the Approach lead to more sustainable use/ sources of energy?	☑ ☐ ☐ ☐
Did the Approach improve the capacity of the land users to adapt to climate changes/ extremes and mitigate climate related disasters?	☐ ☐ ☑ ☐
Did the Approach lead to employment, income opportunities?	☐ ☐ ☑ ☐

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 positive outcome of applying the FREG is considered as a payoff for participating farmers as it gave them the energy to sustain the adopted practices. The outputs of integrating technologies, collective learning, and action allow to see significant yield increment per unit of land, improved soil fertility and soil health, etc.

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Increases farmers understanding of SLM and enables to improve soil fertility and soil health.
- Allows direct and indirect beneficiaries to adopt beneficial agricultural practices.
- Promote peer learning to apply technologies that nurture soil fertility and increase crop production and productivity, supply feed to the livestock, manage pests...

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

- Ensure stakeholders' participation and allows the development of a sense of ownership of the technology.
- Promote knowledge sharing for scaling out of the technologies.

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

- The farmers' group meeting is not so strong and there are absentees or dropouts because of the overlaps with other regular and casual meetings, and private chores. Strengthening appropriate participation in planning, implementation, collective learning and action process.

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

- Lower level of farmers' commitment and non-zealous to bring change with positive impacts. Need regular follow-up and continuous awareness creation exercises.
- Take the project intervention for granted Mainstreaming further land-related issues and the necessity of adopting ISFM and agroecology practices to ensure the sustainability of the management intervention.

REFERENCES

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Date of documentation: Jan. 29, 2023

Last update: April 27, 2023

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Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/approaches/view/approaches_6629/

Linked SLM data
Technologies: Cover crops https://qcat.wocat.net/en/wocat/technologies/view/technologies_6628/
Technologies: Relay Intercropping https://qcat.wocat.net/en/wocat/technologies/view/technologies_6630/
Technologies: Green Manures https://qcat.wocat.net/en/wocat/technologies/view/technologies_6645/
Technologies: Crop Residue Management https://qcat.wocat.net/en/wocat/technologies/view/technologies_6644/
Technologies: Treating acid soils with lime https://qcat.wocat.net/en/wocat/technologies/view/technologies_6641/
Technologies: Livestock Urine Collection and Use https://qcat.wocat.net/en/wocat/technologies/view/technologies_6623/
Technologies: Bioslurry https://qcat.wocat.net/en/wocat/technologies/view/technologies_6646/
Technologies: Vermicomposting https://qcat.wocat.net/en/wocat/technologies/view/technologies_6643/

Documentation was faciliated by

Institution
- CIAT International Center for Tropical Agriculture (CIAT International Center for Tropical Agriculture) - Kenya

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

Key references

- Agricultural extension approach: evidence from an Integrated Soil Fertility Management project in Ethiopia. Leta, G., Schulz, S., Alemu, G. 2020. DOI: 10.15302/J-FASE-2020331: https://www.researchgate.net (Free online)
- Evaluation of Farmer Research Extension Group as Extension Approach: The experience of Sida-Amhara Rural Development Program in Kalu District of Amhara Region, Ethiopia. Abebe, E. 2008.: https://depot.wur.nl/1129

Links to relevant information which is available online
- Farmer research and extension: https://www.researchgate.net/publication/5055710_Farmer_research_and_extension
- Basics of cover cropping: https://organicgrowersschool.org/gardeners/library/basics-of-cover-cropping/

References

Diao, X., K. Pauw, J. Thurlow, and M. Ellis. "Ethiopia's Agrifood System Structure and Drivers of Transformation," July 7, 2023. https://cgspace.cgiar.org/handle/10568/131500.

ICRISAT. "Feeding Degraded Soils in Ethiopia to Feed the People and the Environment." Report. International Crops Research Institute for the Semi-Arid Tropics, February 15, 2018. https://cgspace.cgiar.org/handle/10568/91676.

ILRI. "Africa Research in Sustainable Intensification for the Next Generation Ethiopian Highlands Project, Technical Report, 1 April –30 September 2020." Report. International Livestock Research Institute, October 20, 2020. https://cgspace.cgiar.org/handle/10568/110309.

WOCAT. "Glossary." Wocat. https://www.wocat.net/en/glossary/.

———. "SLM." Wocat. Accessed October 18, 2023. https://www.wocat.net/en/slm/.

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