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MINISTRY OF AGRICULTURE

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ETH-SOIL

3rd Soil Symposium

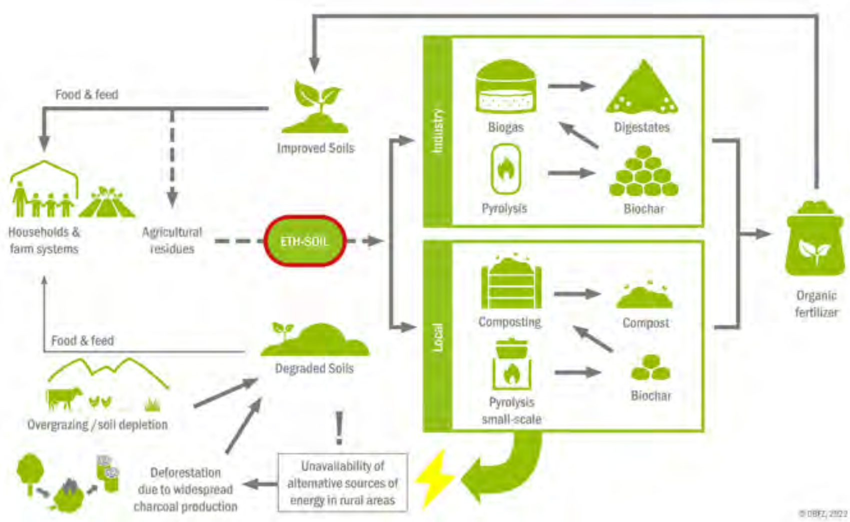
Conference reader

3rd Soil Symposium: Healthy Soils for our Prosperity
6 - 7 March 2025 in Adama, Ethiopia

Implemented by:
DBFZ

ETH-SOIL – BIO-POWER FOR HEALTHY SOILS

The aim of the project is to improve food security in three pilot regions of the Oromia region/Ethiopia through the application of organic fertilisers from pyrolysis and biogas plants as well as composting. The project aims at restoring degraded soils and the resulting problematic food security. The target group is small and micro farmers with low incomes in rural regions, who are often threatened by food shortages.
It contributes to the national implementation of the 2030 Agenda. The project will run from 2021 to 2026.



ETH-Soil addresses solutions to the following challenges within the 2030 Agenda

Combating hunger through untapped agricultural and social potential.

Sustainable management of natural resources.

Education and training for economic, social and technical progress.

PROJECT GOALS

New pyrolysis plants operate profitable with agricultural residues.

Biogas plant provides heat energy and digestate.

Soil amendment with biochar / digestate-based biofertilizers.

Development and introduction of pyrolysis cookstoves for low-emission cooking.

Capacity building on practical, administrative and academic levels.

3rd Soil Symosium 2025

Contents

Ministry of Agriculture Natural Resource Development Sector
Soil Resource Development Lead Executive
Schedule for Soil Symposium 2025, 6th to 7th of March 2025
Adama, Ethiopia

Date and time	Topic	Speaker/presenter	Organization
6/3/2025	**Day one**		
8:30 am - 8:50 am	Participant registration	Participants	Invited Participants
8:50 am - 9:00 am	Welcome address	Mr. Lire Abiyo, SRDLE	Soil Resource Devt LE
9:00 am - 9:10 am	Opening Speech	H.E Prof Eyasu Elias, state Minister for NRD sector	Ministry of Agriculture of Ethiopia
9:10 am - 9:30 am	The Challenge and Opportunities of Soil Health and Fertility of Ethiopia,	Mr. Lire Abiyo	Soil Resource Devt LE
9:30 am - 9:50 am	*Online*: Introduction to ETH-Soil project	Kerstin Wilde ETH-Soil project Manager	DBFZ
9:50 am - 10:00 am	*Keynote Online*: Biochar and COMBI-Mix as Soil Amendments: Implications on Agriculture and the Environment	Dr. Getachew Agegnehu, Senior Researcher	International Crops Research Institute for the Semi-Arid Tropics
10:10 am -10:30 am	Geo-Information in the Bio-Resource Nexus: Evaluation and Visualization of Regional Biomass Distribution to Support Decision Making	Sebastian Semella Researcher, ETH-Soil project	DBFZ
10:30 am -10:50 am	Tea/coffee break	Hotel	
10:50 am -10:55 am	Poster presentations on Creating an Atlas of Agricultural Residues Potential for Oromia Region	Mr. Getachew Haile Researcher, Ms. Woubalem Abera Researcher	Oromia Agricultural Research Institute
10:55 am -11:00 am	Poster presentations on Spatial Variability of Biomethane Potential from Human Excreta in Oromia Region	Mr. Thomas Ayalew	Department of Environmental Health, Jimma University
11:00 am -11:05 am	Poster presentation on Soil Acidity and Fertility Management in SWE	Ms. Konjit Aberham Researcher	Southwest Ethiopia Agricultural Research Institute

Date and time	Topic	Speaker/presenter	Organization
11:05 am -11:10 am	Poster Presentation on Vermicompost Fertilizer for Better Crop Production and Productivity in Sidama Region, Ethiopia	Ms. Genet Getachew Researcher	Sidama Region Agricultural Research Institute
11:10 am -11:35 am.	Farmers Participatory Biochar Production, Nutrient Loading, Characterization, and Evaluation	Prof. Fanuel Laekemariam Professor	Wolaita Sodo Univeristy
11:35 am -11:55 am	Effects of Biochar Based Fertilizer Application on Soil Properties, Yield and Yield Components of Wheat Grown on Nitisols in Hula and Teticha Districts	Dr. Ashenafi Nigussie Senior Researcher	Ethiopian Institute of Agricultural Research / Wondo Genet Agricultural Research Center
11:55 am -12:15 pm	Participatory Evaluation of Biochar-Based Biofertilizers on Smallholder Farms of Gedeo and Sidama Area, South Ethiopia	Dr. Yackob Alemayehu Asst. Professor	Dilla University
12:15 pm -12:35 pm	Blending Bioslurry with Biochar: Effects on Crop Production, Soil Fertility and Nutrient Loss along Varying Soil Types	Dr. Esubalew Getachew Asst. Professor	Jimma University
12:35 pm - 2:00 pm	Lunch	Hotel	
2:00 pm - 2:20 pm	Biochar-Based Biofertilizer Formulations for Soil Amelioration and Yield Increase	Dr. Shimelis Gizechew Asst. Professor	Hawassa University
2:20 pm - 3:40 pm	**Panel discussion Development of Formulation for Biochar-based Biofertilizer**		
	Biochar-Based Biofertilizer Formulations for Soil Amelioration and Yield Increase	Dr. Yackob Alemayehu Asst. Professor	Dilla University
		Mr. Wondimu Tamrat Asst. Professor	Wachemo University
		Mr. Tilahun Abera Director and Researcher	Batu Soil Research Centre, OARI
		Dr. Milkiyas Ahmed Asst. Professor	Jimma University
		Dr. Shimelis Gizechew Asst. Professor	Hawassa University
		Dr. Abebe Nigussie Asso. Professor	Jimma University
3:40 pm - 4:00 pm	Tea/coffee break	Hotel	

Date and time	Topic	Speaker/presenter	Organization
4:00 pm - 4:25 pm	Biochar-Based Fertilizer Application Experiences in Oromia Region	Mr. Kisi Begna	Oromia Bureau of Agriculture
4:25 pm - 4:45 pm.	Production of High-Quality Biochar Employing Kon-Tiki Kilns	Dr. Abebe Nigusie, Asso. Professor	Jimma University
4:45 pm - 5:10 pm	Biochar Production Techniques Applicable to Smallholder Farmers Level	Mr. Getachew Hailu Researcher	Asella Agricultural Engineering Research Centre (OARI)
5:10 pm - 5:30 pm	General Discussion for the 1st Day	Participants	Prof. Eyasu Eliyas
7/03/2025	Day two		
8:30 am - 8:35 am	Participant attendance	Participants	
8:35 am - 8:55 am	Vermi-Compost Technology Disseminations and Experience in Ethiopia	Dr. Teferi Tadesse Asst. Professor	Haramaya University
8:55 am - 9:15 am	Promotion of Alternative Sources of Phosphors Fertilizer from Bone-char: Evidence from Ethiopia	Dr. Milkiyas Ahmed Asst. Professor	Jimma University
9:15 am - 9:35 am	Biofertilizer Production – Availability and Potentials	Dr. Endalkechew Wolde-Meskel Senior Researcher	Center for International Forestry Research and World Agroforestry (CIFOR-ICRAF)
9:35 am - 9:55 am	Integrated Management of Acid Soils: Enhancing Crop Yields with Organic Amendments	Dr Temesgen Desalegn Senior Researcher and Director	Ethiopian Institute of Agricultural Research
9:55 am - 10:15 am	*Online*: Clay-Based Top-Lid-Updraft Pyrolysis Cookstoves for Simultaneous Cooking and Biochar Production	Dr. Clement Owusu-Prempeh Researcher	DBFZ
10:15 am - 10:35 am	Tea/coffee break	Hotel	
10:35 am - 10:55 am	*Online*: Soil Acidity Reclamation Road Map in Amhara Region	Dr. Tesfaye Feyisa Senior Researcher and Director	Amhara Agricultural Research Institute
10:55 am - 11:20 am	Integrated Use of Compost, FYM and Lime for Acid Soil Amelioration and Barley Yield Improvement in Semen Ari District, South Ethiopia	Genenaw Tesema Researcher	Jinka Agricultural Research centre
11:20 am - 12:30 pm	Farmers Witness on BBF and Organic Fertilizer Application	Selected Farmers from Oromia Region	Oromia Bureau of Agriculture/ ETH-Soil
12:30 pm - 2:00 pm	Lunch	Hotel	

Date and time	Topic	Speaker/presenter	Organization
2:00 pm - 2:40 pm	From Data to Action: Integrated Organic Amendments in Soil Health Decision Support Tool (DST) for Ethiopia	Dr. Degefie Tibebe Senior Researcher	International Center for Tropical Agriculture
2:40 pm - 3:10 pm	Introduction of NSIS Portal Execution	Mr. Kiflu Gudeta	SRD, Ministry of Agriculture of Ethiopia
3:10 pm - 4:10 pm	General Discussion and Closing Remark	Participants	H.E. Prof Eyasu Elias
4:10 pm	Health break and end of the session		

Opening Speech by the Minister of Agriculture, Prof Eyasu Eliyas

Soil Symposium 2025

March 6/2025

Madam Kerstin Wilde, ETH-Soil Project Manager

Distinguished Guests,

Researchers, Experts, and Development Partners,

Ladies and Gentlemen,

It is a great honor to welcome you all to the Soil Symposium of the ETH-Soil Project, a collaborative initiative between the German Biomass Research Centre (DBFZ) and the Ethiopian Ministry of Agriculture. Today marks a significant milestone in our efforts to improve soil fertility, enhance agricultural productivity, and contribute to the sustainable management of our natural resources.

Ethiopia has made remarkable progress in transforming its agricultural sector and to achieve national food sovereignty. However, we continue to face critical challenges, particularly in maintaining and restoring soil health. Soil acidification and salinization coupled with soil erosion, nutrient and organic matter depletion are among the top priority issues Ethiopia is currently grappling with. This is why we need innovative technologies that reinforce our current efforts and provide sustainable solutions to these challenges. The parliament has approved up to 1% of the federal spending on restoration of degraded soils and landscapes including forest landscapes. Proper utilization of such resources requires evidence based innovative solutions.

The ETH-Soil Project is an example of such an innovative approach of addressing for soil health/soil fertility problems. Through the energetic and material use of agricultural residues, and bio-fertilizers derived from pyrolysis, and the integration of biochar-based soil amendments, this initiative is set to revolutionize soil management practices in Ethiopia.

The Ministry of Agriculture is particularly excited about the project's contribution to our national goals, including the implementation of the 2030 Agenda (a model country for economic growth in Africa), and the fight against hunger through the utilization of untapped agricultural and social potential.

The current project is in a way a scale up successful experiences and best practices from pilot initiatives in Oromia region. Since 2022, DBFZ and its partners—Jimma University, the Oromia Bureau of Agriculture, Oromia region Agricultural Research Institute, and more recently, the Sidama Bureau of Agriculture—have been actively engaged in piloting biochar-based solutions in five woredas across Oromia and Sidama regional states. Their commitment to supporting Ethiopia's agricultural transformation is commendable. By improving bio-fertilizer production processes, optimizing the use of organic residues, and conducting formulation and application tests, the ETH-Soil Project is generating evidence-based solutions that will directly benefit smallholder farmers by enhancing food security and strengthening climate resilience.

Biochar technology, which converts agricultural crop residues, waste, and sustainable wood resources into carbon-rich material through pyrolysis, has great potential to enhance soil fertility. The application of biochar-based fertilizers can increase soil organic carbon, retain essential nutrients, reduce soil acidity, improve water-holding capacity, and enhance soil structure. Additionally, biochar plays a crucial role in climate change mitigation by sequestering carbon and reducing greenhouse gas emissions.

Today's gathering brings together senior soil scientists from research institutes and universities and extension experts from the federal and regional levels of the Ministry of Agriculture to discuss the challenges and opportunities of soil improvement through bio-char solutions. Over the course of this workshop, you will be discussing some critical topics such as biochar-based fertilizer preparation, acid soil reclamation by means of organic residues and chemical methods, and the rehabilitation of salt-affected soils -by means of bioremediation. Through panel discussions, keynote presentations, and interactive sessions, we aim to foster knowledge exchange and strengthen collaboration among key stakeholders.

This symposium reflects our government's commitment to an evidence-based and multidisciplinary approach to addressing soil health challenges. We must, therefore, work together to bridge the gap between research, policy, and practice, ensuring that our agricultural systems remain productive, resilient, and sustainable. If we succeed in preserving our soil's health and fertility, we can secure the delicate balance of food, water, energy, carbon, and biodiversity, ultimately safeguarding the well-being of future generations.

In closing, I would like to extend my deepest gratitude to DBFZ and the financiers for their dedication in making this project a reality. I thank the Soil Resource Directorate of my Ministry, the Ministry of Agriculture, for all the hard work in organizing this workshop. May this workshop inspire new ideas, foster meaningful discussions, and lead us toward actionable solutions that will enhance soil health and productivity in Ethiopia.

With that, I officially declare the ETH-Soil Project launching workshop open.

Thank you.

ETH Soil
Bio-Power for Healthy Soils

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Objective: The health of degraded soils is improved in pilot regions by the target group through the application of fertilizers composed of biochar and digestates or compost.

=> Smallholder farmers in rural areas with food insecurity can generate increased yields and income through their agricultural activities.

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Implementation Partner and Pilot Woredas

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DBFZ stands for transdisciplinary research expertise on biomass and its uses (energetic / material)

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MINISTRIES IN THE DBFZ SUPERVISORY BOARD

BMEL: Federal Ministry of Food and Agriculture

BMBF: Federal Ministry of Education and Research

BMUV: Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection

BMDV: Federal Ministry for Digital and Transport

BMWK: Federal Ministry for Economic Affairs and Climate Action

SMEKUL: Saxon State Ministry for Energy, Climate Protection, Environment and Agriculture

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Research focus areas at the DBFZ

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- Systemic contribution of biomass
- Smart biomass heat
- Catalytic emission control
- Biobased products and fuels
- Anaerobic processes

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Core questions

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1. Which quantities of what kind of biogenic resources are currently not used (in the best way)?
2. How can they be mobilised?
3. Which technology is best suited to make use of specific agricultural residues?

Biochar-based fertilizer

Societal objectives

⇒ Secure food and nutrition

⇒ Sustainable natural resource management

⇒ Reduced dependence on imports & non-renewable resources

⇒ Mitigation & adaptation to climate change

⇒ More employment and economic growth

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Driving Forces of transition

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The innovation system

- Research and technology
- Interactive learning
- Quality assurance
- Awareness in policy and society
- Market development
- Consumer preferences

Societal objectives

⇒ Secure food and nutrition
⇒ Sustainable natural resource management
⇒ Reduced dependence on imports & non-renewable resources
⇒ Mitigation & adaptation to climate change
⇒ More employment and economic growth

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Thank you for sound testing BBF formulations!

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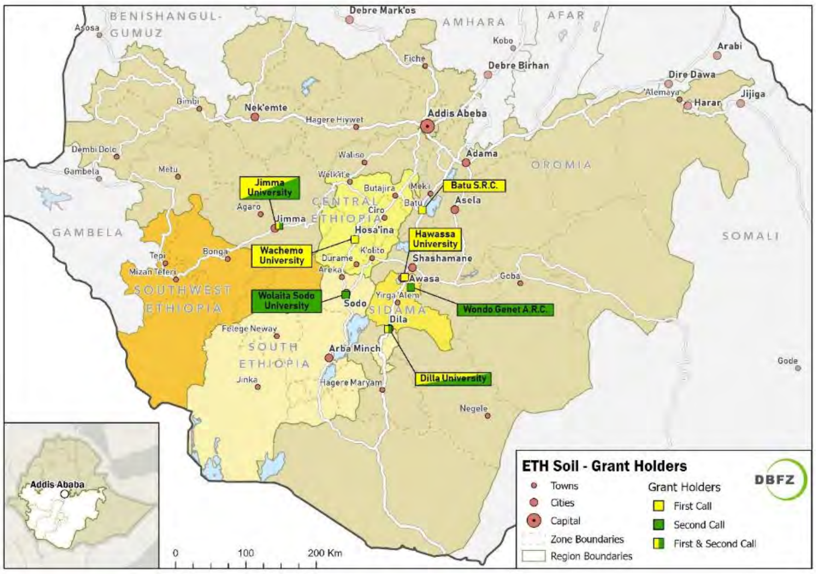

Focus: maize, teff, soghum, wheat, barley.

Thank you
IQQO Batu & Asela, JUCAVM, BoA Oromia

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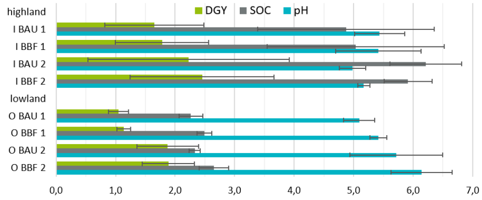

=> 350t BBF on ca. 17ha of 244 smallholders

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Can we make biochar a profitable business ?

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Biomass screening in the pilot Woredas and district centers: interviews with 261 business owners in agriculture, processing and crafts

⇒ most residues are used;

⇒ some amounts of pulp, husks, bones, cuttings from trees and khat shrubs, maize cobs and avocado kernels can be used for biochar production;

⇒ No significant amount of invasive plants (like lantara camara, water hyacinth, etc.) in the pilot-Woredas.

Generic business models will be developed in 2025.

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Can we alter farmers' cost-benefit relation and make the use of biochar-based fertilizer sustainable and widespread?

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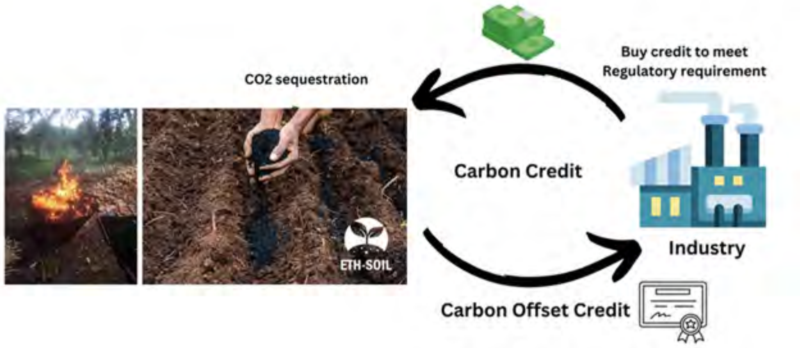

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Can we diminish the intoxication of women ... with biochar co-production?

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Thank you very much for your attention & cooperation !

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Biochar and COMBI-Mix as Soil Amendments: Implications on Agriculture and the Environment

Getachew Agegnehu
Soil Symposium
March 7, 2025
Adama, Ethiopia

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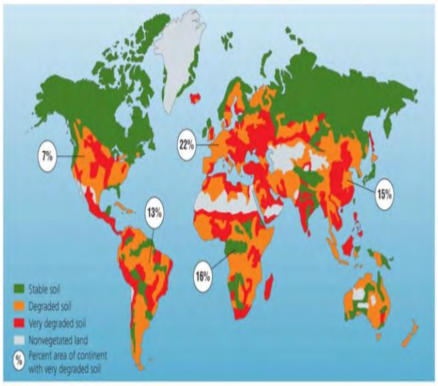
What are the key challenges of agriculture?

- Increasing agric. production without exacerbating environmental problems, while coping with climate change (Pender 2009; Parry et al. 2007).
- Building food systems that meet increasing demand and remain profitable and sustainable in the face of climate change (Steiner et al., 2020).
- Multiple soil health issues affecting various areas to different extents: e.g., topsoil erosion, organic matter depletion, soil acidity, salinity, and deficiency of macro-and micro-nutrients (Lal, 2015; Sanchez et al. 1997; Zeleke et al. 2010).
- About half of Ethiopia's cultivated land (6.5 mln.) is severely degraded due to poor agricultural activities (FAO, 2018).

3

Major causes of land degradation and soil fertility depletion

- Overgrazing (35%)
- Deforestation (30%)
- Agricultural activities (28%)
- Overexploitation of land (7%)
- Significant decrease in cropland per capita



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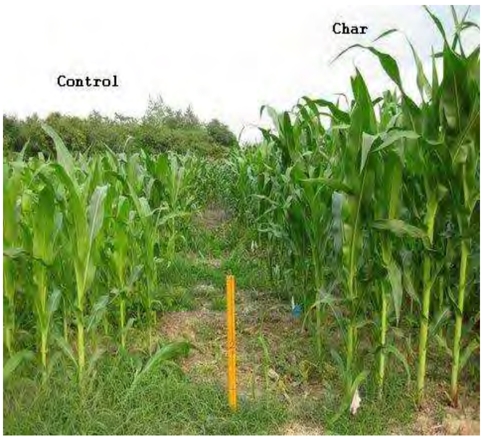
Competing use of resources

- 85% of total crop residues as feed, energy source, and thatching (Amare et al. 2005)
- Amount of nutrients in crop residues are higher than the amount applied as fertilizers (Agegnehu et al., 2012)
- Negative soil nutrient balance (Zeleke et al., 2010)
  - E.g. Ethiopia: -47, -7, and -32 kg NPK/ha/y

5

What are the main issues of sustainable agriculture?

- SA faces significant constraints due to:
  - enhanced SOM decomposition (Lal, 2015)
  - soil fertility depletion
- Fertilizer + seed technology reaching a point of diminishing returns (Barrow 2012).
- Low fertilizer use efficiency and environmental pollution
  - low N recovery efficiency of ~33% (Raun et al. 2002), with 67% (~$19 billion) global loss of N fertilizer per year (WB 2015).
  - Loss of nutrients via fixation, leaching, or gas fluxes
- High cost and need for continuous fertilizer application.



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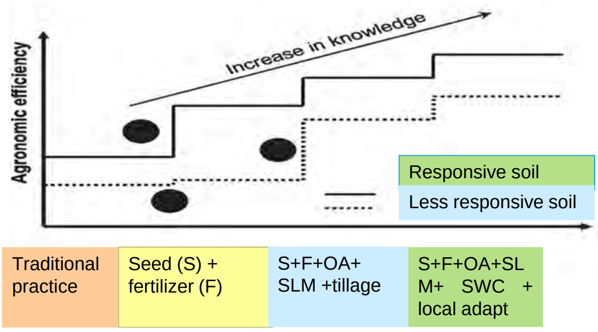
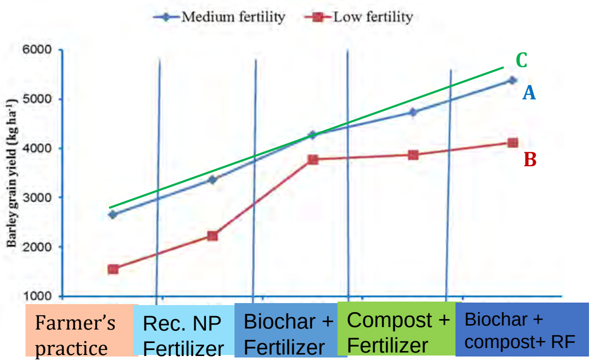
The relationship between fertilizers and organic amendments and implementation of various components of ISFM developing into complete ISFM towards the right side of the graph

Time to comprehensive ISFM depends on what is already taking place and extent of intervention

Efficient utilization of resources to achieve sustainable soil fertility management (ISFM)



Source: Vanlauwe et al. (2010)



Source: Agegnehu et al. (2017)

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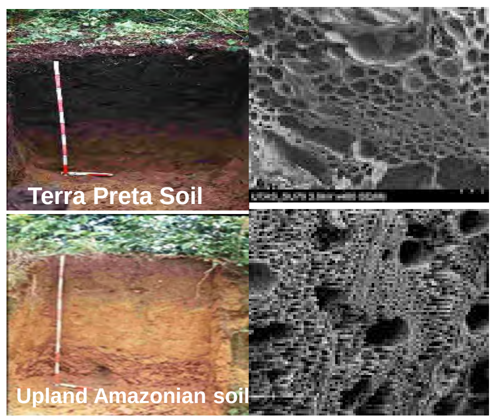
What is biochar?

- A carbon-rich product produced from biomass by controlled pyrolysis, or under oxygen-limited environment (Lehmann & Joseph, 2009).
- Emerged in conjunction with soil management and C-sequestration.
- Terra Preta soils contain up to 70 times more C than adjacent soils (Lehmann et al. 2009; Glaser et al. 2002)
- Recalcitrant (half-lives of 100-900 years). Pyrolysis makes biomass recalcitrant and can be sequestered in the soil.
- Carbon species in biochar can be classified as carbonate and bicarbonate in the inorganic phase and aliphatic, aromatic and functionalized carbon in the organic phase.



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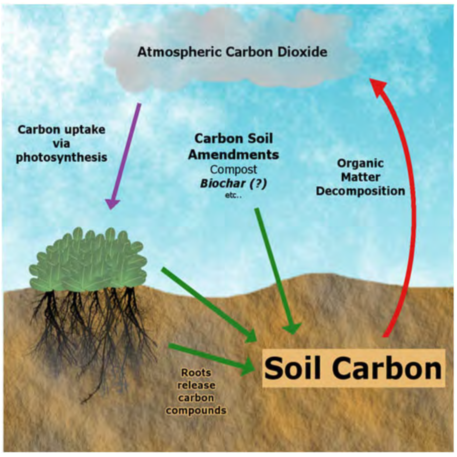
Carbon sequestration using biochar

- A plant absorbing CO2 from the atmosphere through photosynthesis, producing biomass.
- 10.2 Gt C/yr. fixed by photosynthesis used by humans (Haberl 2007).
- 8 Gt C/yr - current fossil-C emissions
- Biochar is C negative - reduces GHG emission from biomass via C sequestration (Lehmann & Joseph, 2015).
- Soils have a great potential to sequester carbon.



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Composting with biochar

- ➢ Provides both stable and labile carbon.
- ➢ Increases rate of carbon mineralization reducing bulk.
- ➢ Increases nitrogen retention.
- ➢ Provides nutrients and a mechanism for retention in the soil.
- ➢ Accelerates biochar ‘aging’ and hence improves soil function and microbial habitat faster.
- ➢ Use of biochar as a bulking agent could reduce N2O emissions by up to 52% during composting (Steiner et al. 2010).

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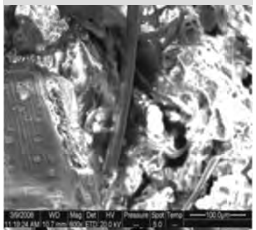
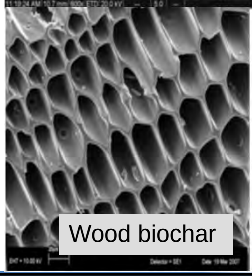
Characteristics of biochars

- All biochars are not created equal.
- The physicochemical properties of biochar vary according to biomass type used and temperature.
- Pore size and distribution is determined by the feedstock structure.
- Mineral contents vary among feedstock types.





Chicken litter biochar

Wood biochar

Characterizing biochar

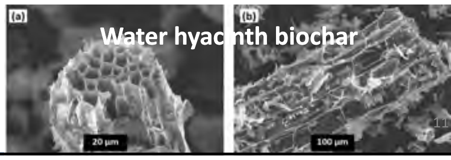
According to structure

Physicochemical characteristics

According to Function

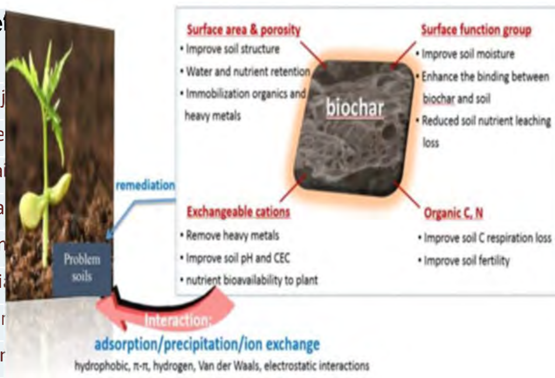
Ability to improve plant growth and microbial processes

Ability to store carbon



Amendment effect of different biochar types on grain yield in problematic soils

Soil type	Biochar type	Crop type	Yield increase (%)	Re
Acid soil	Wood	Maize	28-140	Maj
Acid soil	Acacia	Barley	30-78	Age
Sandy soil	Wood	Rice	20	Asa
Acid soil	Sewage sludge	Rice	149–175	Kha
Saline soil	Bamboo	Rice	20	Don
Heavy clay soil	*Gliricidia sp.*	Maize	43-50	Obi
Waterlogged paddy soil	Rice husk	Rice	12	War
Cd, Pb	Wheat straw	Rice	17–18	Biar
Poor sandy loam soil	Rice straw	Rice	12	Kamara et al. (2015)
Saline-sodic paddy soil	Wheat straw	Rice	13	Jin et al. (2018)
Saline-sodic paddy soil	Peanut shell	Rice	22-24	Ran et al. (2019)



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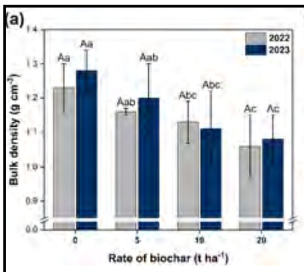
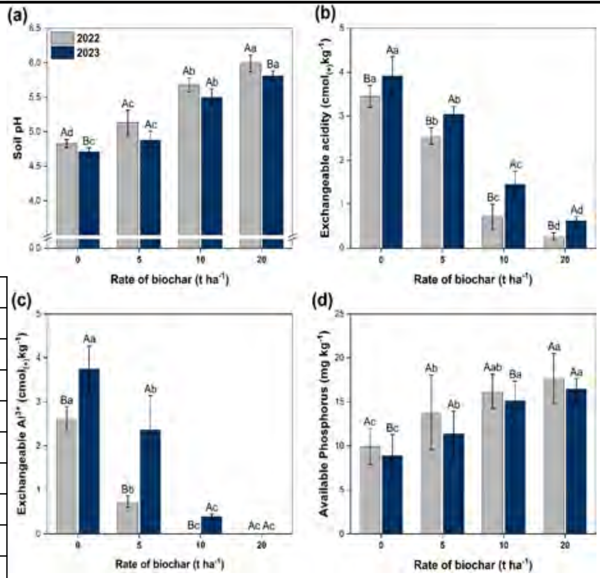


Treatment	2022	2023
F×WHB interaction	GY (t/ha)	GY (t/ha)
H0	3.73g	3.95f
H5	4.46f	4.61e
H10	5.00ef	4.68de
H20	5.10de	5.17d
F0	5.93bc	5.76c
F5	5.66cd	6.25c
F10	6.37b	7.03b
F20	7.41a	7.86a
F×WHB	0.0345	0.0242
CV (%)	6.57	5.17

Effect of WH Biochar and fertilizer on maize yield (2022 - 2023)



Effect of WH Biochar on some soil physical and chemical properties (2022 - 2023)

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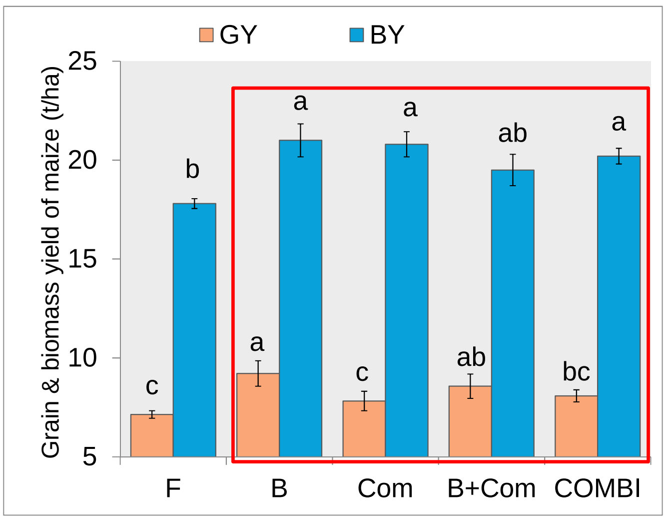
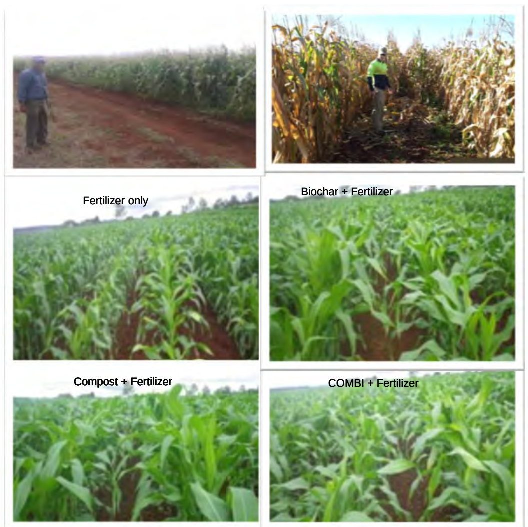
Biochar and COMBI-mix increase plant growth and yield relative to inorganic fertilizer alone.





F = Fertilizer; B = Biochar; Com = Compost; COMBI = Co-composted biochar-compost

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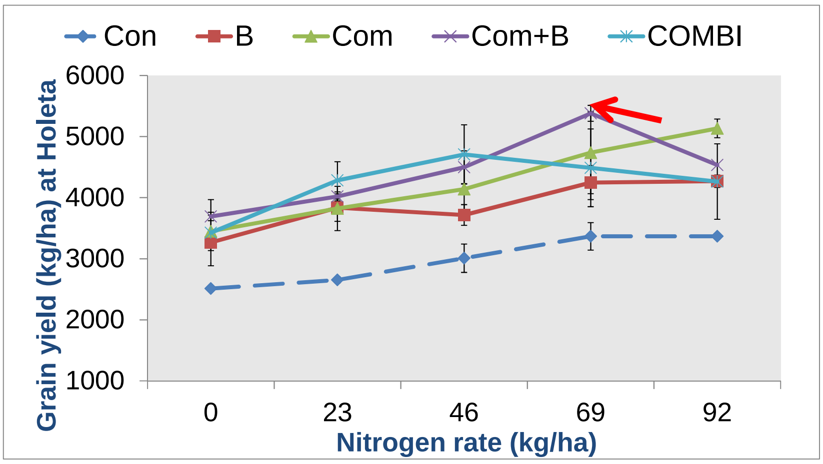
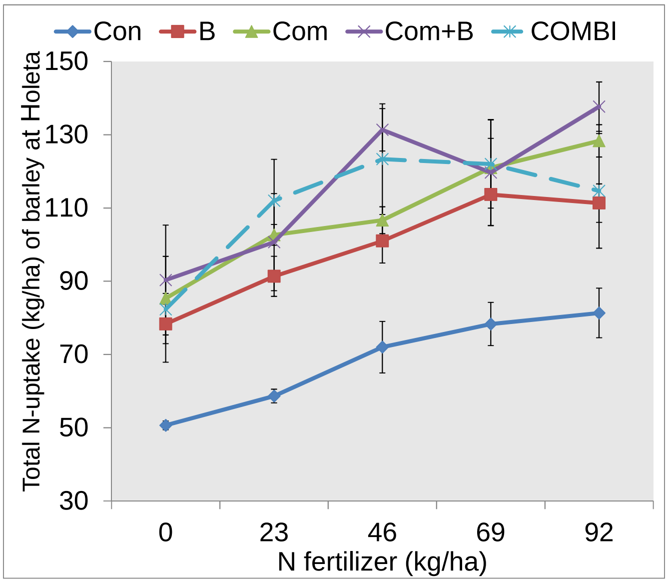
Response of barley grain yield to OAs and N fertilizer

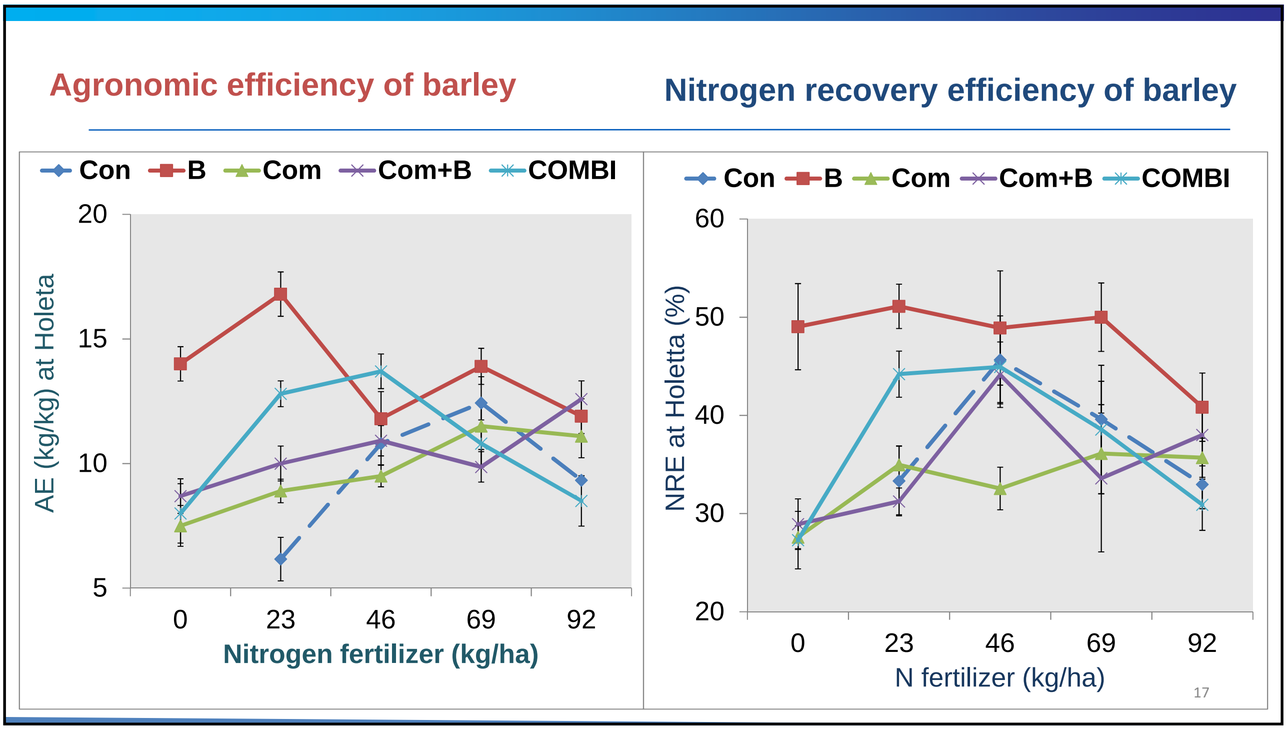


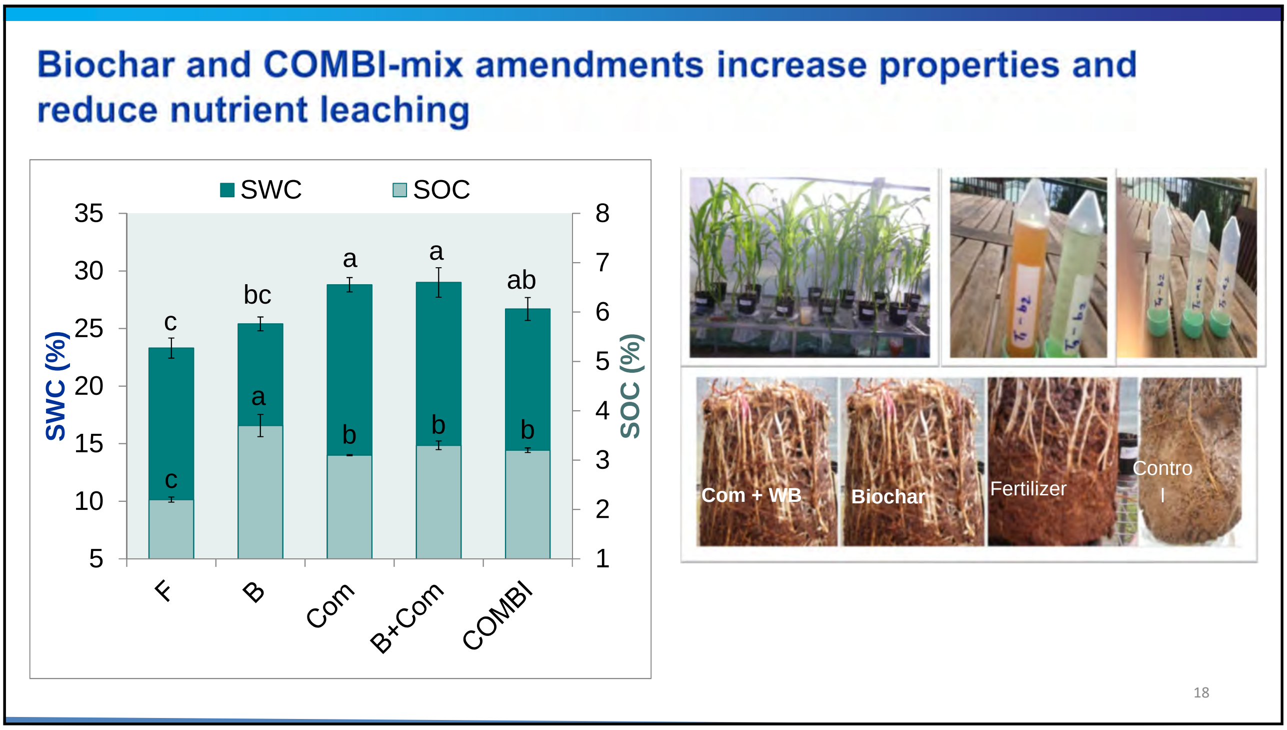
15

Biochar and COMBI-mix improve plant nutrient uptake and use efficiency.

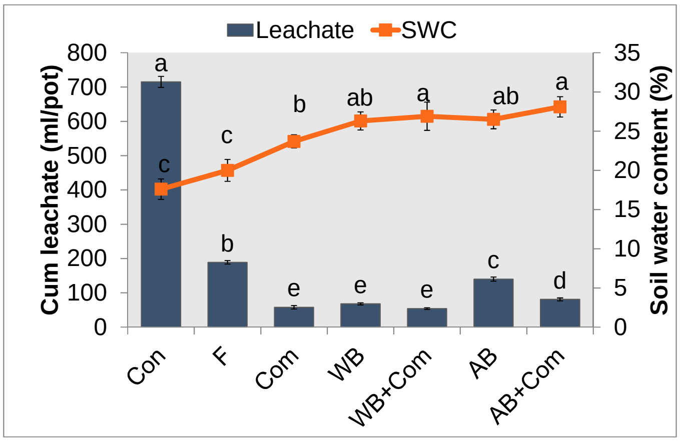


16


Agronomic efficiency of barley
Nitrogen recovery efficiency of barley
Con B Com Com+B COMBI
AE (kg/kg) at Holeta
20
15
10
5
0 23 46 69 92
Nitrogen fertilizer (kg/ha)
NRE at Holetta (%)
60
50
40
30
20
0 23 46 69 92
N fertilizer (kg/ha)
17


Biochar and COMBI-mix amendments increase properties and reduce nutrient leaching
SWC SOC
SWC (%)
SOC (%)
35 30 25 20 15 10 5
8 7 6 5 4 3 2 1
c bc a a ab
c a b b b
F B Com B+Com COMBI
Com + WB
Biochar
Fertilizer
Contro l
18

Cumulative leachate and soil water content

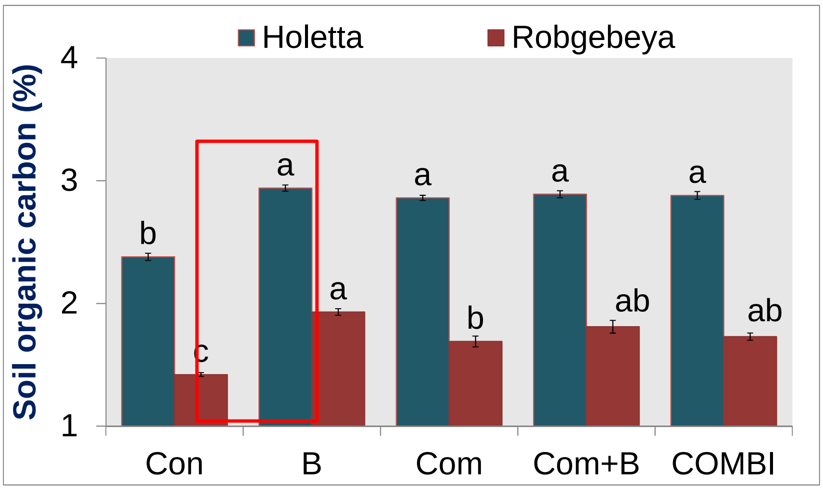


Treatment	Nutrient leaching (mg pot^{-1})		
	NO_3-N	P	K
Control	102.1 b	0.37 d	22.8 a
Fertilizer (F)	133.6 a	1.23 a	20.7 b
F + Com	85.7 c	0.18 f	10.8 c
F + WB	44.7 ef	0.26 e	6.5 e
F + WB +Com	35.6 f	0.14 g	6.4 e
F + AB	69.4 d	0.46 c	11.0 c
F+ AB + Com	47.9 e	0.63 b	8.4 d
p level	***	***	**
LSD $_{(0.05)}$	10.1	0.04	1.7

Con=Control; F= Fertilizer; Com= Compost; WB=Willow biochar; AB=Acacia biochar

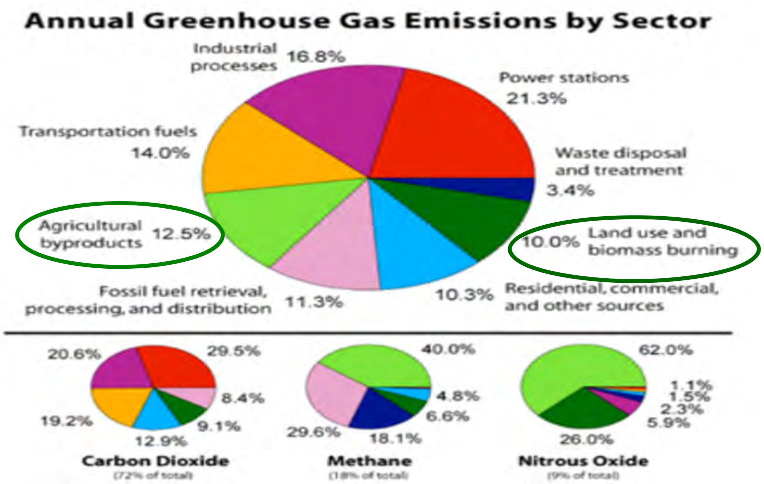
19

Application of biochar and biochar-compost improved soil pH and SOC after barley harvest



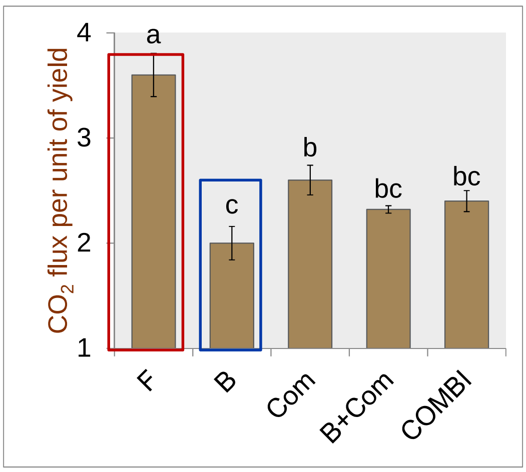
20

4. Organic amendments reduce greenhouse gas emissions

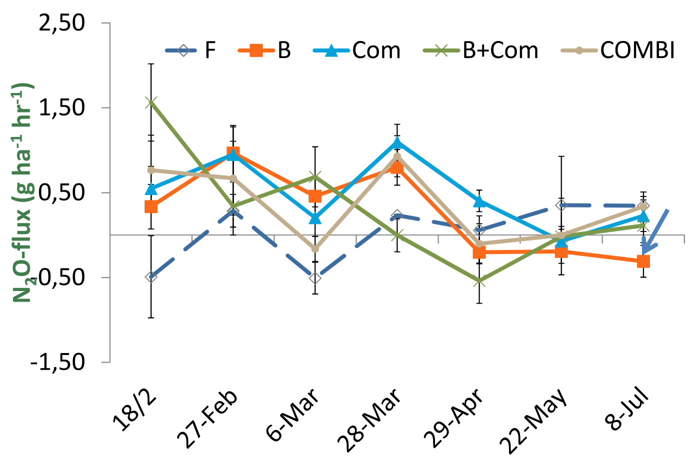


21

Units of CO_2 produced per unit of maize yield (kg CO_2 ha^{-1}/kg yield ha^{-1})



N_2O flux from organic amendments compared to fertilizer only in maize field



22

Conclusions: Biochar, Biochar + Compost mixture and COMBI-mix

Increase:

- Plant growth and crop yields
- Soil organic matter
- Soil pH and P availability
- Soil fertility and nutrient retention
- Soil microbial biomass
- Soil water holding capacity

Decrease:

- Soil bulk density
- Al saturation and soil acidity
- Fertilizer needs
- Nutrient leaching
- Greenhouse gas emissions

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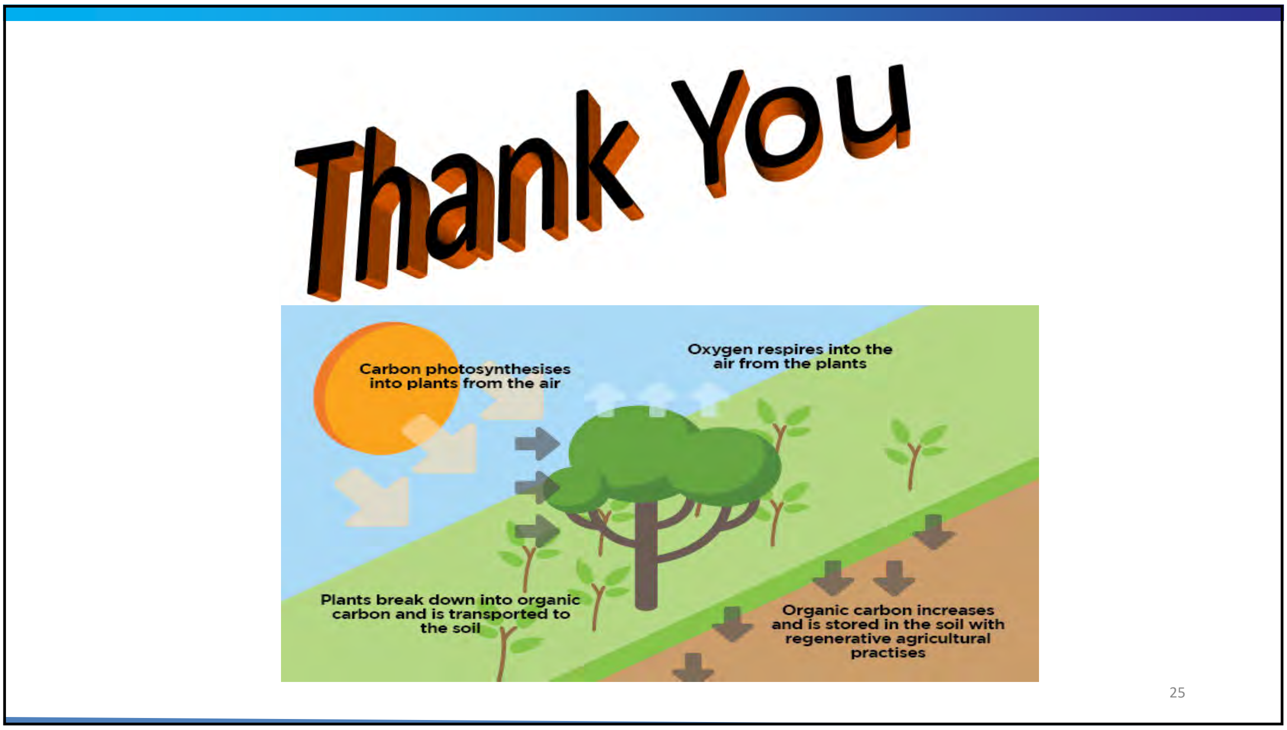
Way Forward

- Mechanistic understanding of long-term effects of biochar application beyond the first year.
- Factors that determine the magnitude and direction of the response.
- Impacts of biochar on C sequestration, soil quality, crop yield, and GHG emission.
- Interaction effects of biochar and fertilizers on soil properties and crop yield.
- Optimal application rates, amount of fertilizer that can be reduced, and long-term re-application practice.
- Develop the mechanistic understanding of interactions between biochar, soil, nutrients, water, microorganisms, and crops that underpin improvements in crop yield and soil quality.
- The quality of biochar as a soil amendment varies significantly with the feedstock and the production conditions.
- Policy on biochar use (standards; mapping feedstock source, amount and source, preparation, economics, etc.)

24


Thank You
Carbon photosynthesises into plants from the air
Oxygen respires into the air from the plants
Plants break down into organic carbon and is transported to the soil
Organic carbon increases and is stored in the soil with regenerative agricultural practises
25

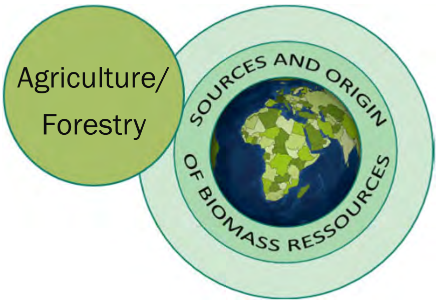
Soil Symposium 2025

Geo-Information in the Bio-Resource Nexus:
Evaluation and Visualization of Regional Biomass Distribution to Support Decision Making

Soil Symposium 2025, 6th to 7th of March 2025, Adama, Ethiopia

The Bio-Resource Nexus

ETH-SOIL



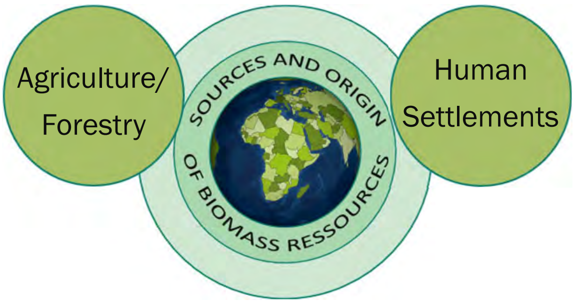
- Agricultural By-Products:
  - Straw, Stalks, Leaves, Husks, Shells, etc.
  - Manure from Livestock
  - Prunings from Orchards and Forestry

ETH-SOIL - ein Projekt des DBFZ

2

The Bio-Resource Nexus

ETH-SOIL



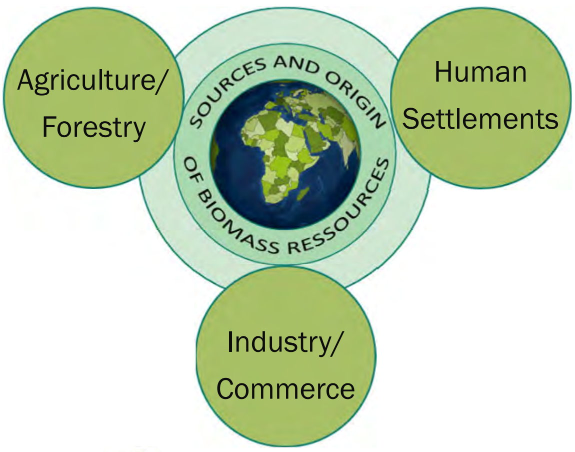
- Human Settlements
  - Biogenic Household Waste
  - Cuttings from parks and other urban greenery
  - Human Feces

ETH-SOIL - ein Projekt des DBFZ

3

The Bio-Resource Nexus

ETH-SOIL



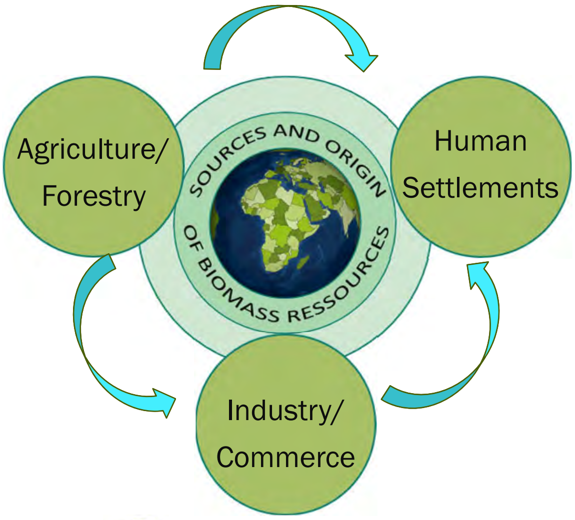
- Industry/Commerce
  - Food Processing
  - Waste from Canteens and Food Markets
  - Wood Processing Residues
  - Slaughterhouse Wastes

ETH-SOIL - ein Projekt des DBFZ

4

The Bio-Resource Nexus

ETH-SOIL



Material and Energy Flow accumulates in Cities

- Depletion of Soil
- Unutilised Opportunities
- Challenges for Urban Waste Management and (Peri-)Urban Ecosystems
- ...

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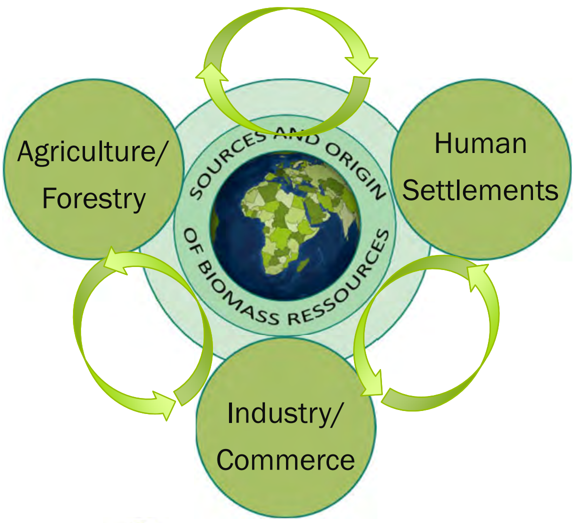
5

The Bio-Resource Nexus

ETH-SOIL



Closing the Cycle with smart Bio-Resource Systems!

- Multiple Oppurtunities for
  - Soil Health
  - Income Diversification
  - Economic Oppurtunities
  - Energy Production
  - *and much more!*

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6

Assessment of Biomass Potentials

Key Questions

ETH-SOIL

- Which biomasses are of particular interest?
- What quantities are potentially available?
- Where are the resources located?





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Agriculture/Forestry

Agricultural Residues

ETH-SOIL

Production Quantitity of Crop

„Residue-to-Crop Ratio“ Theoretical Potential

Recovery Rate Technical Potential

% already in use Mobilization Potential

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Tolessa (2023): Bioenergy potential from crop residue biomass resources in Ethiopia 8

Agriculture/Forestry
Agricultural Residues

ETH-SOIL

1000kg of Corn

- RCR Corn Cobs = 0.3 → **300kg** Cobs
- RCR Corn Husks = 0.2 → **200kg** Husks
- RCR Corn Stalks = 1.5 → **1500kg** Stalks

= **2000kg** Maize residues

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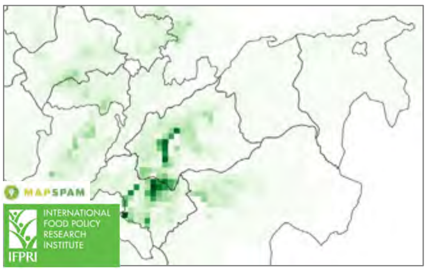
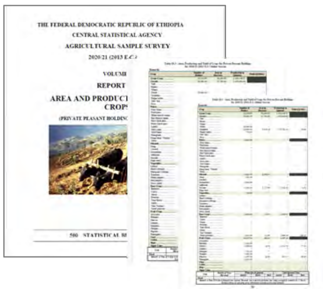
Tolessa (2023): Bioenergy potential from crop residue biomass resources in Ethiopia 9

Agriculture/Forestry
Agricultural Residues

ETH-SOIL



Global Models on Agricultural Production (e.g. IFRPI)



National/Regional Official Statistics (e.g. Central Statistical Agency)

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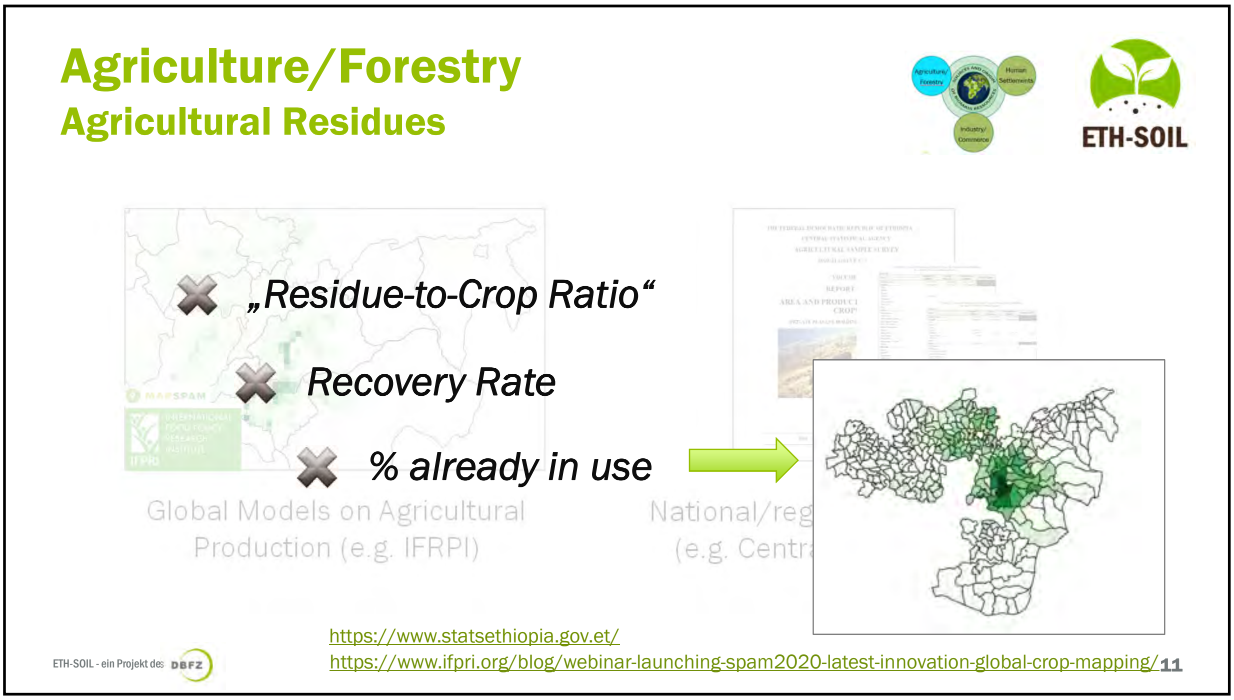
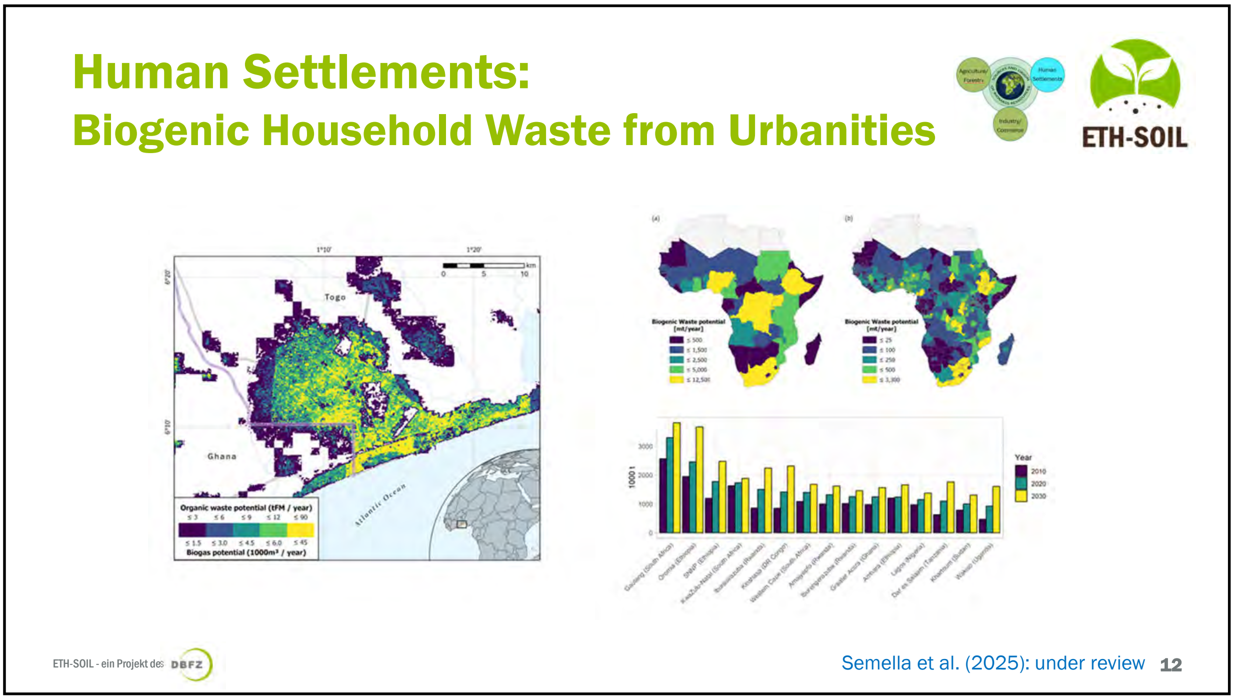
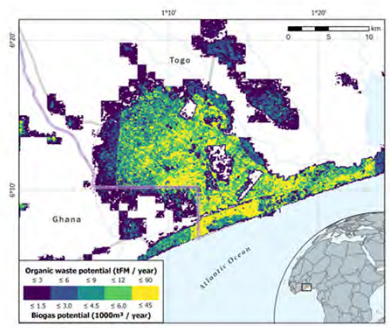
https://www.statsethiopia.gov.et/
https://www.ifpri.org/blog/webinar-launching-spam2020-latest-innovation-global-crop-mapping/ 10

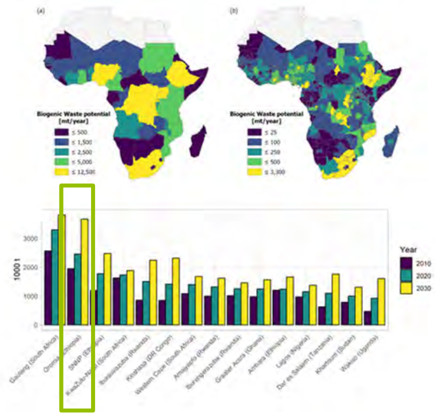

Agriculture/Forestry
Agricultural Residues
ETH-SOIL
„Residue-to-Crop Ratio“
Recovery Rate
% already in use
Global Models on Agricultural Production (e.g. IFRPI)
National/reg
(e.g. Centra
https://www.statsethiopia.gov.et/
https://www.ifpri.org/blog/webinar-launching-spam2020-latest-innovation-global-crop-mapping/
ETH-SOIL - ein Projekt des DBFZ
11


Human Settlements:
Biogenic Household Waste from Urbanities
ETH-SOIL
Togo
Ghana
Atlantic Ocean
Organic waste potential (tFM / year)
Biogas potential (1000m³ / year)
Biogenic Waste potential [mt/year]
Year
2010
2020
2030
Semella et al. (2025): under review
ETH-SOIL - ein Projekt des DBFZ
12

Human Settlements:
Biogenic Household Waste from Urbanities

ETH-SOIL





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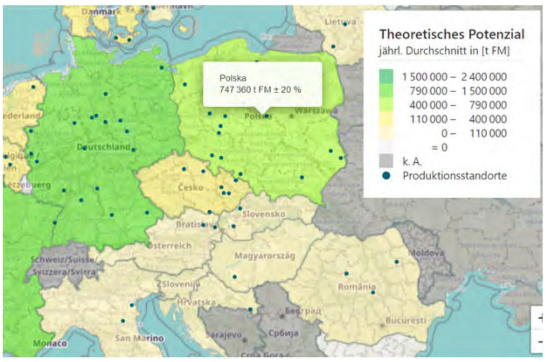
Semella et al. (2025): under review 13

Industry/Commerce:
Mapping of Production Sites

ETH-SOIL

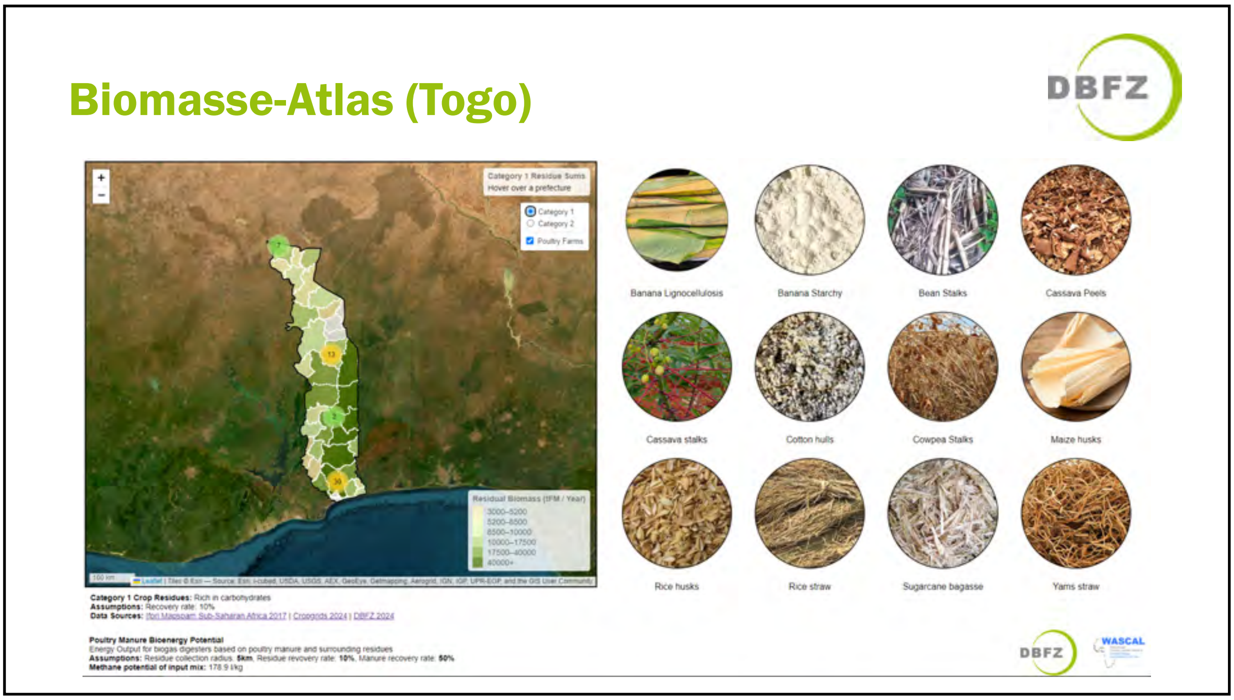


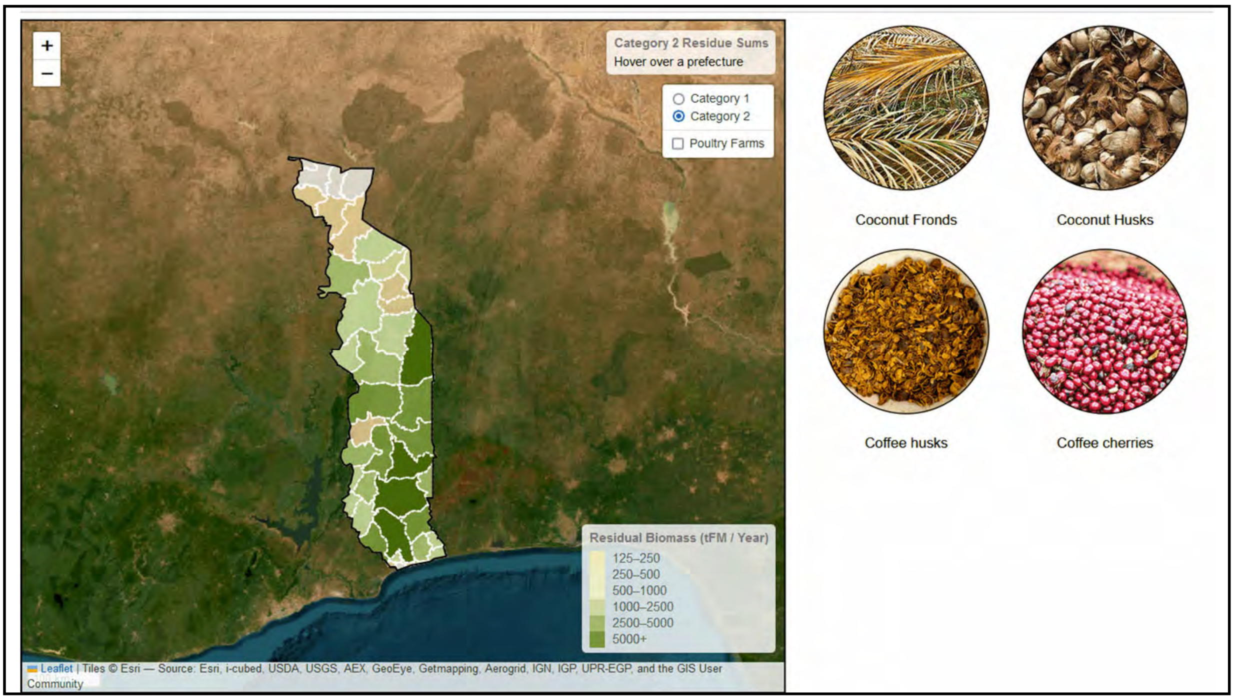
- Industrial wastes are usually very pure
- Stakeholders can directly get in touch
- Efficient resource stream for larger scale facilites

- Data acquisition is very time- and labour-intensive
- Must be constantly updated

ETH-SOIL - ein Projekt des DBFZ

14


Biomasse-Atlas (Togo)
DBFZ
Category 1 Residue Sums
Hover over a prefecture
Category 1
Category 2
Poultry Farms
Residual Biomass (tFM / Year)
3000–5200
5200–8500
8500–10000
10000–17500
17500–40000
40000+
Banana Lignocellulosis
Banana Starchy
Bean Stalks
Cassava Peels
Cassava stalks
Cotton hulls
Cowpea Stalks
Maize husks
Rice husks
Rice straw
Sugarcane bagasse
Yams straw
Category 1 Crop Residues: Rich in carbohydrates
Assumptions: Recovery rate: 10%
Poultry Manure Bioenergy Potential
Energy Output for biogas digesters based on poultry manure and surrounding residues
Assumptions: Residue collection radius: 5km, Residue revovery rate: 10%, Manure recovery rate: 50%
Methane potential of input mix: 178.9 l/kg
DBFZ
WASCAL


Category 2 Residue Sums
Hover over a prefecture
Category 1
Category 2
Poultry Farms
Residual Biomass (tFM / Year)
125–250
250–500
500–1000
1000–2500
2500–5000
5000+
Leaflet | Tiles © Esri — Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, UPR-EGP, and the GIS User Community
Coconut Fronds
Coconut Husks
Coffee husks
Coffee cherries

Outlook and Summary

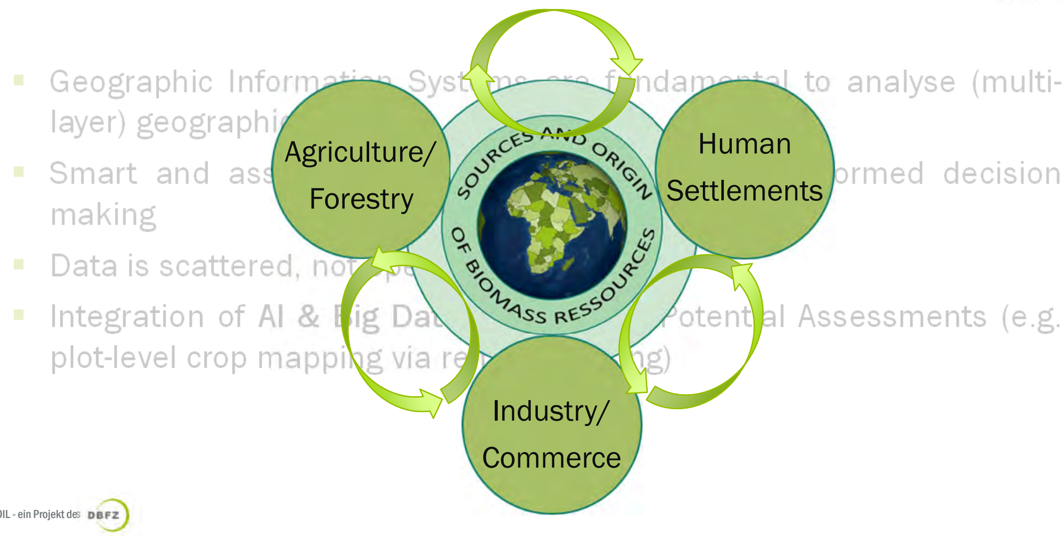
ETH-SOIL

- Geographic Information Systems are fundamental to analyse (multi-layered) geographical data
- Accessible data visualisations are key for informed and efficient decision making
- The data is scattered and not available to stakeholders
- Integration of **AI & Big Data** for Biomass Potential Assessments (e.g. plot-level crop mapping via remote sensing)

ETH-SOIL - ein Projekt des DBFZ

Outlook and Summary

ETH-SOIL



ETH-SOIL - ein Projekt des DBFZ

DBFZ

ETH-SOIL

Kontakt

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www.dbfz.de

www.eth-soil.com

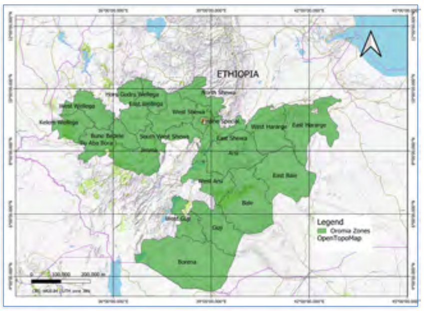
Creating an Atlas of Agricultural Residues Potential for Oromia Region

Getachew Haile [1] Woubalem Abera [2]

1. Oromia Agricultural Research Institute
2. Fiche Agricultural Research Center

Introduction

- The potential depletion of fossil fuels and climate change have boosted the global demand for renewable and alternative energy.
- Agricultural biomass residue based energy generation is one of the major focus areas of renewable energy in different countries around the world.
- Geographic Information Science(GIS) has been identified as a valuable tool for biomass energy potential estimation.
- This study aimed at quantifying and mapping a theoretical biomass potential of agricultural residues of Oromia region using GIS.



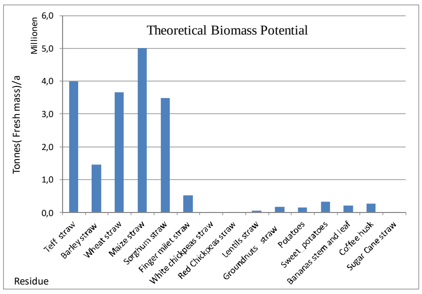


Figure 1 and 2: Study area map and potential of each residue

Methods

- Production data of Oromia region was collected from Central Statistical Agency (CSA).
- After preprocessing, the excel data was merged to attribute table of boundary data.
- The theoretical biomass potential of agricultural residues was estimated using annual crop production and the residue to-production ratio.
- The sums of theoretical biomass potentials of each residue were aggregated to a specific use case.

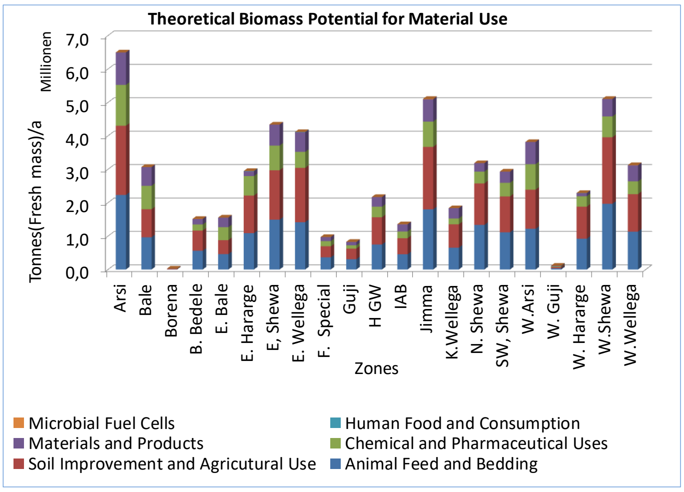


Figure 3: Theoretical Biomass Potential of agriculture residue for Material use

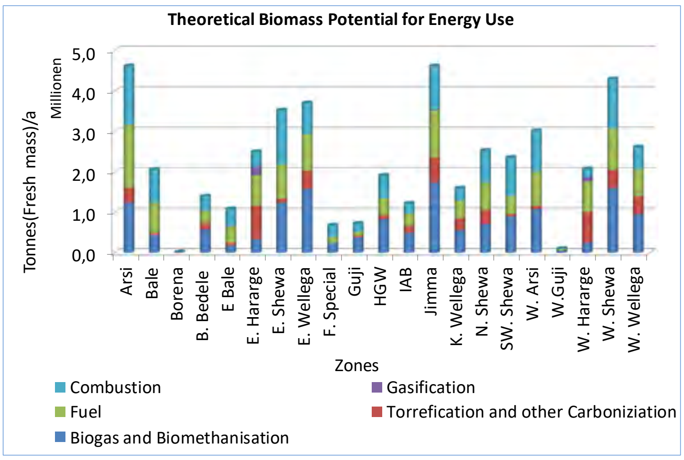


Figure 4: Theoretical biomass potential of agriculture residue for energy use

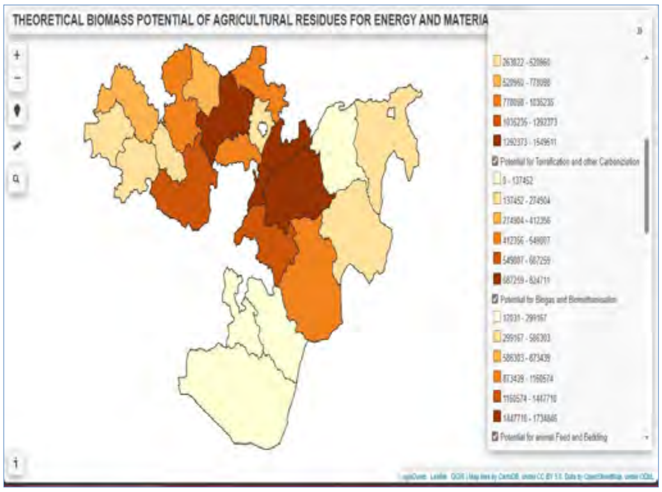


Figure 5: The web map for residue potential of oromia region

Highlights

- GIS based assessment allows allocating biomass resources and potential across the region.
- Mapping biomass potential at regional and national levels enables stakeholders and planners to plan biomass usage according to the potentials.
- Registering the exact amount of residue produced for all types of crops and vegetables help in Understanding the exact potential of a region.

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[1] Natural Resource Directoret
[2] Natural Resource Directoret

Im Auftrag des
Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung


IQQO
Oromia Agricultural Research Institute
ETH-SOIL
DBFZ
Creating an Atlas of Agricultural Residues Potential for Oromia Region
Woubalem Abera and Getachew Haile
GeoSpatial Analyst/ Researchers/ Oromia Agricultural Research Institute


IQQO
ETH-SOIL
DBFZ
Goal/Focus Area
Introduction of Biochar production technology (different level pyrolysis)
Selection of pilot districts (Adami Tulu Jido Kombolcha, Kofale and Dedo)
Introduction of biochar Based Bio-fertilizer (BBF) formulation
Capacitating of Batu Soil Research Centre's and Asela gricultural Engineering Research Centre's
Enabling IQQO the competence to certify the quality of biochar produced from agricultural residue and invading plant
Capacity building through professional and farmers training
Training material supply
Granting some organic fertilizers related research activities
Granting and demonstration of biochar and BBF through extension

Introduction

- Increased demand for renewable energy:
  - Driven by the depletion of fossil fuels and climate change.
  - Significant for national development and progress.

- Global energy demand projections:
  - Expected to rise by almost 28% by 2040.

- Biomass energy as a renewable resource:
  - Contributes to global energy needs.
  - Accounts for around 10% of primary energy consumption globally.

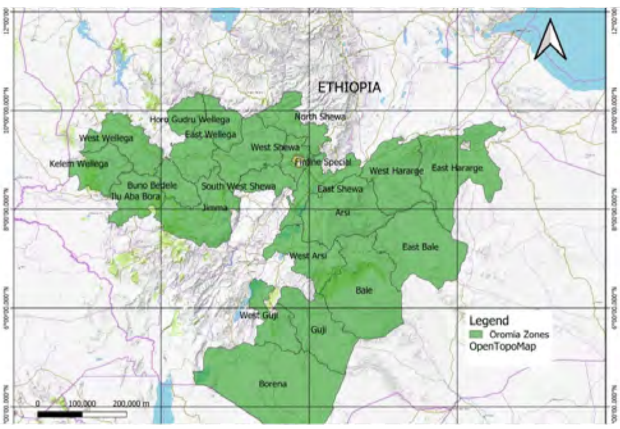
- Agricultural biomass residue energy generation:
  - Focus area of renewable energy in various countries.
  - Low cost and low emission source.

- Geographic Information Science
  - Assess biomass potentials.
  - Allocates biomass to existing power plants.
  - Helps decision makers plan utilization.

Objective

- To asses a theoretical bio mass potential for Agricultural Residues of Oromia region
- To classify theoretical potential according to residues energetic and material use case.
- To build an atlas and web map that shows the theoretical potential of Agricultural Residues of Oromia region.

2. Material and Methods



01. Oromia

An area of 32,314,123.261ha, the region lies between 34° 7' 27.2856", and 42° 58' 47.4492" longitude and 10° 23' 12.7284", and 3° 30' 50.004" latitude. The Region has 21 zones and 335 Woredas (districts).

02. Data Collection and Preprocessing

- Crop production data was collected from Central Statistical Agency (CSA).
- cereals, pulses, oilseeds, root crops, fruit crops, stimulant crops and sugar cane
- Preprocessing of excel data has been done
- Geocoding

03. Analysis, Aggregation and Visualization

- The theoretical biomass potential of agricultural residues was estimated from the regional annual crop production of each crop type **(BP = CP * RCR)**

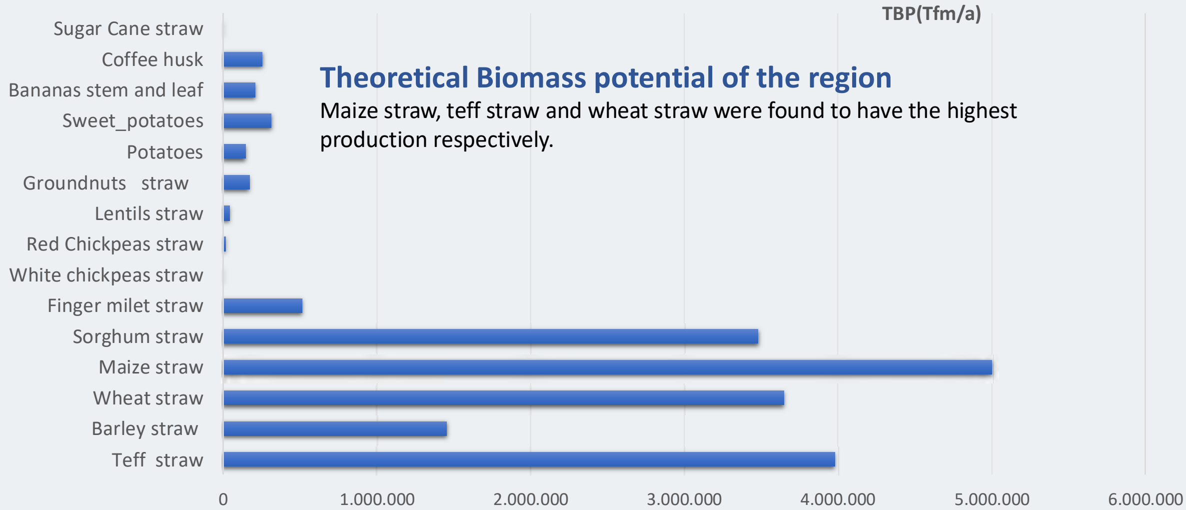
04. Web Map Generation

- Web maps were produced from the sums of theoretical biomass potentials of each residue which were aggregated to a specific energetic and material use case.

3. Result

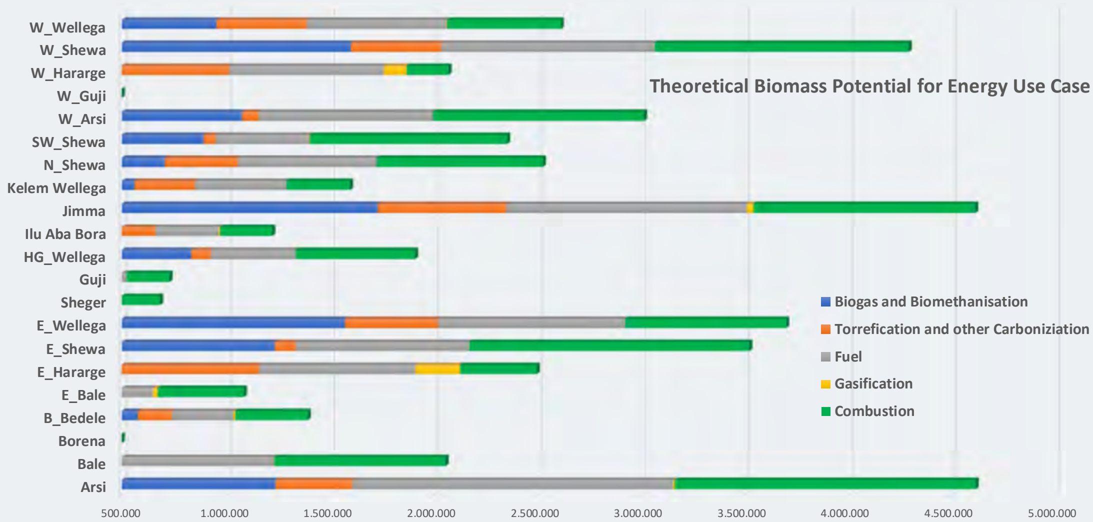
Theoretical Biomass potential of the region

Maize straw, teff straw and wheat straw were found to have the highest production respectively.

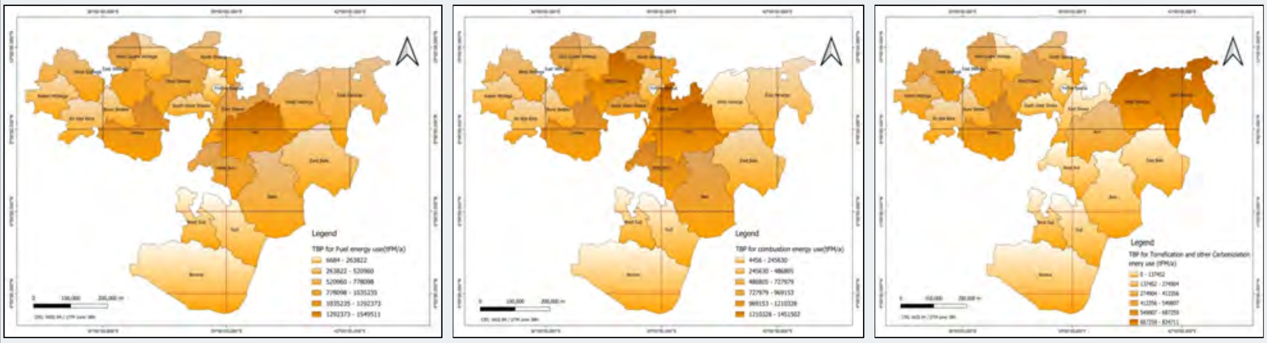


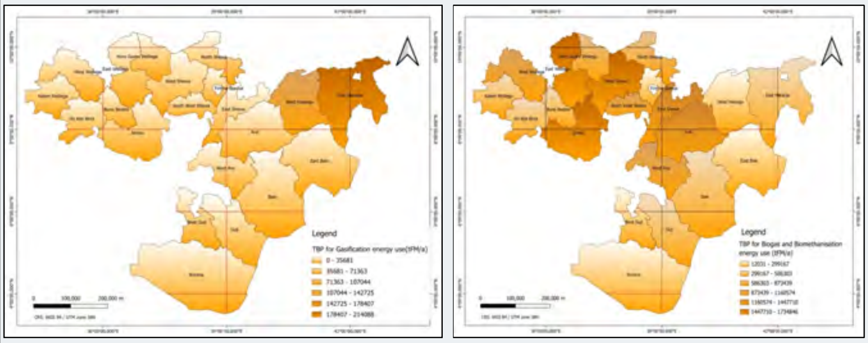
	Teff straw	Barley straw	Wheat straw	Maize straw	Sorghum straw	Finger milet straw	White chickpeas straw	Red Chickpeas straw	Lentils straw	Groundnuts straw	Potatoes	Sweet_potatoes	Bananas stem and leaf	Coffee husk	Sugar Cane straw
TBP(Tfm/a)	3979298	1451343	3648784	4999669	3481012	509880	1548	15530	41535	169324	146061	313672	209823	254810	3365

Theoretical Biomass Potential for Energy Use Case

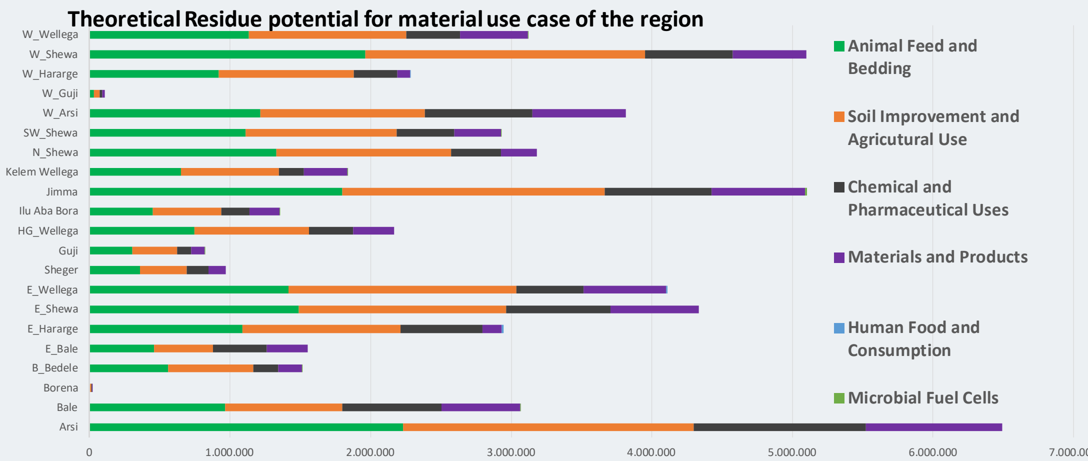


	Arsi	Bale	Borena	B_Bedele	E_Bale	E_Hararge	E_Shewa	E_Wellega	Sheger	Guji	HG_Wellega	Ilu Aba Bora	Jimma	Kelem Wellega	N_Shewa	SW_Shewa	W_Arsi	W_Guji	W_Hararge	W_Shewa	W_Wellega
Biogas and Biomethanisation	1242124	438617	12031	576549	178374	337136	1238595	1577811	240442	380152	835841	494044	1734846	561063	707316	895069	1080074	51138	247830	1605047	957188
Torrefication and other Carboniziation	370762	54016	2228	165296	67368	824711	99819	448153	0	35792	93901	168084	621224	292107	352723	58194	80055	9470	768807	437265	435393
Fuel	1549511	741297	6684	297465	405339	756323	839876	904547	154834	107375	410261	306150	1161803	441420	670940	451334	842529	28410	749069	1029565	675634
Gasification	7678	2026	0	8725	22110	214088	0	0	0	0	0	6605	31142	0	0	3936	0	0	108846	314	2226
Combustion	1451502	826916	4456	349878	416507	370437	1350669	776101	289763	206303	575718	251132	1070545	307297	801620	951407	1018371	18940	202551	1226464	548141



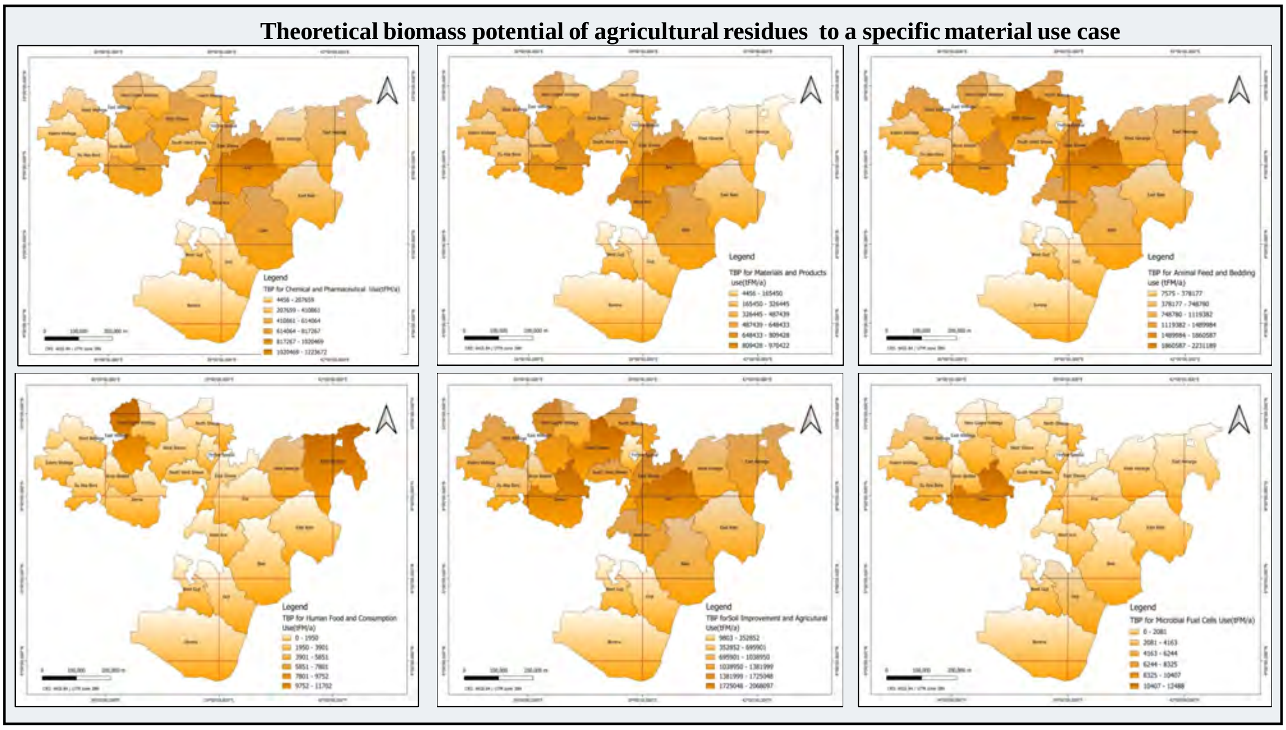


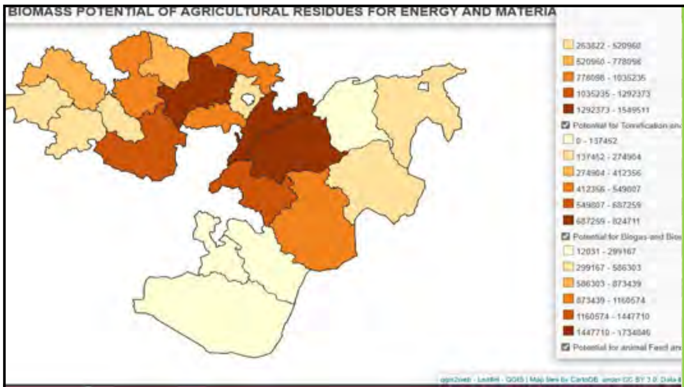
Theoretical biomass potential of agricultural residues for specific energy use case



	Arsi	Bale	Borena	B_Bedele	E_Bale	E_Hararge	E_Shewa	E_Wellega	Sheger	Guji	HG_Wellega	Ilu Aba Bora	Jimma	Kelem Wellega	N_Shewa	SW_Shewa	W_Arsi	W_Guji	W_Hararge	W_Shewa	W_Wellega
Animal Feed and Bedding	2231189	965748	7575	561157	459314	1087626	1490065	1416979	363019	308569	747090	453649	1800648	651533	1333047	1112595	1217342	32198	921374	1965128	1133862
Soil Improvement and Agricutural Use	2068097	835442	9803	604972	419281	1125210	1477339	1623350	330762	317337	814244	483756	1866338	699099	1241325	1073531	1171905	41668	958561	1988702	1121968
Chemical and Pharmaceutical Uses	1223672	703004	4456	179880	385650	583557	740057	477686	154834	98607	316360	200109	760388	176394	353671	408637	762474	18940	311514	624819	379912
Materials and Products	970422	560450	4456	166991	289868	137983	627862	583960	122577	98607	289909	214786	663930	307316	255229	334323	664113	18940	92985	522513	482458
Human Food and Consumption	0	0	0	0	0	11702	0	9793	0	0	0	0	0	0	0	0	0	0	4673	0	0
Microbial Fuel Cells	0	836	0	770	0	0	0	0	0	2823	0	3521	12488	499	0	573	0	0	0	0	2969

4.2 Creating an Atlas of Agricultural Residues Potential for Oromia Region, Woubalem Abera & Getachew Hailu, Oromia Agricultural Research Institute





Dynamic Web Mapping

1 Interactivity/Accessibility

Enhances user engagement and enables users to explore data more thoroughly. Accessible in mobile devices

2 Real-time Data

Useful for applications that require up-to-date information.

3 Customization

Users can often customize dynamic maps according to their needs

4 Integrity

Dynamic maps can integrate with other datasets and applications, allowing users to visualize and analyze geographical information in conjunction with other data sets

5 Visualization

Enhanced Visualization: Dynamic maps can incorporate various visualization techniques, such as heatmaps, choropleth maps, and more, helping users to understand complex datasets visually.

6 Data Layers

Users can toggle different layers on and off, allowing for a personalized view depending on what information is currently relevant

4. Conclusion

1. Animal Feed and Bedding
   Arsi, West Shewa and Jimma
2. Soil Improvement and Agricultural Use:
   Arsi, West Shewa and Jimma
3. Chemical & Pharmaceutical Uses
   Arsi, West Arsi, Jimma, East Shewa
4. Human Food and Consumption
   East Hararge, East Wellega
5. Microbial Fuel Cells
   Jimma, Ilu Aba Bora, West Wellega, Guji

1. Biogas and Biomethanisation
   Jimma, West Shewa, East Wellega, Arsi
2. Torrefaction and Carbonization
   East Hararge, West Hararge, Jimma, East Wellega
3. Fuel Production
   Arsi, Jimma, West Shewa, East Wellega
4. Gasification
   East Hararge, West Hararge, Jimma
5. Combustion
   Arsi, East Shewa, West Shewa, Jimma

Thank you

12

Spatial Analysis of Human Fecal Waste in Rural Oromia, Ethiopia: Biomethane and Nutrient Recovery Potential

Thomas Ayalew[1], Sebastian Semella[2] , and Gudina Terefe[1]

1 Department of Environmental Health, Jimma University
2 DBFZ Deutsches Biomasseforschungszentrum gemeinnützige GmbH

Background

Ethiopian context:

- A Widespread lack of safely managed sanitation (**93%**) poses significant health risks.
- Only **0.3%** of households (HH) have biogas systems,
  - * 60% of these are non-functional;
  - * most digesters are also not connected to **toilets**.
- Severe soil nutrient loss, top soil erosion and productivity loss
- The heavy reliance on biomass fuels worsens indoor air pollution
- Each Ethiopian HH faces an energy deficit of **5-7 GJ** per year.
- The existing CLTSH program fosters stigma toward fecal waste.
- This valuable resource is **underused**, and its geographical potential remains **unclear**.
- Spatial analysis is essential for identifying high potential areas

Aim of the study

- This study aims to analyze the spatial distribution of fecal waste and assess biomethane and bio-fertilizer (N, P, & K) potential in rural Oromia, Ethiopia.

Methods

- This study employed three approaches: rural population mapping using satellite data, resource potential estimation with lab-derived data (Donacho et al., 2023), and spatial visualization of results in QGIS, as detailed below.
- Rural Population Mapping: We used population data derived from satellite imagery (Global Human Settlement Layer: GHS POP 2023A & GHS SMOD 2023A) to classify urban/rural areas in QGIS
- Rural population was estimated using raster masking and validated with Ethiopian CSA data.
- Resource Potential Estimation: Feces production (73 kg/year/person) and biomethane yield (28.71 m³ CH_4/year/person) based on lab-derived data.
- Calculated nutrient recovery (N, P, K) (3.71, 1.12, 2.29 g/kg feces, respectively).
- Used conversion factors (e.g., 1 m³ CH_4 = 36 MJ) to quantify energy potential.
- Spatial Visualization & Analysis: Data processed in Excel and mapped in QGIS to highlight resource disparities across districts.
- Generated distribution maps for feces, biomethane, and nutrients to identify high-potential districts.

Results

- Oromia's rural population is 27 million (61% of the total).
- Approximately **2 million tonnes** of human feces is produced annually in rural areas.
- Highest production (>15.4kt/year) is concentrated in southwestern and central districts.
- Annual methane generation is estimated at **775 million m³**.
- Districts with high potential (>6.05 million m³/year) correspond to areas with high fecal production, particularly in the southwest.
- Estimated energy potential: **27.89** PJ per year.
- Annual Nutrient Recovery Potential from Feces: **7,309 tonnes** of Nitrogen (N), **2,206 tonnes** of Phosphorus (P) and **4,511 tonnes** of Potassium (K).
- Southwestern and central districts produce over 75% of the valuable outputs, while northern and eastern districts contribute less.

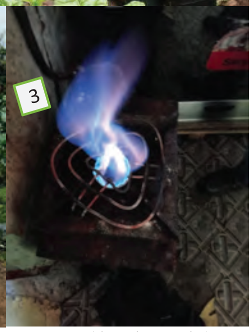


Fig. 1: Bio slurry use (Source: Flexi Biogas). Fig. 2: Biogas Digester (Photo: Thomas Ayalew). Fig. 3: Bio-methane Energy (Photo: Thomas Ayalew).

Results

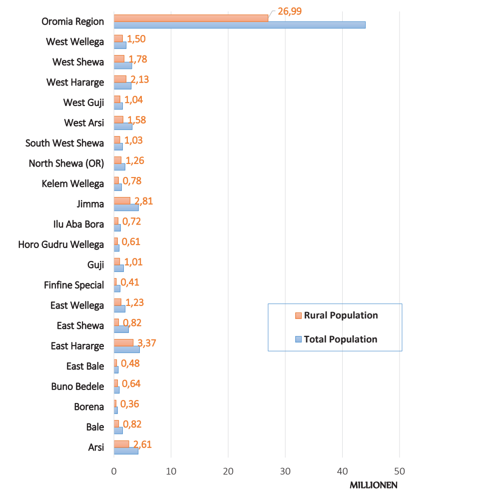


Fig. 4: Total population versus rural population of Oromia region (Source: Global Human Settlement Layer GHS POP 2023A & GHS SMOD 2023A)

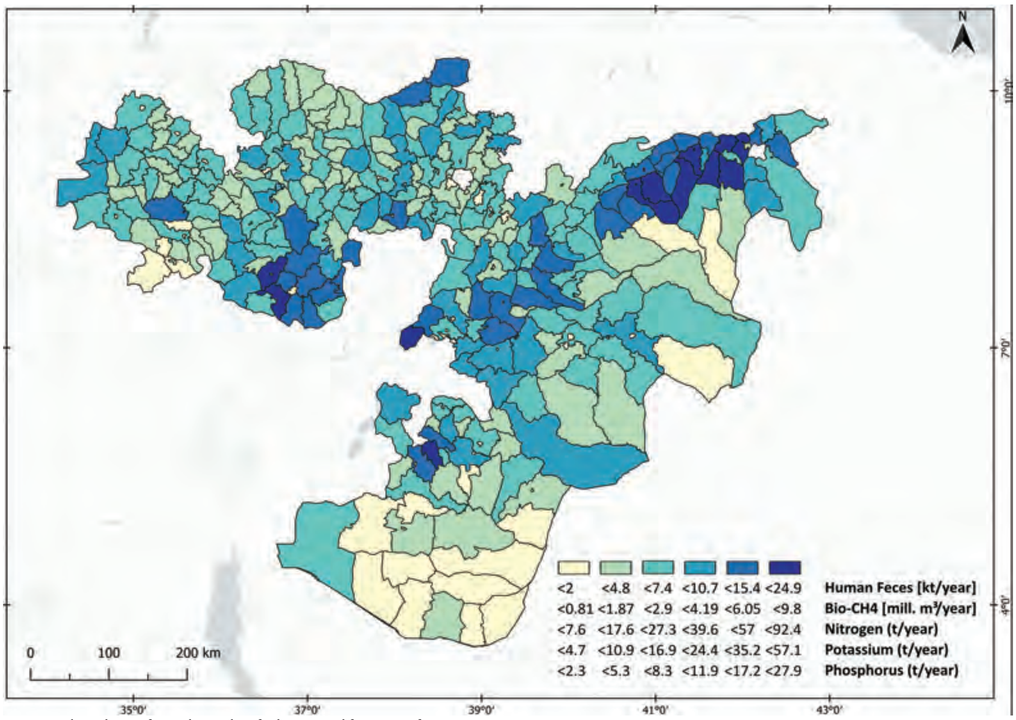


Fig. 5: Spatial Distribution of Biomethane and Bio-fertilizer Potential from Human feces in Oromia, 2025.

Conclusion

- The energy potential of 27.89 PJ/yr. from human feces is sufficient for **89%** of rural Oromia households.
- Bio-fertilizer yield could cut synthetic fertilizer imports by **2.6B** birr **annually** and improve soil health.
- Expanding low-cost resource oriented sanitation technologies and targeted subsidies in high-yield districts will enhance sustainability.
- Incorporating ROST into Ethiopia's WASH policy is key to sustainable sanitation and resource management.
- Strengthen waste-to-resource programs in collaboration with private sector and NGOs.

Acknowledgements

We sincerely thank Jimma University, Faculty of Public Health, and the Department of Environmental Health for this valuable opportunity. Our heartfelt gratitude also goes to DBFZ for their generous sponsorship and for organizing such an outstanding symposium in collaboration with the Ethiopian Ministry of Agriculture.

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Im Auftrag des

Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung

Spatial Analysis of Fecal Waste Potential and Barriers to Adopt as Resource in Oromia

Authors/Institutions:

Thomas Ayalew (Jimma University), Semella Sebastian (DBFZ), Gudina Terefe (Jimma University)

March 2025 **|** *Adama town*

1

The Crisis

- Low access: 93% lack Safely Managed Sanitation → fecal contamination of water/soil.
- Only 0.3% of households (HH) have biogas—60% are non-functional.
- High soil nutrient depletion and erosion (137kt/h/yr.)
- Energy deficit: rural HHs require 5-7 GJ
- Sanitation Program Stigam towadrs feces.

2

Methods

- Rural Population mapping: used satellite imagery and GHS POP & GSH SOMD 2023data layer
- Bio-methane and Bio-fertilizers Potential Estimation: using lab-derived data
  - 73 kg/year/person
  - 28.71 m^3 CH_4/year/person.
  - nutrient recovery (N, P, K) (3.71, 1.12, 2.29 g/kg feces, respectively).
  - 1 m^3 CH_4 = 36 MJ to quantify energy potential.
- Spatial Visualization & Analysis: Processed data in Excel and mapped outputs in QGIS

3

Untapped Potential/Opportunity

Key Findings

- Feces production: 2M tonnes/year.
- Methane production: 775 million cubic meters per year.

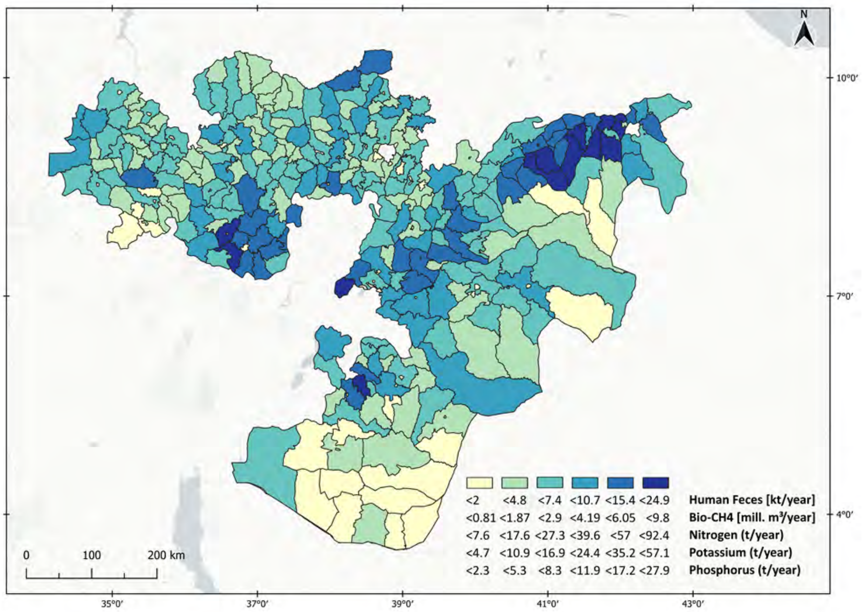
Energy potential: 27.89 pet joules per year, sufficient for millions of rural households.

Bio-fertilizer potential: 7,309t—N, 2,206t—P, 4,511t—K.

- 15-20% offset IO fertilizer imports ($591M/year)

4

Spatial Distribution of Bio-fertilizer and Biogas Potential in Oromia



5

Barriers to Biogas and Nutrient Recovery Adoption

- Low adoption rate: Only 0.3% of rural HH use biogas (60% are non-functional).
- Behavioral barrier: 70% perceive as culturally inappropriate.
- Financial constraints: only 7% financial committed
- Safety Risks: Pathogen transmission risks from untreated fecal sludge.

6

Unlocking the Potential of these Resources

- Scale up **Low cost ROST** in high-yield districts
- **Smart Subsidy** of ROST via government – NGO partnership.
- Integrate **waste-to-resource policies** into Ethiopia's National WASH Strategy.
- **Design programs** to raise awareness and address cultural barriers besides NBPE.

7

"Unlock fecal waste's potential to achieve energy security, food sovereignty, and equitable sanitation !"

Thank You !

8

Soil Acidity and Fertility Management in SWEARI

Southwest Ethiopia Agricultural Research Institute Bonga Agricultural Research Center

SWEARI

March 6 - 7 2025,
Adama

Introduction

Soil acidity has become a serious threat to crop production in Ethiopia in general and in the South western part of the country in particular. An earlier study estimated that about 43% of arable lands of Ethiopia are affected by soil acidity/Al^{3+} toxicity. In South western Ethiopia acidification occurs simultaneously with conditions including eroded topsoil and depleted organic matter, depleted nutrients and high rainfall which is high enough to leach appreciable amounts of exchangeable basic cations. As a result soil acidity and low soil fertility became one of the bottlenecks to sustain agricultural production and productivity in the area .Thus ,correction of the low pH through liming, and/or application of organic materials: ISFM are critical for sustainable management of these soils. Based on the existing problem south west Ethiopia Agricultural Research Institute conduct different Experiment and DEMOs on Soil Acidity effect and its amendment and Soil fertility management options So, this poster presentation is to over view those findings.

Methods

Experiment and DEMOs were conducted at different Zones (Kaffa, Sheka, Bench Sheko) of South west Ethiopia. The experiment was laid out in an RCBD design, with three replications and DEMOs with farmer replications. The Seed rate and fertilizer added were applied based on crop specific recommendations and Vermi-compost added with N equivalence. Different rate of lime(3,2,1,0 tone/ha) :various ratios of organic and inorganic fertilizers (25:75,50:50,75:25 and 100) were applied.

Findings

Soil Fertility Management		
(Vermi compost: Inorganic)	GY(qt/ha)	Woreda
1.Wheat (25 :75)	48.71	Adiyo
2.Rice(50 : 50)	53.8	Gimbo
3.Head Cabbage (25:75)	420.3	Sheshinda
4.Maize (25:75)	86	Gimbo
Acid Soil Management (lime, lime + vc)		
1.Wheat 50%(Lime+ inorganic Fertilizer + OF)	40.05	Shey Bench
2.Teff 50%(Lime+ inorganic Fertilizer + OF)	15.1	Shey Bench
3. Wheat(20 tone +Inorganic Fertilizer)	45,35,37	Chena, semen bench and Shay bench
4. Barley (20 tone +Inorganic Fertilizer)	39.3	Chena
5. Faba bean (20 tone +Inorganic Fertilizer)	41.50	Chena

Conclusion

Amending soil acidity and improving fertility is crucial for promoting Yield ,soil health and environmental sustainability. Soil acidity affects nutrient availability, microbial activity, and soil structure. It could be managed through practices such as liming, fertilization, and crop rotation.

HEALTHY SOILS ARE FULL OF LIFE!

Food System Resilience Program

EIAR

VERMICOMPOST FERTILIZER FOR BETTER CROP PRODUCTION AND PRODUCTIVITY IN SIDAMA REGION , ETHIOPIA

Genet Getachew
Sidama Region Agricultural Research Institute
Hawassa Agricultural Research center, Hawassa ,Ethiopia

Introduction

Practically, sustainable agriculture uses less external inputs and employs locally available natural resources more efficiently (Lee, 2005).Vermicompost has found to effectively enhance the root formation, elongation of stem and production of biomass, vegetables, ornamental plants etc. Many authors agree that vermicompost act as fertilizers and contribute to the improvement of soil physicochemical characteristics (Genet. G and Matiwos. M ,2022).

Vermicomposting is a suitable, hygienic and cost effective technique practiced for organic waste management, and is the process of devouring, digestion and excretion of any organic waste by earthworms, in which complex organic fractions of organic solid waste are broken down into good quality compost (Reddy M V. 2009) (figure 1). therefore the objective of this study were to evaluate vermicompost technology for better crop production .

Vermi (Earthworm) vermicompost

Figure 1

Material and methods

- ✓ The study were conducted more than 12 woredas of Sidama Region .

Vermicompost preparation method

1. Construction of bin 2. collection of agricultural residues 3. preparration of bedding 4 . Sprinkling of water 5. adding the worm, Vermicomposting takes 2 to 3 month 6.separation of vermicompost from bin 7.driying of the collected vermicompost 8. storage of vermicompost . 9. Vermicompost applied coffee (figure 2)

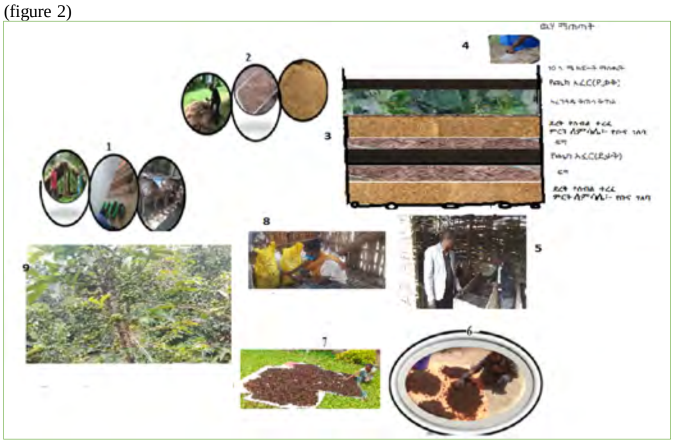


Figure 2

Field experiment

Volunteer farmers will be selected at each location in collaboration with agriculture offices . Vermicompost applied 3 ton /ha for vegetables and root crops.5ton/ha for barley , 0.7kg for avocado seedling .The experimental **design** RCBD replicated three times. Soil and crop data were collected. The data were analyzed using SAS software.

Results and Discussion

High yield obtained by 3 tone /ha vermicompost only for vegetables . 5 ton per hectare gave economic yield for barley and wheat, also 0.7 kg/pot showed avocado seedling growth and early maturity for grafting. Acidity improved from strong acidic to weekly acidic and from neutral to alkaline which is important for soil fertility.

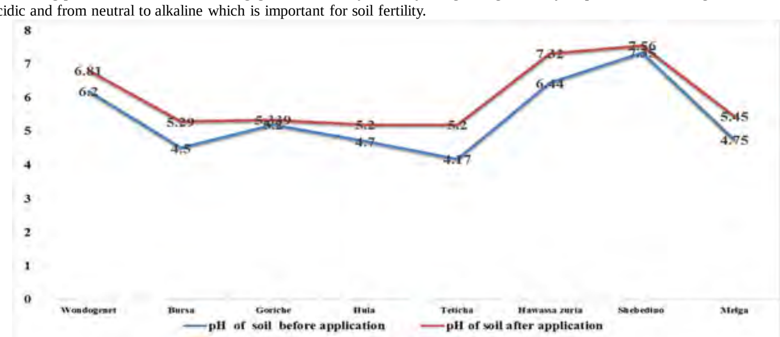


Figure 3 : soil acidity improvement

Figure 5: crops

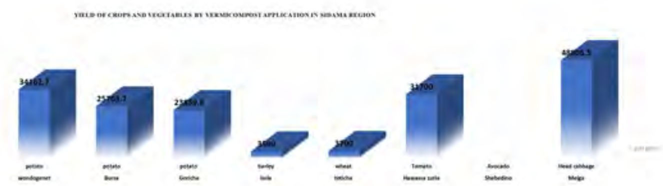


Figure 4: effect of verimicompost on yield of crops

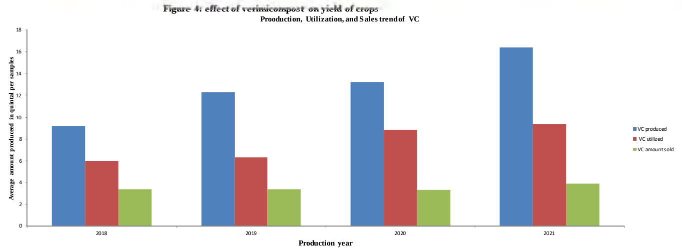


Figure 6: Production status of vermicompost. Source: Author survey, 2022

Figure 7 : Vermicopost ready for sale and receipt from its sale

Conculusion and recommendations

- Soilacidity improved by using vermicompost .
- Yield of crops boosted by vermicompost application
- Earthworm and Vermicompost beyond as fertilizer is also s income generation purpose for farmers and youth
- Therefore it is must each stakeholder should establish and promote the expansion of vermicompost technology for sustainable soil fertility improvement and crop production in the region and as a country as a whole.
- Also each concerned body should play its role in finding market linkage for vermicompost producers .

A poster presented at soil symposium 2025
March , 2025
SIDAMA /ETHIOPIA

Lime rate on wheat

Lime rate on Fababean

Demonstration of Acid Tolerant Croups

5.3 Yield Responses of Barley under Different Soil Amendment Options in Acidic Soil Areas of Central Ethiopia Region, Tarekegn Tefera, Central Ethiopia Agricultural Research Institute

Central Ethiopia Agricultural Research Institute

Worabe Agricultural Research Center

Poster Presentation on Soil Symposium 2025

Prepared by:- Tarekegn Tefera

March 6-7, 2025

Adama, Ethiopia

1

Title: **Yield Responses of Barley under Different Soil Amendment Options in Acidic Soil Areas of Central Ethiopia Region**

Introduction

- Soil acidity is the major challenge affecting productivity
- It limits nutrient availability, and reduced microbial activity
- Soil amendment option (s) not widely adopted in acid-affected areas in the regions.
- There is need for promoting adoption among farmers in acid-affected areas.

2

Objective

- To evaluate the yield responses of barley under different soil amendment options in acidic soil areas of Central Ethiopia Region.

Materials and methods

Treatments

- T1: 50% of Rec. 92N $69P_2O_5$ kg/ha; 50% Vermicompost (2 tons/ha), 50% lime (1.5 tons/ha)
- T2: 100% Rec. 92N $69P_2O_5$+ 50% lime (1.5 tons/ha)
- T3: Full Rec. 92N $69P_2O_5$ kg/ha
- T4: 50% NP (46N $635P_2O_5$ kg/ha) +50% ag lime (1.5 tons/ha)
- T5: Full Rec. ag-lime (3 tons/ha)

3

Materials and methods……

- Locations: Alicho and Gumer Woredas (10 farm fields as a replication from each Woreda), Silte and Gurage Zones
- NP and Vermicompost were applied at planting time.

Table 1: Pre-sowing soil sample lab analysis

pH	CEC (meqi/100g soil)	ExH	ExAl	%sand	%clay	%silt	Type
4.7	29.2	1.12	0.8	21.08	29.64	49.28	Clay loam

4

Row application of lime, Vermicompost and Barley at different growth stages

5

Table 2: Barley result in Alicho, 2024

Treatments	Biomass (kg/ha)	Yield (kg/ha)
T1: 50% NP +50% Vermicompost (2 t/ha)+1.5 t/ha lime	16240 [a]	5527 [a]
T2: 92N 69P_2O_5+1.5 t/ha lime	15570 [a]	5202 [a]
T3: 92N 69P_2O_5 kg/ha	13430 [ab]	4122 [ab]
T4: 46N 35P_2O_5 kg/ha	9764 [bc]	2946 [bc]
T5: 3 t/ha lime	6550 [c]	1742 [c]
Mean	12310	3908
LSD (0.05)	4801	1551
CV(%)	29.5	30.0

6

Table 3: Barley result in Gumer, 2024

Treatments	Biomass (kg/ha)	Yield (kg/ha)
T1: 50% NP +50% Vermicompost (2 t/ha)+1.5 t/ha lime	13858 [a]	5526 [a]
T2: 92N 69P_2O_5+1.5 t/ha lime	13745 [a]	5647 [a]
T3: 92N 69P_2O_5 kg/ha	11775 [ab]	4364 [ab]
T4: 46N 35P_2O_5 kg/ha	10066 [b]	3169 [b]
T5: 3 t/ha lime	7050 [c]	1627 [c]
Mean	11299	4067
LSD (0.05)	2392	1504
CV(%)	17.81	31.11

7

Result and Recommendation

- Yield results showed that 50% of Vermicompost (2t/ha) + 46N 35P_2O_5 kg/ha + 50 % of ag. lime (1.5t/ha) gave statistical highest yield and
- It gave statistical similar yield with application of Rec. 92N 69P_2O_5 kg/ha+50% ag. lime
- The results suggest that the application of 50% of vermicompost (2 t/ha) + 50% NP (46N 35P_2O_5 kg/ha) + 50% agricultural lime (1.5 t/ha) reclaims acidic soil and
- improves barely yield in acidic areas of central Ethiopia region.

8


CEARI
Thank you!!
9

Farmers Participatory Biochar Production, Nutrient Loading and Evaluation in Wolaita Zone, Southern Ethiopia

March 6, 2025, Adama, Ethiopia

Project members

- **Fanuel Laekemariam (PI)**
- **Abera Habtee (PhD) (Member)**
- **Mesfin Bibiso (Prof.) (Member)**

2

Contents

3

1. Introduction

- **Soil degradation is threat of food security in Wolaita, Southern Ethiopia (Fikeremareyam et al., 2022).**
    - **Soil erosion**
    - **Soil acidity**
    - **Continues cultivation,**
    - **Soil OC & nutrient depletion.**
- **Changing climate impacts fuels the problem.**
- **Biochar-based fertilizer (BBF) is a promising material for its contribution against the challenges (Murtaza *et al.*, 2023).**
- **However, empirical studies in Ethiopia remains limited.**

4

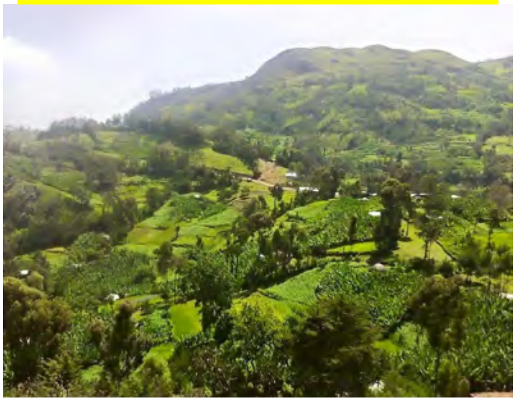
2. Objectives

- **To produce biochar, check quality and prepare BBF.**
- **To evaluate biochar-based fertilizer (BBF)**
  - **Crop response**
  - **Farmers preference**
  - **Economic feasibility**
  - **Soil properties**
- **To assess farmers' perspective about the opportunities and challenges of BBF production and utilization.**

5

3. Methodology

Study Area



- Wolaita Zone, Ethiopia
- Woreda and *Kebele*
  - **Sodo Zuria**
    - **Kebele:** Kokate Marachere
  - **Humbo**
    - **Kebele:** Ampo Koyisha

6

Key stakeholders

Researchers

- **DA**

Farmers (Male & Female

- **Approach: Participatory**
- **Method = Farmers Research Group (FRG)**

7

Activities

1 • **Biochar Production and Nutrient Loading**

2 • **Evaluating BBF: Crop, Farmers Preference, Soil Properties and Economic feasibility**

3 • **Assessing the opportunities and challenges from Participant Farmers Perspectives**

8

Activity I. Biochar Production and Nutrient Loading

A) Materials

Sawdust

Coffee husk

9

Cont….Activity I.

B. Biochar Production Technique

Rounding the corrugated roofing sheet
Average efficiency: 40-45%

10

Cont…Biochar production

11

Lab results

eurofins | Umwelt

Parameter	Lab.	Akkr.	Methode	BG	Einheit	Sawdust, Crop straw, coffee husk, amaranthus weeds	Coffee husk	Cordia sawdust
					Probenbezeichnung	TK-02590-001	TK-02598-001	TK-02599-001
					Probennummer	124011513	124011521	124011552
Physikalisch-chemische Kenngrößen aus der Originalsubstanz								
Gesamtwassergehalt	FR	FS	DIN 51718: 2002-06	0,1	Ma.-%	47,0	52,7	50,9
PAK aus der Originalsubstanz nach Toluol-Extraktion								
Naphthalin	FR	FS	DIN EN 17503, Verfahren 10.2.3: 2022-08	0,1	mg/kg	4,7	3,2	3,7
Acenaphthylen	FR	FS	DIN EN 17503, Verfahren 10.2.3: 2022-08	0,1	mg/kg	<0,1	<0,1	<0,1
Acenaphthen	FR	FS	DIN EN 17503, Verfahren 10.2.3: 2022-08	0,1	mg/kg	<0,1	<0,1	<0,1
Fluoren	FR	FS	DIN EN 17503, Verfahren 10.2.3: 2022-08	0,1	mg/kg	0,5	0,6	0,4
Phenanthren	FR	FS	DIN EN 17503, Verfahren 10.2.3: 2022-08	0,1	mg/kg	3,6	3,6	1,1
Anthracen	FR	FS	DIN EN 17503, Verfahren 10.2.3: 2022-08	0,1	mg/kg	0,5	0,4	0,3
Fluoranthen	FR	FS	DIN EN 17503, Verfahren 10.2.3: 2022-08	0,1	mg/kg	0,8	0,6	0,2
Pyren	FR	FS	DIN EN 17503, Verfahren 10.2.3: 2022-08	0,1	mg/kg	0,8	0,7	0,3
Benzo[a]anthracen	FR	FS	DIN EN 17503, Verfahren 10.2.3: 2022-08	0,1	mg/kg	0,3	0,3	0,1
Chrysen	FR	FS	DIN EN 17503, Verfahren 10.2.3: 2022-08	0,1	mg/kg	0,3	0,3	<0,1
Benzo[b]fluoranthen	FR	FS	DIN EN 17503, Verfahren 10.2.3: 2022-08	0,1	mg/kg	0,1	0,1	<0,1
Benzo[k]fluoranthen	FR	FS	DIN EN 17503, Verfahren 10.2.3: 2022-08	0,1	mg/kg	<0,1	<0,1	<0,1
Benzo[a]pyren	FR	FS	DIN EN 17503, Verfahren 10.2.3: 2022-08	0,1	mg/kg	0,1	0,1	<0,1
Indeno[1,2,3-cd]pyren	FR	FS	DIN EN 17503, Verfahren 10.2.3: 2022-08	0,1	mg/kg	<0,1	<0,1	<0,1
Dibenzo[a,h]anthracen	FR	FS	DIN EN 17503, Verfahren 10.2.3: 2022-08	0,1	mg/kg	<0,1	<0,1	<0,1
Benzo[ghi]perylen	FR	FS	DIN EN 17503, Verfahren 10.2.3: 2022-08	0,1	mg/kg	<0,1	<0,1	<0,1
Summe 8 EFSA-PAK exkl. BG	FR	FS	DIN EN 17503, Verfahren 10.2.3: 2022-08		mg/kg	0,8	0,8	0,1
Summe 16 EPA PAK exkl. BG	FR	FS	DIN EN 17503, Verfahren 10.2.3: 2022-08		mg/kg	11,1	9,9	6,1

- **PAH (mg/kg) : 6.1**
- **pH**
  - **Sawdust: 10.2**
  - **Coffee husk: 9.65**
- **EC (mS):**
  - **Sawdust: 0.4**
  - **Coffee husk: 0.41**
- **OC (%)**
  - **Sawdust: 15.9**
  - **Coffee husk: 19.3**
- **TN(%):**
  - **Coffee husk: 1.66%**
  - **Sawdust: 1.37%**
- **Av. P (%)**
  - **Sawdust: 0.043%**
  - **Coffee husk: 0.045%**

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Hands on training to Farmers' and DAs'

13

Activity I….. C) Nutrient Loading

Materials

Croton leaves

Vermicompost

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Dried croton leaves

- OC (%): 50.83
- N (%): 5.20
- P (mg/kg): 11.07
- K (%): 3.06
- C/N: 10

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Vermicompost

- pH: 7.15+7.9
- OC (%): 12.1 +10.89
- N (%): 1.9%
- P (mg/kg): 571.38
- K (%): 1.98%
- C/N: 8.83
- CEC (meq/100gm): 54.3

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BBF Preparation (Nutrient Loading)-Process



Mixed at 1:1 **Incubated for : 2 weeks**

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Activity II. Evaluating BC and BBF

1. **Crop Response**
2. **Farmers preference**
3. **Soil Properties**
4. **Economic feasibility**

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Field Evaluation….

- **Crop types**: Wheat and common bean
  - Wheat (**Dandea variety)**
  - **Common bean (Hawassa Dume)**
- **No. of farmers fields: 9 (M=7 and F= 2)**
- **No. FRG= three (each 8-10 participants)**
- **No. of Participants: 26 (M=20 and F=6)**

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Treatments and Design

1. **Control (No Fertilizer)**
2. **Mineral Fertilizer (Min.F)**
   1. **50% NPSB**
   2. **100% NPSB**
3. **BC (Biochar) x Min.F**
   1. **BC + 50% NPSB**
   2. **BC + 100% NPSB**
4. **BBF [BC, Vermicompost (VC) and Croton Leaves (CL)]with/out Min.F**
   1. **BBF Only**
   2. **BFF + 50% NPSB**
   3. **BFF + 100% NPSB**

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Research Design: RCBD

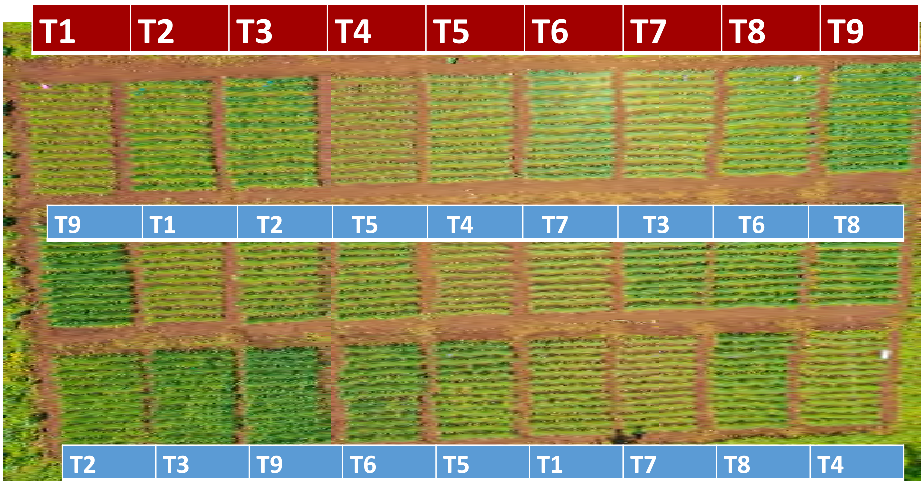

Photo: EthSoil Project

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Farmers engagement during field Experiment

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Data collected and analysis

- **Data Collected**
  - Crop parameters
  - Farmers preference
  - Soil parameters
- **Data Analysis**: following standard procedures.
- **Economic analysis**: CYMMIT (1998)

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Activity III. Assessing the Opportunities & Challenges of BBF: Farmers Perspectives

24

Discussion with participant farmers+ DAs

25

Fields at Vegetative Stage

26

Discussion during field day

27

Opportunities & challenges were surveyed using questionnaire.

28

4. Preliminary results

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A. Crop Performance

30

Wheat [Control Vs (BBF+ Fertilizer)

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Field 1

	Plant Height	Tillers	Seeds per spike	Spike Length	Dry biomass	Grain Yield
	Cm	No./m2	No.	Cm	t/ha	t/ha
Control	72.0 g	374.67c	26.19d	6.33d	3.62d	1.21d
50%MF	82.1de	432.00abc	40.81abc	7.66abc	6.13c	2.23c
100%MF	**85.67cd**	**473.33a**	**33.09cd**	**7.27bcd**	**8.62b**	**3.08b**
BC	69.95g	428.00abc	25.48d	6.78cd	3.52d	1.06d
BC+50%MF	80.43 ef	448.00 ab	37.95bc	7.82abc	5.59c	1.89c
BC+100%MF	89.67b	453.33ab	44.00ab	8.38ab	9.14b	3.04b
BBF	78.2 f	413.33bc	36.48 bc	7.63abc	5.493c	1.86c
BBF+50%MF	**86.9bc**	**476.00a**	**48.38a**	**8.39ab**	**8.37b**	**3.30 b**
BBF+100%MF	**94.7 a**	**473.33a**	**43.29ab**	**8.65a**	**11.59a**	**3.98 a**
$LSD_{0.05}$	3.67	59.4	8	1.22	1.23	0.63
CV (%)	2.6	7.5	12.4	9.2	10.3	15.1

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Field Two

	Tillers	Dry biomass	Grain Yield
	No./ m2	t/ha	t/ha
Control	394.7de	2.57d	0.80g
50%MF	406.7cde	5.04c	1.50ef
100%MF	470.7abc	7.58b	2.56c
BC	377.3de	2.72d	1.06fg
BC+50%MF	484.0ab	5.39c	1.94de
BC+100%MF	434.7bcd	8.79b	3.36b
BBF	348.0e	5.92c	2.27cd
BBF+50%MF	442.7abcd	7.81b	3.22b
BBF+100%MF	512.0a	11.59a	4.39a
$LSD_{0.05}$	75.68	1.57	0.55
CV (%)	10.2	14.2	13.6

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Average

	Tillers (No./m2)	Dry biomass (t/ha)	Grain Yield (t/ha)
Control	385.8d	3.2d	1.1e
50%MF	421.8cd	5.7c	2.1d
100%MF	**464.4ab**	**7.9b**	**2.9c**
BC	416.9cd	3.2 d	1.2e
BC+50%MF	452.4abc	5.5c	2.1d
BC+100%MF	**436.0bc**	**8.6b**	**3.1bc**
BBF	391.1d	5.8c	2.2d
BBF+50%MF	450.2abc	8.5b	3.3b
BBF+100%MF	**486.70a**	**11.1a**	**4.1a**
$LSD_{0.05}$	42.1	0.73	0.36
CV (%)	5.6	6.5	8.4

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Control vs (BBF + 100%MF)

385.8e → 486.7a
(+26%)

3.2d → 11.1a
(+247%)

1.1e → 4.1a
(+273%)

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Common bean [Control Vs (BBF+ Fertilizer)]

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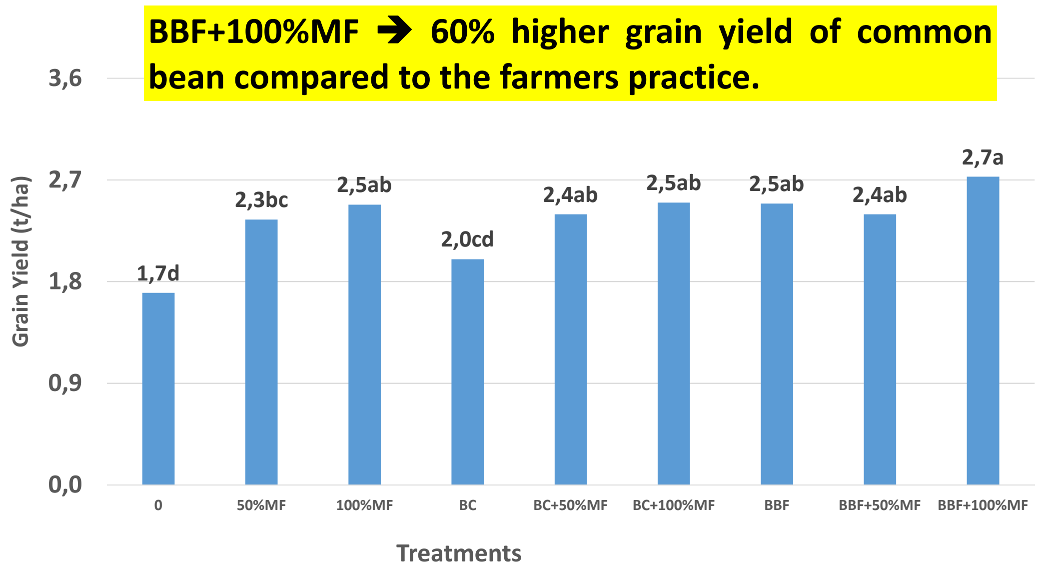
Common bean



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B) Farmers Preference Ranking

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Ranks

Rank	Wheat		Common bean
1st	**BBF+100%MF**		**BBF+100%MF**
2nd	**BBF+50%MF**		**BBF+50%MF**
3rd	**BC+100%MF**		**BC+100%MF and 100%MF**
4th	100%MF		BC+ 50%MF
5th	BC+ 50%MF		50%MF

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C. Changes in soil properties

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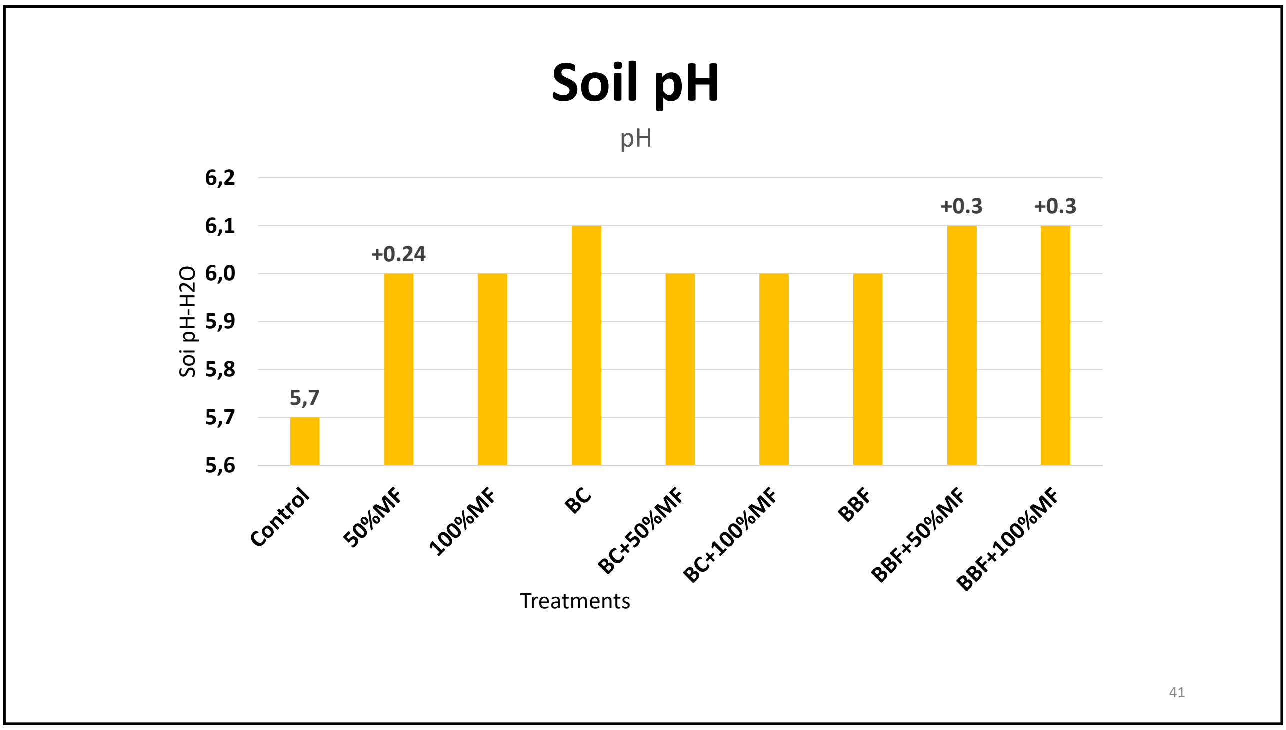
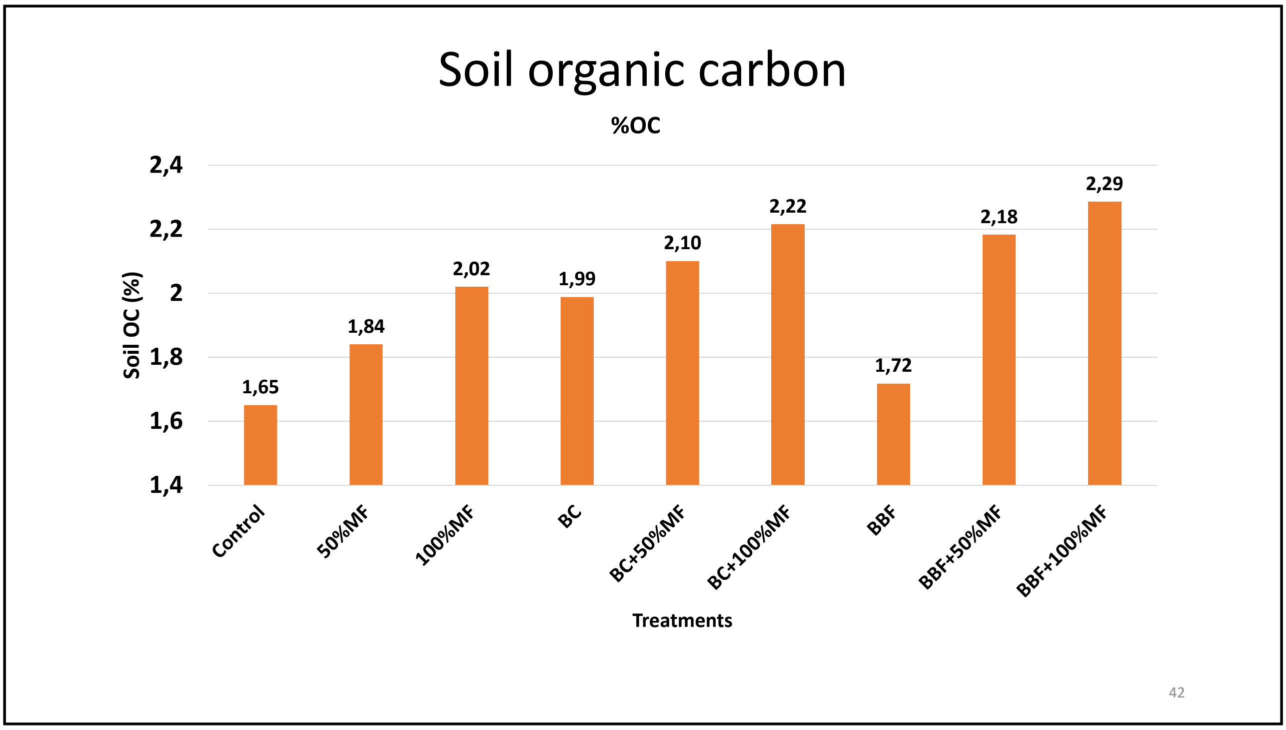
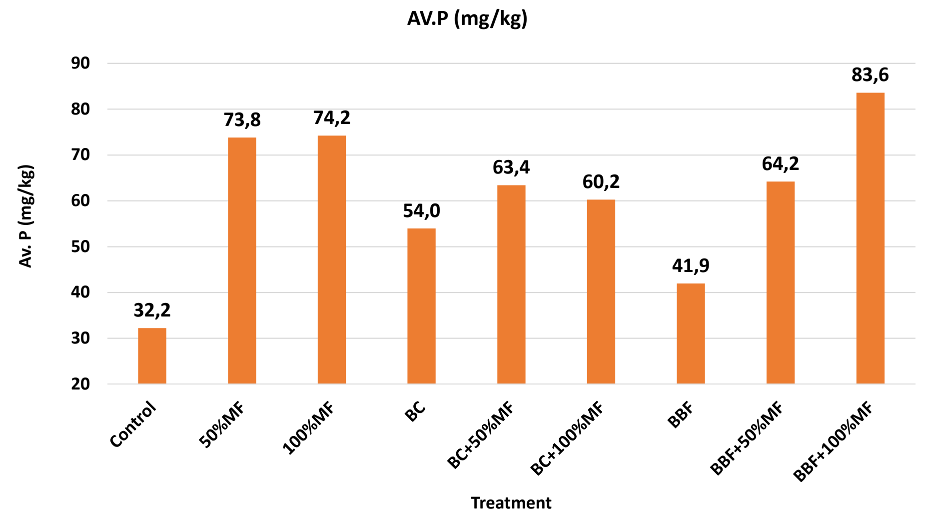

Soil pH
pH
6,2
6,1
6,0
5,9
5,8
5,7
5,6
Soi pH-H2O
5,7
+0.24
+0.3
+0.3
Control
50%MF
100%MF
BC
BC+50%MF
BC+100%MF
BBF
BBF+50%MF
BBF+100%MF
Treatments
41


Soil organic carbon
%OC
2,4
2,2
2
1,8
1,6
1,4
Soil OC (%)
1,65
1,84
2,02
1,99
2,10
2,22
1,72
2,18
2,29
Control
50%MF
100%MF
BC
BC+50%MF
BC+100%MF
BBF
BBF+50%MF
BBF+100%MF
Treatments
42

Available soil P (mg/kg)



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D. Economic feasibility result-wheat

	Income (Br/ha)	TVC (Br/ha)	Net income(B/ha	Effect
Control	79,200.00	0	79,200	
50%MF	151,200.00	8,155	143,045	+
100%MF	208,800.00	23,000	185,800	+
BC	86,400.00	66,400	20,000	-
BC+50%MF	151,200.00	74,600	76,600	-
BC+100%MF	223,200.00	82,800	140,400	+
BBF	158,400.00	71,400	87,000	+
BBF+50%MF	237,600.00	79,600	158,000	+
BBF+100%MF	295,200.00	87,800	207,400	+

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Economic feasibility-common bean

	Income (Br/ha)	TVC (Br/ha)	Net income (Br/ha)
Control	122,400.00	0	122,400
50%MF	169,056.00	8,155	160,901
100%MF	178,632.00	23,000	155,632
BC	143,827.20	66,400	77,427
BC+50%MF	172,454.40	74,600	97,854
BC+100%MF	179,913.60	82,800	97,114
BBF	179,316.00	71,400	107,916
BBF+50%MF	172,454.40	79,600	92,854
BBF+100%MF	196,416.00	87,800	108,616

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Activity III. Assessing the Opportunities & Challenges of BBF: Farmers Perspectives

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Soil Fertility Status and Biochar

- 90% rated their farm under moderately fertile soil.
- 85% replied soil fertility status has been declining over the past few years.
- 85% of respondents didn't know about biochar and 15% have some information about biochar but didn't use.
- 95% don't have Bio/char production experience

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Perceived opportunities

- **Improved soil fertility, soil moisture and yield**
  - **Yes (95%) and No (5%)**
- **Applicable (equipment, and application)**
  - **Yes (85%) I am not sure (15%)**
- **Better performance**: Integration of BC/BBF with mineral fertilizer vs mineral fertilizer (100%)
- **Social Acceptance (Positive feed backs)**: Farmers didn't hesitate to adopt BBFs

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Challenges

- **Challenges**
  - High initial cost (25%) (production and application)
  - Limited Technical knowledge (65%)
    - Demand capacity building training
- Topics/areas that farmers need assistance
  - Production techniques (95%)
  - Application methods 5%

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Experience Sharing

50

To students (under and post graduate)

51

Researchers and EthSoil Team

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EthSoil team

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3. Conclusion

- **BC and BBF alone performed the least.**
- **Integration of BC and BBF with mineral fertilizer were found promising.**
- **Despite it has significant contribution, the technology has high initial cost to farmers.**
- **Biochar or BBF with mineral fertilizer was found economically profitable for wheat production.**

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Suggestion

- **For sound conclusion**
  - **The experiment has to be repeated.**
  - **Residual effects has to be investigated.**

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Acknowledgment

Farmers and Development Agents in the study area

56


Thank you
for listening
57

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EIAR Ethiopian Institute of Agricultural Research

Effects of Biochar-Based Fertilizer Application on Soil properties, Yield and Yield components of Wheat grown on Nitisols in Hula and Teticha districts

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Senior researcher, Ethiopian Institute of Agri. Research

March 2025
Adama, Ethiopia

Outline of the presentation

- **Background**
- **Materials and Methods**
- **Results/Major findings**
- **Conclusions and Recommendation**

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6.2 Effects of Biochar-Based Fertilizer Application on Soil properties, Yield and Yield components of Wheat grown on Nitisols in Hula and Teticha districts, Dr. Ashenafi Nigussie, Ethiopian Institute of Agricultural Research

Backgrounds

- **Land degradation** is one of the major obstacles preventing agricultural production from meeting Ethiopia's goals

  = improved development, food security, and poverty reduction

- The **primary causes** of land degradation in Ethiopia are,

  = erosion, soil acidity, loss of SOM and nutrient mining (Getachew and Tilahun, 2017).

- **Soil acidity** is one of the major causes for land degradations,

  = covering about **43%** of the cultivated land in the country

  = **28%** is strongly acidic which demands reclamation to give production.

- To reduce the effects of **land degradation** on crop productiovity, numerous studies have been conducted

  = **sole and combined** use of organic and inorganic inputs.

3

Count….

- **Co-application** of organic inputs (FYM, CC, VC and biochar) and mineral fertilizers, **improved**,

  = soil quality and reduce the impacts of land degradation on crop productivity.

- Among organic sources, **biochar** is considered as an important inpute, mainly as **soil conditioner** to reclaim different soil degradations.

- However, **limited information** is currently available regarding the combined effects of **biochar** along with other organic and/or inorganic sources.

- The available few study results confirmed that the **positive effects of using biochar** with other improved agricultural technologies (Getachew et al., 2016; Mekdes et al., 2022).

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Specific Objectives

- To evaluate the effects of biochar-based fertilizer **(BBF)** application on soil properties and wheat yield and yield componets
- To demonstrate the beneficial effects of **BBF** application on soil properties and wheat productivity

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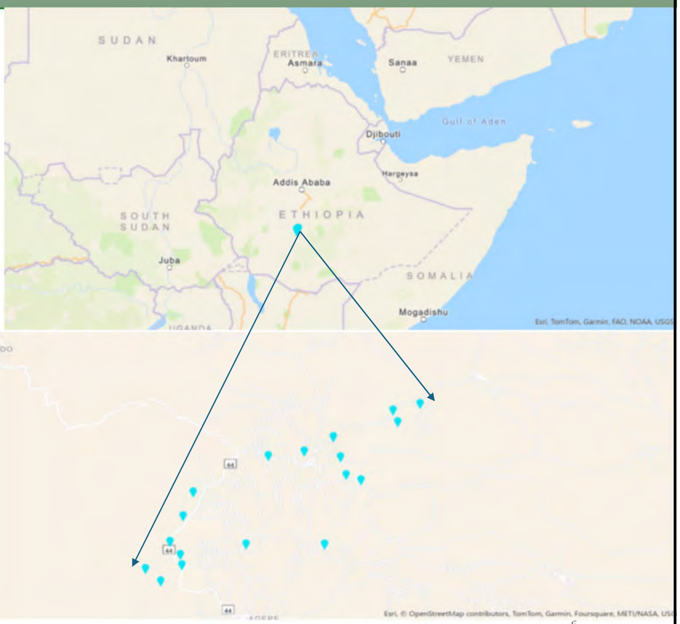
Materials and Methods

Participatory field evaluation of BBF was conducted on eighteen **(18)** farmer fields, **10** in Teticha and the remaining **8** in Hula districts, respectively.

Table 1. Geographical discrition of the study stites

No	Farmers name	District	Kebele	Latitude	Longitude	Altitude
1	Demeke Dangura	Hula	Gase	6^{0} 30’ 56.07"	38^{0} 29’ 25.58"	2730
2	Gasse FTC	Hula	Gase	6^{0} 31’ 15.78"	38^{0} 29’ 11.78"	2763
3	Gezahagn Denka	Hula	Gase	6^{0} 31’ 54.32"	38^{0} 29’ 29.24"	2724
4	Kefale Nono	Hula	Werama	6^{0} 32’ 30.47"	38^{0} 29’ 42.74"	2671
5	Kawato Dangura	Hula	Gase	6^{0} 30’ 40.56"	38^{0} 29’ 27.64"	2736
6	Ayelech Asefa	Hula	Gase	6^{0} 30’ 34.91"	38^{0} 28’ 38.99"	2738
7	Tibebu Arusa	Hula	Gase	6^{0} 30’ 16.13"	38^{0} 28’ 59.35"	2793
8	Wiramma FTC	Hula	Werama	6^{0} 31’ 11.981"	38^{0} 30’ 53.31"	2677
9	Petros Naka	Teticha	01	6^{0} 33’ 32.06"	38^{0} 32’ 11.01"	2665
10	Sororo FTC	Teticha	Sororo	6^{0} 32’ 48.66"	38^{0} 33’ 26.72"	2663
11	Logita Boroge	Teticha	Sororo	6^{0} 32’ 56.50"	38^{0} 33’ 06.89"	2677
12	Yirda Kebana	Teticha	Wonjela	6^{0} 34’ 43.62"	38^{0} 34’ 45.66"	2668
13	Wakeyo Base	Teticha	Wonjela	6^{0} 34’ 33.92"	38^{0} 34’ 09.51"	2651
14	Belay Baye	Teticha	Debecha	6^{0} 34’ 16.19"	38^{0} 33’ 15.77"	2662
15	FTC	Teticha	Debecha	6^{0} 31’ 11.67"	38^{0} 32’ 38.12"	2687
16	Ayiresam Wele	Teticha	Debecha	6^{0} 33’ 53.74"	38^{0} 32’ 49.80"	2676
17	Debalke Dasa	Teticha	Debecha	6^{0} 33’ 23.33"	38^{0} 32’ 59.34"	2685
18	Wake Keltera	Teticha	Teticha Badiya	6^{0} 33’ 25.09"	38^{0} 31’ 22.97"	2661



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6.2 Effects of Biochar-Based Fertilizer Application on Soil properties, Yield and Yield components of Wheat grown on Nitisols in Hula and Teticha districts, Dr. Ashenafi Nigussie, Ethiopian Institute of Agricultural Research

Experimental treatments and Design

- **Three (3) fertilizer treatments** were evaluated,

1. Sole BBF
2. BBF + half does of INF (46 **kg N**)
3. 100% recommended INF (92 **kg N**)

- Laid out in **RCBD** and farmers considered as replications.

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Biochar production

- A total of **3000 kg** of dry **coffee husk** was collected from near by coffee processing industry Abosto Kebele
- Before pyrolysis taken place, **sorting** of other mixed materials was employed
- Pyrolysis of the feedstock was undertaken using locally available **barrels** at Awada AR subs-center
- A total of **900 kg** BC was produced

Vermicompost production

- Vermicompost was prepared at **WgARC vermi-house**
- Using locally available agricultural wastes
- A total of **1800 kg** of vermicompost was prepared and used for the study.

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BBF formulation

- BBF was prepared **at each participating** farmers' experimental site
- Formulation of BBF was made from **BC** and **VC**
- Dry weight bases 1:2 ratio of **BC to VC**
- A total of **2700 kg of BBF** was formulated by mixing
  = 900 kg BC + 1800 kg VC
- Before applying BBF, three representative samples were taken for analysis.

Experimental procedure and MP

- The experimental plots were plowed **three times** before seed sowing
- Two weeks before seed sowing, BBF was applied in rows and then incorporated into the soil.
- **Recently released and locally adaptable Dened'a wheat** variety was used as test crop and sown at rate of 150 kg ha 1
- Recommended (P) from (TSP) (**69 kg P_2O_5**) was uniformly applied in a band
- Nitrogen (N) was applied as per treatments from urea fertilizer in two splits:

  = 1/3 during seed sowing and the remaining 2/3 at tillering

Count....

Soil and BBF sampling and Analyses: -

- Representative **soil samples were** collected**, three times; at a depth of 0-20 cm**

  = First, before application of any treatments,

  = Second, when seedlings reached at height of 10–20 cm, core samples from each plot was collected and

  = Third, just after harvest; plot based samples were collected.

- Befor application, three representative **BBF samples** were collected and analyzed

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Data collection and analysis

- **Growth, yield and yield compoents** of the test crop (wheat) were collected.
- The collected was subjected to **ANOVA** using SAS statistical package
- **Mean separation** was performed using the LSD test at the 5% P level.
- **Field days** were organized

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Results/Major findings

Table 1. Initial selected soil chemical properties

Soil chemical properties	Strongly acidic soils (pH < 5.5) (N=5)			Moderately acidic soils (pH b/n 5.6 to 6.0) (N=8)			Slightly acidic soils (pH b/n 6.1 to 6.5) (N=5)		
	Min	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**
Soil pH in water	5.18	5.5	5.32	5.66	5.89	5.76	6.16	6.21	6.15
Exchangeable acidity (EA)	1.26	2.66	1.78	0.54	3.02	1.11	0.3	0.79	0.55
Organic carbon (%)	0.98	2.29	1.56	0.47	2.62	1.63	0.39	1.55	1.37
Total N (%)	0.09	0.17	0.13	0.04	0.23	0.14	0.03	0.17	0.12
Available P (ppm)	3.12	12.5	7.46	7.57	16.68	12.45	10.37	19.57	15.18

- Mean soil pH (H_2O) ranged from strongly acidic-to slightly acidic -------- Jones, J. Benton (2003).
- **EA** varied from 0.55 to 1.78;
- Both **OC** and **TN** of the soils ranged from **very low to medium** -------------Tekalign's (1991).
- While **avail. P** ranged from **low to medium** -------------------------------------Tekalign's (1991).
- To replenish depleted OC and ameliorate acidic soil conditions; therefore, it is crucial to apply **BBF** for most soils and thereby enhancing soil health and crop productivity.

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6.2 Effects of Biochar-Based Fertilizer Application on Soil properties, Yield and Yield components of Wheat grown on Nitisols in Hula and Teticha districts, Dr. Ashenafi Nigussie, Ethiopian Institute of Agricultural Research

Table 2. Some selected chemical analysis of BBF prior treatment application

Sample Code	pH	EA	OC%	OM%
BBF1	8.66	0.52	38.24	44.83
BBF2	8.58	0.63	39.95	46.83
BBF3	8.93	0.38	35.67	41.81
Mean	**8.72**	**0.51**	**37.95**	**44.49**

- The mean pH was **8.72** and rated as **alkaline**, which influence nutrients availability in the soil
- The **EA** ranged between **0.38** and **0.63**, which is generally below one (1) and favorable for most plant growth
- The **OC** content ranged from **35.67** to **39.95** and its mean value was **37.95**, which is a moderate level and beneficial for **maintaining soil fertility and promoting ecological balance**.

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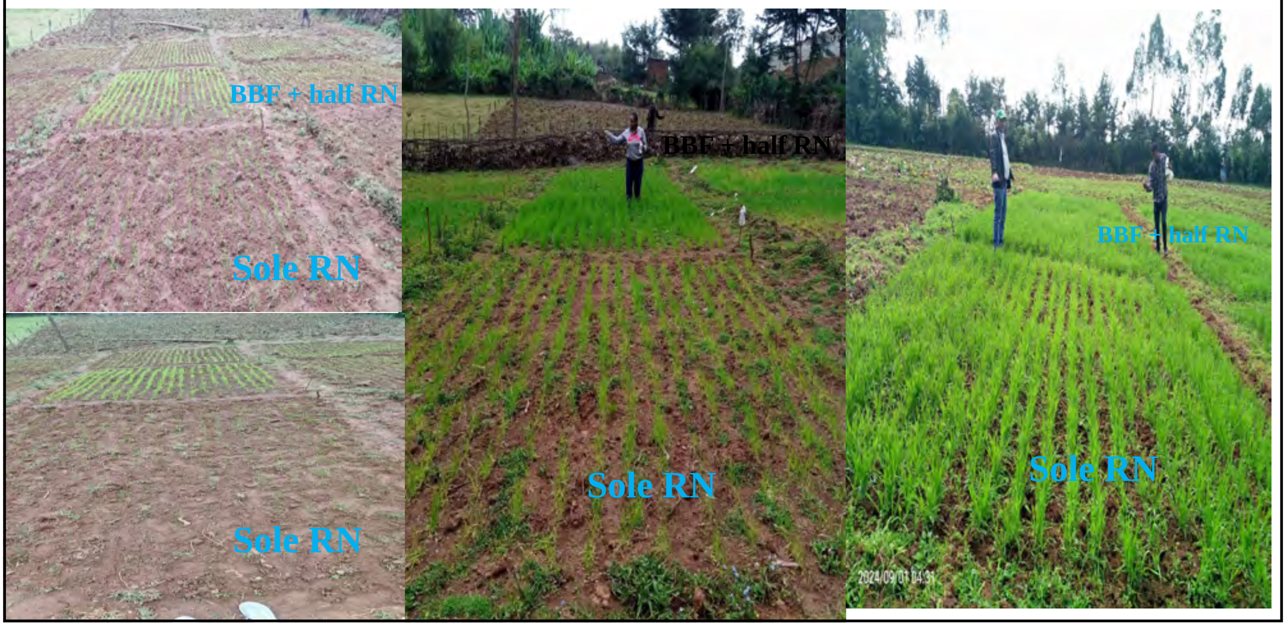
Effects of fertilizer treatments on seed germination and crop growth in highly acidic conditions



6.2 Effects of Biochar-Based Fertilizer Application on Soil properties, Yield and Yield components of Wheat grown on Nitisols in Hula and Teticha districts, Dr. Ashenafi Nigussie, Ethiopian Institute of Agricultural Research

Pictorial presentation field conditions

6.2 Effects of Biochar-Based Fertilizer Application on Soil properties, Yield and Yield components of Wheat grown on Nitisols in Hula and Teticha districts, Dr. Ashenafi Nigussie, Ethiopian Institute of Agricultural Research

➢ To evaluate the treatments effects on **soil BD and moisture content;** core soil samples were taken from each plot when the seedlings reach at 10-20 cm height

Table 3. Responses of bulk density and soil moisture content to applied fertilizer treatments

Treatments	Bulk density g/cm³	Gravimetric SMC (%)	Volumetric SMC (V³/V³)
Sole BBF	1.31^{b}	28.29^{a}	36.78^{a}
BBF + half dose of N	1.37^{a}	23.22^{b}	31.69^{b}
Recommended N (BAU)	1.40^{a}	17.91^{c}	24.92^{c}
LSD (0.05)	0.03	2.66	3.1
CV (%)	2.24	11.53	9.98

Application of sole BBF and BBF plus a half dose of IN fertilizer reduced soil **BD** by **6.4% and 2.2%,** respectively, compared to 100% RIN fertilizer (BAU).

While gravimetric **SMC** improved by **57.95 and 29.65%**, due to the application of sole BBF and BBF + half dose of IN fertilizer, respectively over the sole RIN fertilizer.

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Table 4. Effects of fertilizer treatments on plant height (**PH**), spike length **(SL**) and number of seed per spike (**NSPS**) of wheat grown under very acidic soil conditions

Treatments	**Strongly acidic soils (pH < 5.5) (N=5)**			**Moderately acidic soils (pH b/n 5.6 to 6.0) (N=8)**			**Slightly acidic soils (pH b/n 6.1 to 6.5) (N=5)**		
	PH (cm)	**SL (cm)**	**NSPS**	**PH (cm)**	**SL (cm)**	**NSPS**	**PH (cm)**	**SL (cm)**	**NSPS**
Sole BBF	82.04^{a}	6.12^{a}	24.76	100.03^{ab}	6.75^{b}	27.62	105.44	6.64	25.6
BBF + 50% RN	89.46^{a}	6.04^{a}	21.24	103.8^{a}	7.37^{a}	25.94	108.04	7.04	23.36
100% RN	56.32^{b}	4.56^{b}	19.64	93.35^{b}	6.78^{b}	27.06	100.48	7.44	28.2
LSD (0.05)	13.81	1.32	ns	8.18	0.51	ns	ns	ns	ns
CV (%)	12.47	16.26	22.42	7.7	6.77	15.59	6.77	10.31	15.4

In case of **strongly acidic soil**, **PH** and **SL** improved by **58.8%** and **32.5%,** due to application of **BBF + half dose IN**, respectively, as compared to 100% RIN

While in **moderately acidic soil**, **PH** and **SL** improved by **11.2%** and **8.7%,** respectively, as compared to 100% RIN .

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6.2 Effects of Biochar-Based Fertilizer Application on Soil properties, Yield and Yield components of Wheat grown on Nitisols in Hula and Teticha districts, Dr. Ashenafi Nigussie, Ethiopian Institute of Agricultural Research

Table 5. Effects of fertilizer treatments on above ground biomass, grain yield and harvest index (HI) of wheat grown under very acidic soil conditions

Treatments	Strongly acidic soils (pH < 5.5) (N=5)			Moderately acidic soils (pH b/n 5.6 to 6.0) (N=8)			Slightly acidic soils (pH b/n 6.1 to 6.5) (N=5)		
	AGB (kg ha^{-1})	GY (kg ha^{-1})	HI (%)	AGB (kg ha^{-1})	GY (kg ha^{-1})	HI (%)	AGB (kg ha^{-1})	GY (kg ha^{-1})	HI (%)
Sole BBF	4769.0^{a}	2075^{a}	44.24^{b}	5825.6^{b}	2306.3^{b}	39.39^{b}	5706	2440^{b}	43.14
BBF + 50% RN	4790.0^{a}	2380.0^{a}	49.74^{a}	6633.8^{a}	2943.8^{a}	44.51^{a}	6462	3032^{a}	47.14
100% RN	3432.0^{b}	1430^{b}	42.18^{b}	5483.1^{b}	2339.4^{b}	42.49^{ab}	6034	2580^{ab}	42.86
LSD (0.05)	602.42	307.73	5.13	521.07	289.28	3.46	ns	480.16	ns
CV (%)	9.54	10.75	7.76	8.12	10.66	7.66	8.91	12.26	7.28

In case of **strongly acidic soil**, due to application of BBF + half dose IN, **AGB and GY** improved by **39.57%** and **66.4%,** respectively, as compared to 100% RIN

While in **moderately and slightly acidic soils**, GY improved by **25.8%** and **17.5%,** respectively, as compared to 100% RIN .

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Field days were organized in both experimental districts at green and physiological maturity stages

Table 6. Number of participants

No.	Participants	Hula district Male	Hula district Female	Hula district S. total	Teticha district Male	Teticha district Female	Teticha district S. Total	Total
1	Farmers	25	5	30	45	12	57	87
2	Development agents	3	1	4	3	2	5	9
3	Woreda Agr. Expertise	4	-	4	4	-	4	8
4	Researchers	7	1	8	5	2	7	15
5	Others	3	1	4	3	1	4	8
	Total			50			77	127

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6.2 Effects of Biochar-Based Fertilizer Application on Soil properties, Yield and Yield components of Wheat grown on Nitisols in Hula and Teticha districts, Dr. Ashenafi Nigussie, Ethiopian Institute of Agricultural Research

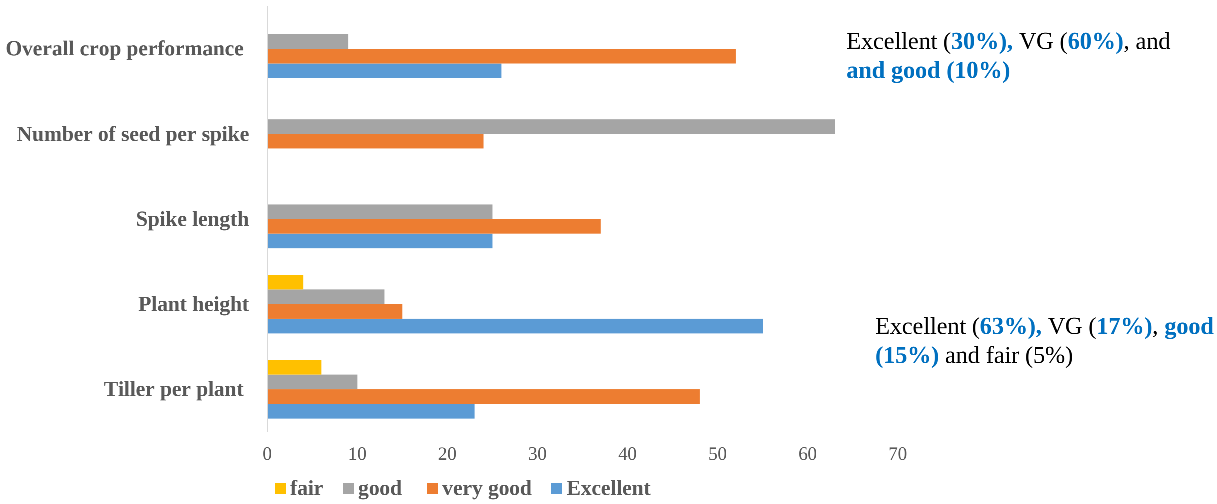

Figure 1. Farmers' rating the effects of BBF plus half dose of inorganic N application on some selected crop parameters against recommended inorganic N fertilizer alone (N= 87).

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Conclusions and recommendations

- Agronomic and yield parameters, including plant height, spike length, grain yield, biomass yield, and harvest index, were significantly affected by fertilizer treatments.
- The highest wheat grain yield was achieved with the application of **BBF plus 50% recommended** nitrogen from urea.
- The effects of BBF application either in sole or combined form were pronounced highly in **strongly acidic soil**, followed by **moderate and slightly acidic** conditions.
- Therefore, it is advisable to **promote the use of BBF plus half dose of inorganic N** fertilizer for wheat production and can be used as best alternatives especially in regions where strongly and moderately acidic soil conditions.
- Additional studies should be conducted to explore the **buildup and residual benefits** of BBF application on soil fertility and acid soils amelioration across different soil types and climatic conditions.

6.2 Effects of Biochar-Based Fertilizer Application on Soil properties, Yield and Yield components of Wheat grown on Nitisols in Hula and Teticha districts, Dr. Ashenafi Nigussie, Ethiopian Institute of Agricultural Research

Dilla University

ETH-SOIL

Evaluation of Biochar-Based Fertilizers in low-input acidic soils of Gedeo-Sidama area, Southern Ethiopia

Preliminary Field Trial Results

By: Yackob Alemayehu
Dilla University

Soil Symposium 2025,
March 6-7, 2025
Adama, Ethiopia

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Project Team Members:

Presentation outline

- Background & Justification
- BBF preparation methods and trial set up
- Results
- Conclusion and Way Forward

2

Background & justification

- Challenges crop productivity in Ethiopia, particularly in (sub)humid…highlands
- Declining soil fertility due to (major constraints):
  - Inherent soil acidity associated fertility constraints
  - Low input and poor nutrient management
  - Severe erosion… soil degradation, population pressure

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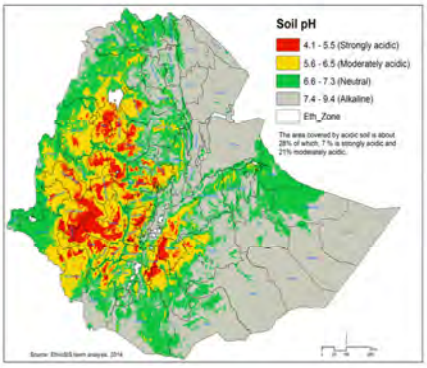
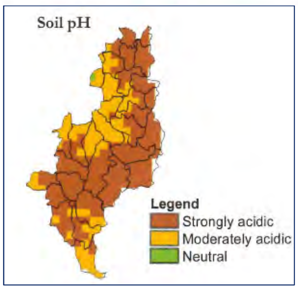
Background & justification….

- Severe soil acidity in most parts of **Gedeo zone** and adjoining districts of Oromia-Sidama region,
  - hindering productivity of large tracts of land.
  - threatening rural livelihoods (Berihun et al., 2017; Wolde et al., 2020)
- **Agricultural lime**:
  - liming is widely practiced
  - high cost and limited supply to smallholder farmers.
- **Rising chemical fertilizer price**
  - Low use efficiency of applied fertilizer (Soil acidity

This underlines the need for alternative sustainable solution

- Innovative, affordable approaches are urgently required to manage acid soil and enhance productivity.





Bule district

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6.3 Evaluation of Biochar-Based Fertilizers in low-input acidic soils of Gedeo-Sidama area, Southern Ethiopia, Dr. Yackob Alemayehu, Dilla University

Background & justification….

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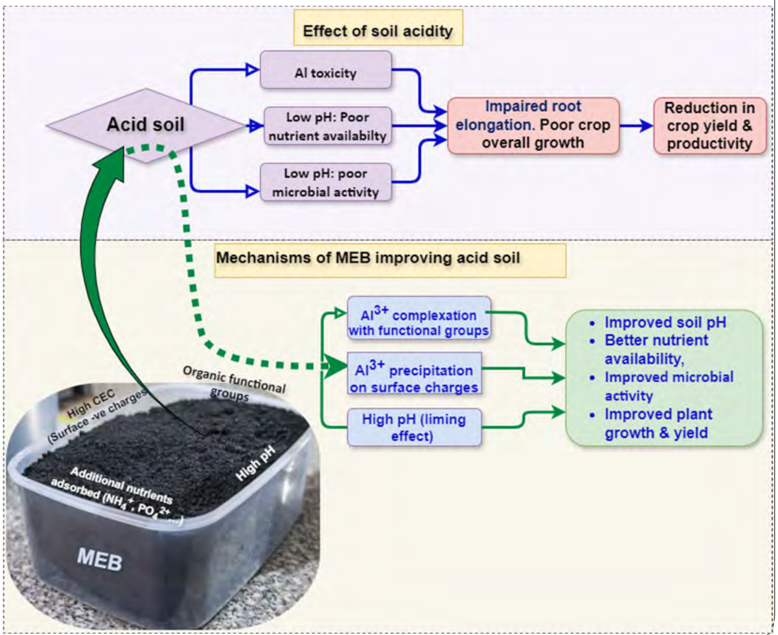
Biochar-Based Fertilizer Technologies: A solution for acidic soils

Biochar's properties, surface area, Porous structure, high inherent pH, CEC, base cation content

- Retain nutrients effectively…. Slow release fertilizer

Acting as **liming agent (**ameliorating acidity**)** and **fertilizer**.



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Background & justification….

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•The present project study (**ETH-Soil Project**) was conducted in BBF preparations in low-input acidic soils in Gedeo zone and the neighboring districts, using a farmer-participatory approach.

- Using locally available waste biomass (coffee processing waste)

Objectives:

- to evaluate the potential effect of BBF strategies (types, rates) on crop yield, selected soil properties, and available nutrients across varying soil-farming condition
- to assess the performance of BBF strategies on a large number of farms (tested on 12 farms)

6

Biochar and BBF production process

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Biochar quality: PAHs (polycyclic aromatic hydrocarbons) analysis result.

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16 PAHs parameters	Unit	Sample 1 TK-02643-001	Sample 2 TK-02569-001
Naphthalene	mg/kg	1.1	0.8
Acenaphthylene	mg/kg	< 0.1	< 0.1
Acenaphthene	mg/kg	< 0.1	< 0.1
Fluorene	mg/kg	< 0.1	0.1
Phenanthrene	mg/kg	0.5	0.4
Anthracene	mg/kg	0.1	< 0.1
Fluoranthene	mg/kg	0.2	0.2
Pyrene	mg/kg	0.1	0.2
Benzo(a)anthracene	mg/kg	< 0.1	< 0.1
Chrysene	mg/kg	< 0.1	< 0.1
Benzo(b)fluoranthene	mg/kg	< 0.1	< 0.1
Benzo(k)fluoranthene	mg/kg	< 0.1	< 0.1
Benzo(a)pyrene	mg/kg	< 0.1	< 0.1
Indeno(1.2.3-cd)pyrene	mg/kg	< 0.1	< 0.1
Dibenzo(a.h)anthracene	mg/kg	< 0.1	< 0.1
Benzo(g.hi)perylene	mg/kg	< 0.1	< 0.1
Sum of 8 EFSA-PAK	mg/kg	(n. b.) 1)	(n. b.) 1)
Sum of 16 EFSA-PAK	mg/kg	2	1.7

PAH within the threshold of **6 mg/kg**, meeting the EBC requirements for biochar for soil application (EBC, 2021).

Property	CB	EB	Coffee Biochar
MC (%)	34.5±1.5	37.5±1.5	5.9±0.9
pH	7.78±0.04	8.64±0.15	8.78±0.11
EC (mS/cm)	4.51±0.41	8.41±1.73	7.95±1.18
P (g/kg)	29.77	11.51	2.8
TN (g/kg)	22.20	17.2	4.4
TOC (g/kg)	329.70	394.10	303.3

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Field Trial Setup

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- **Participatory approach:** Mother-baby trial design

BBF type	Application strategy	Mother-trial	Baby-trial
Enriched biochar (EB)	EB2	15 t/ha + 0	
	EB1+F1	7.5 t/ha + 50%	*
	EB1+F2	7.5 t/ha + 100%	
	EB2+F1	15 t/ha + 50%	*
	EB2+F2	15 t/ha + 100%	
Co-composted biochar (CB)	CB2	7.5 t/ha + 0	
	CB1+F1	7.5 t/ha + 50%	*
	CB1+F2	15 t/ha + 100%	
	CB2+F1	15 t/ha + 50%	*
	CB2+F2	15 t/ha + 100%	
Reference (ctl)	Unfertilized control	0 t/ha + 0	
	F2 (Fertilized)	0 t/ha + 100%	*
	PB (Pure biochar)	15 t/ha + 100%	

Participatory field trial:
12 farmers' fields at Bule district, using five treatments:

1. EB2+F1
2. CB2+F1
3. EB2+CB2
4. Fertilizer alone (BAU),
5. Unfertilized control.

Farmers considered as replication

RFD: 120 kg N/ha and 40 kg P/ha considered as BAU
EB at a high dose (15 t/ha) estimated as 55.1 kg N /ha, along with 32.9 kg P/ha

9

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Table: Site characteristics where the mother trials established

Field trial location	Setamo FTC, Dara	Chito FTC Yirgacheffe	Okulo 1 FTC, Bule	Semero, Abaya
Altitude (m asl)	1829 m	1863 m	2824 m	1491 m
Soil properties				
Texture	Clay	Clay	Clay	Clay loam
pH	4.6	4.44	4.67	6.28
P_{av} mg/kg Mehlich-3 P	2.41	4.99	7.23	12.63
TN%	0.16	0.18	0.15	0.11
CEC ($cmol_c\ kg^{-1}$)	23.33	16	24.43	19.5
Test crop (variety)	Maize (variety: Damot)	Maize (variety: Shone)	Barley (HB-1307)	Wheat (variety: Boru)

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6.3 Evaluation of Biochar-Based Fertilizers in low-input acidic soils of Gedeo-Sidama area, Southern Ethiopia, Dr. Yackob Alemayehu, Dilla University

Field application of EB, CB, and pure biochar

- Application of EB, CB, and pure biochar treatments in the 10-20 cm deep furrows, depending on the crop row-spacing

A total of:

- **4 Mother-trials**
- **12 Baby-trials**

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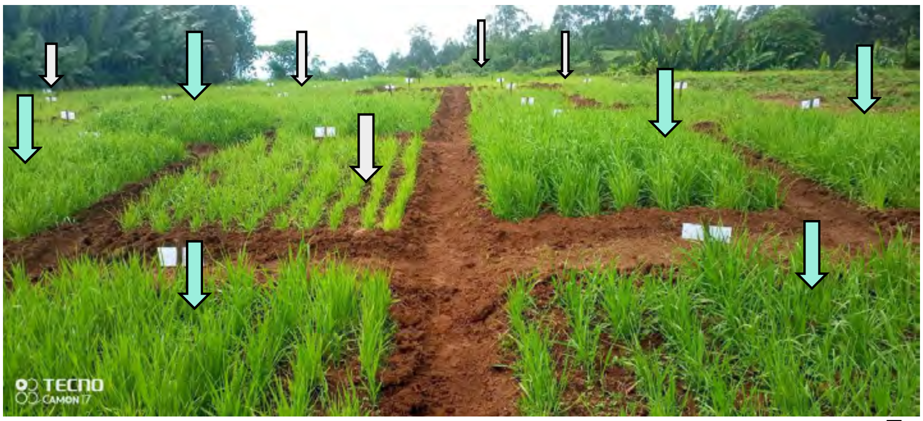
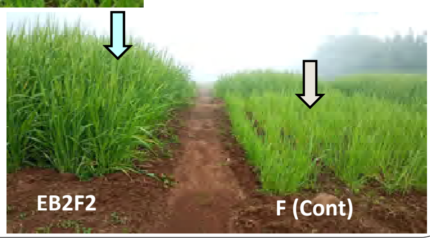
Crop performance at early growth stage



Clear differences observed on barley crop plot level performance to applied BBF (EB & CB) treatments compared to conventional fertilization. Mother-trial at Bule site (Photo : Oct 14, 2024)



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6.3 Evaluation of Biochar-Based Fertilizers in low-input acidic soils of Gedeo-Sidama area, Southern Ethiopia, Dr. Yackob Alemayehu, Dilla University

Data collection

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Data related to the following parameters was collected just before harvesting the barley mother trials:

- Plant height
- Spike length
- Number of spikelets per spike
- Number of tillers

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Threshing, Measuring biomass

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Yield related data

Maize :

1. Plant height
2. Stem diameter
3. Leaf area
4. Cob length
5. Cob diameter
6. Number of rows/cob
7. Number of grain/row cob
8. Hundred-grain weight
9. Grain yield
10. Biomass yield

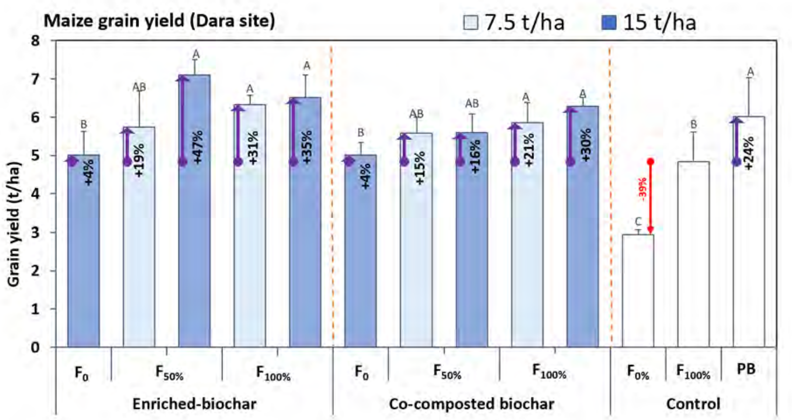
Barley :

1. Plant height
2. Spike length
3. Number of spikelets per spike
4. Number of tillers
5. Thousand-grain weight
6. Grain yield
7. Grain moisture content
8. Biomass yield

Nutrient uptake

Soil data

Results



Yirgachefe site: Strongly acidic (4.3), very low P

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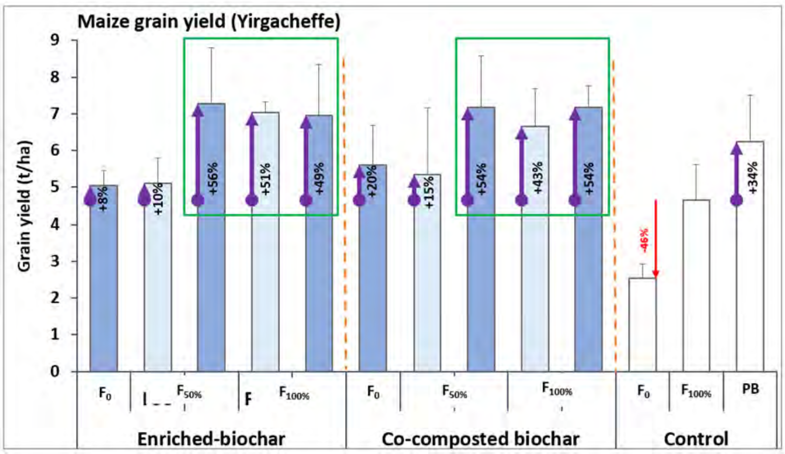
Results.....



Average maize yield increased 49-56% increase over fertilizer alone

Yirgachefe site: Strongly acidic (pH=4.30), medium OC, low P

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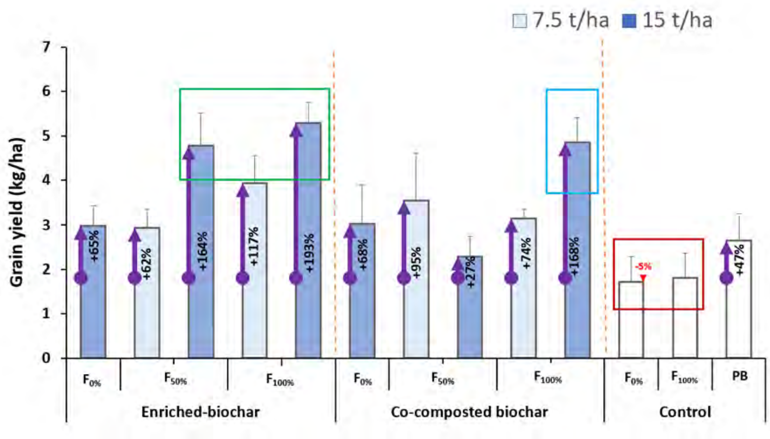
Results.....

Barley grain yield (Bule site): high altitude (2824 m), strongly acidic, very low P



Barley yield increase
1.5X-2X for EB over sole fertilizer
1.6X for CB over sole fertilizer

Source	*Pr > F*
BBF_type	*0.018*
BBF_rate	*0.009*
fert	*0.0003*
*BBF_rate*fert_rate*	*0.022*
*BBF_ty*BBF_ra*fert*	*0.0144*

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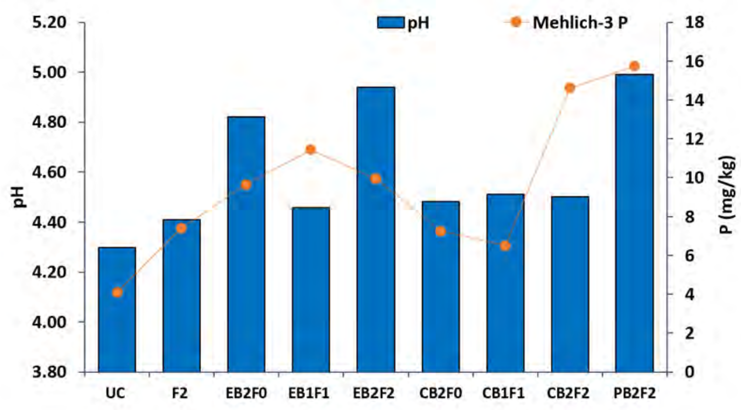
Results.....

Soil properties after harvest (Dara site)



Pattern of pH and Mehlich-3 P: change in pH tended to increase in available P with EB and CB application in strongly acidic soils

Available Ca, K tended to increase, exch acidity did not show (data not shown)

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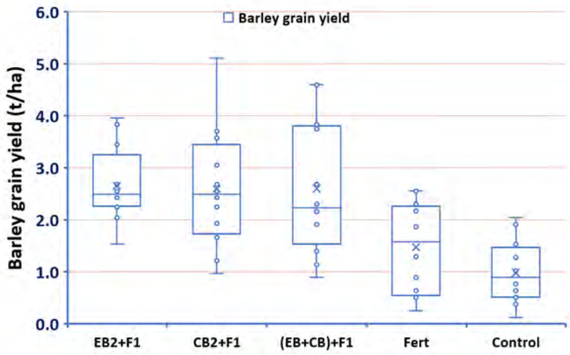
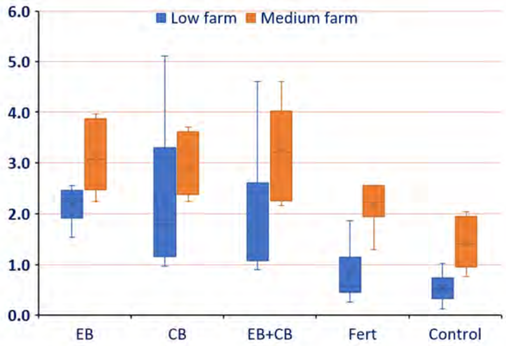
Results.....

Farmers' field trials





- Farm variability was greater when farmers applied inputs by low productivity farm when compared with medium productivity farms

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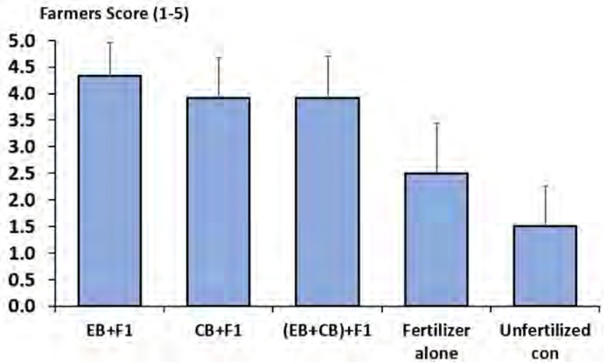
Farmers visual evaluation of plot performance (n=12)



Among Farmers Participating in the trials

Farmer's plot crop performance: comparison between BBF-treated vs untreated plots

20

Conclusion and Way Forward

Promising results was observed

Average barley yield increased 1.5-2 fold for EB, up to 1.6 for CB over sole fertilizer .

Average maize yield increased up to 50% for both BBF

- Yield increment was with **50% reduction** in fertilizer input costs in acid soil
  - EB relatively better performed in crop than CB, or in their combination with F at lower dose.
  - EB at 10 t/ha reduce N input req by half
  - However, it is 1st season…. More season trials needed to confirm

- **Repeating trials: the second season field trial**
- **Promotion of best results (community outreach)**

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Awareness creation workshop

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A workshop was organized on December 5, 2024, at Dilla University

Our team members delivering training

ffee waste that is used as a biochar feedstock and co-composting

Visiting BBF production site

On-the-spot briefing by the team members to participants

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6.3 Evaluation of Biochar-Based Fertilizers in low-input acidic soils of Gedeo-Sidama area, Southern Ethiopia, Dr. Yackob Alemayehu, Dilla University

Acknowledgments

ETH-SOIL giz Dilla University

Thank you all for attending !!!

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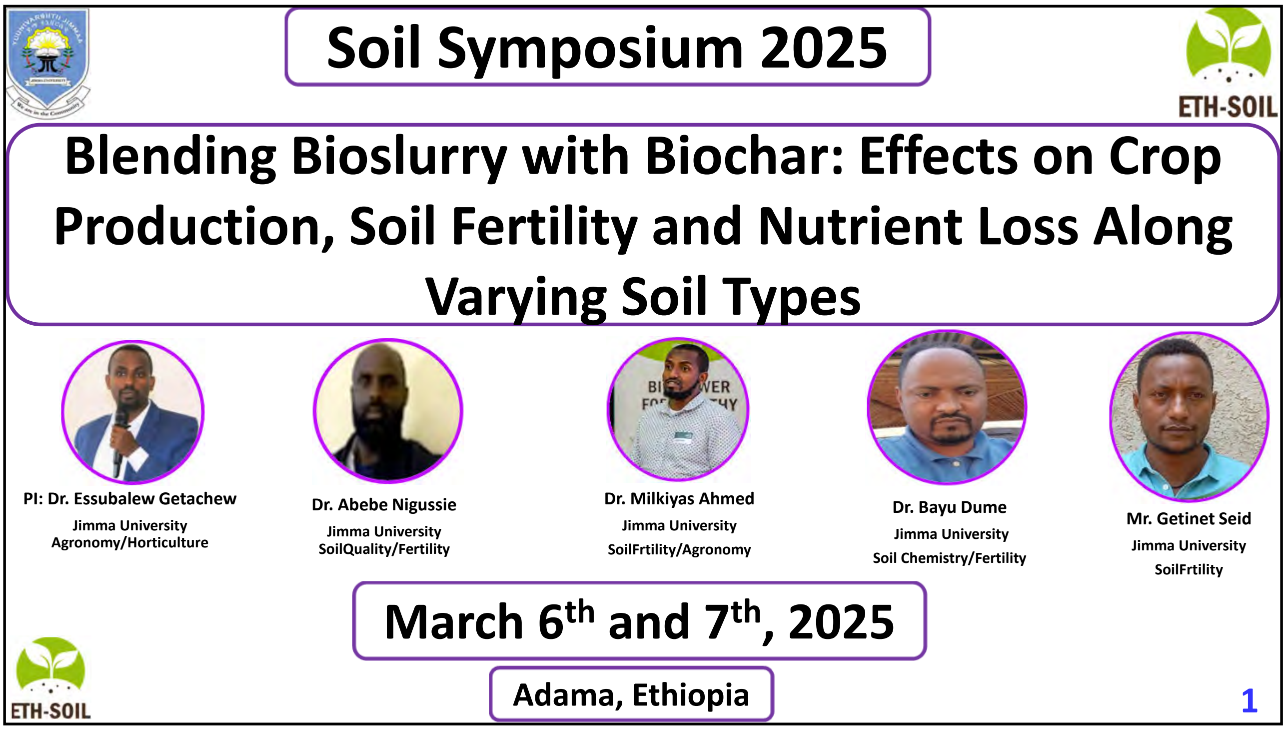
Soil Symposium 2025
ETH-SOIL
Blending Bioslurry with Biochar: Effects on Crop Production, Soil Fertility and Nutrient Loss Along Varying Soil Types
PI: Dr. Essubalew Getachew
Jimma University
Agronomy/Horticulture
Dr. Abebe Nigussie
Jimma University
SoilQuality/Fertility
Dr. Milkiyas Ahmed
Jimma University
SoilFrtility/Agronomy
Dr. Bayu Dume
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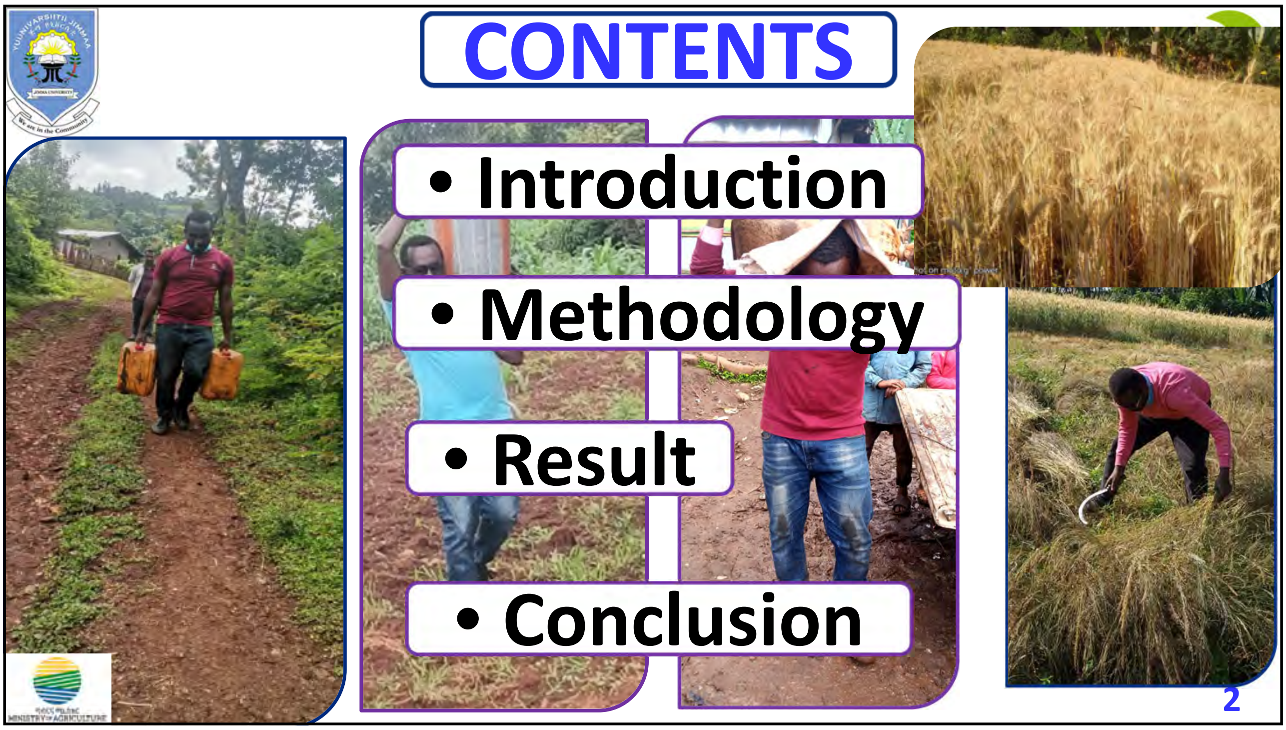
CONTENTS
• Introduction
• Methodology
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• Introduction

ETH-SOIL

- Ethiopia **soil nutrient depletion** has been the **main challenge** for crop production

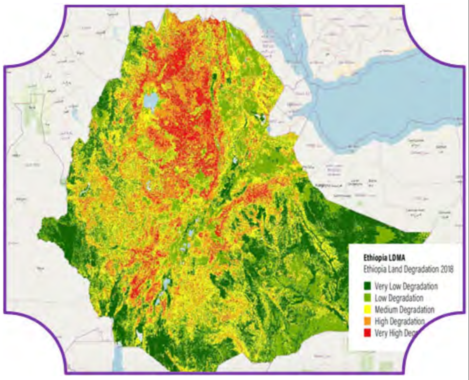
  (Abay et al., **2021**)

- Crop production mainly dependent on **chemical fertilizers**

  (Nigussie et al., **2015**)

- The price of of chemical fertilizers increased by **2-3x** in the year 2023

  (Ethiopian business review, **2023**)



(Battistelli et al., **2022**)

Developing alternative fertilizers is therefore urgently required for farmers

3

• Introduction

ETH-SOIL

- **Agricultural byproducts** contain high concentrations of plant nutrients (**N** and **P**)

  (Chojnacka et al., **2020**)

- In Ethiopia the **utilization** of these resources as alternative fertilizers is **not yet well explored**

Organic fertilizers in organic farming

Fertilizer Type	Liquid/Solid	In Situ/Ex Situ	Primary Nutrients Provided	Rate of Mineralization
Compost	Solid	In Situ/Ex Situ	Nitrogen (N), Phosphorus (P), Potassium (K), Micronutrients	Slow to Moderate
Farmyard Manure	Solid	In Situ	Nitrogen (N), Phosphorus (P), Potassium (K)	Moderate
Vermicompost	Solid	In Situ/Ex Situ	Nitrogen (N), Phosphorus (P), Potassium (K)	Moderate
Green Manures	Solid	In Situ	Nitrogen (N)	Moderate
Crop Residues	Solid	In Situ	Carbon (C), Small amounts of N, P, K	Slow
Bone Meal	Solid	Ex Situ	Phosphorus (P), Calcium (Ca)	Moderate
Fish Meal	Solid	Ex Situ	Nitrogen (N), Phosphorus (P)	Moderate
Feather Meal	Solid	Ex Situ	Nitrogen (N)	Moderate to Slow
Blood Meal	Solid	Ex Situ	Nitrogen (N)	Fast
Oilseed Cakes	Solid	Ex Situ	Nitrogen (N), Potassium (K)	Moderate
Chicken Manure	Solid	In Situ/Ex Situ	Nitrogen (N), Phosphorus (P), Potassium (K)	Fast
Cow Manure (Dung)	Solid	In Situ	Nitrogen (N), Phosphorus (P), Potassium (K)	Moderate
Urine (Animal)	Liquid	In Situ	Nitrogen (N), Small amounts of P and K	Fast
Seaweed Extract	Liquid	Ex Situ	Potassium (K), Micronutrients	Moderate
Fish Emulsion	Liquid	Ex Situ	Nitrogen (N), Phosphorus (P)	Moderate
Compost Tea	Liquid	In Situ	Nitrogen (N), Micronutrients	Moderate
Slurry (Manure or Biogas Digestate)	Liquid	In Situ	Nitrogen (N), Phosphorus (P), Potassium (K)	Fast
Molasses-Based Fertilizer	Liquid	Ex Situ	Potassium (K), Carbon for microbial activity	Moderate
Plant Extracts (e.g., Fermented Nettle)	Liquid	In Situ	Nitrogen (N), Micronutrients	Moderate

- It has **huge potential** to secure a significant amount of chemical fertilizer demand through the **trapping of nutrients from agricultural byproducts**

(Simon et al., **2014**)

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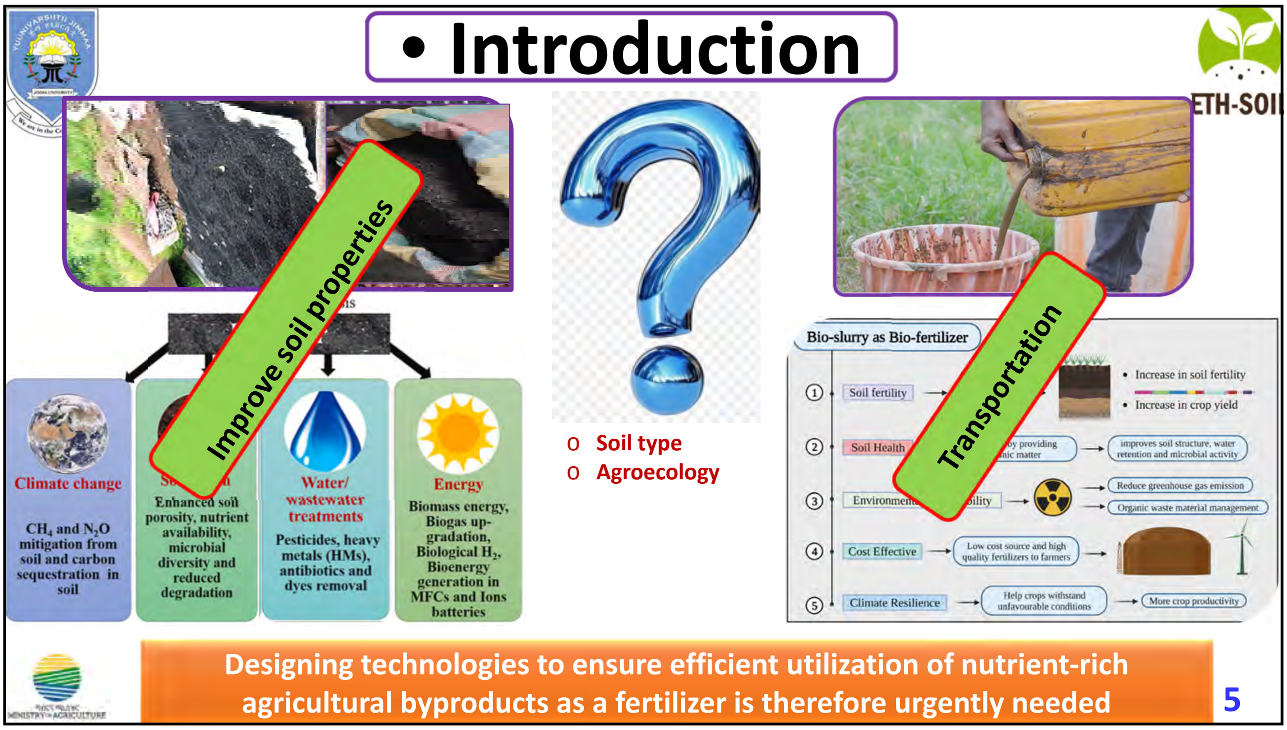
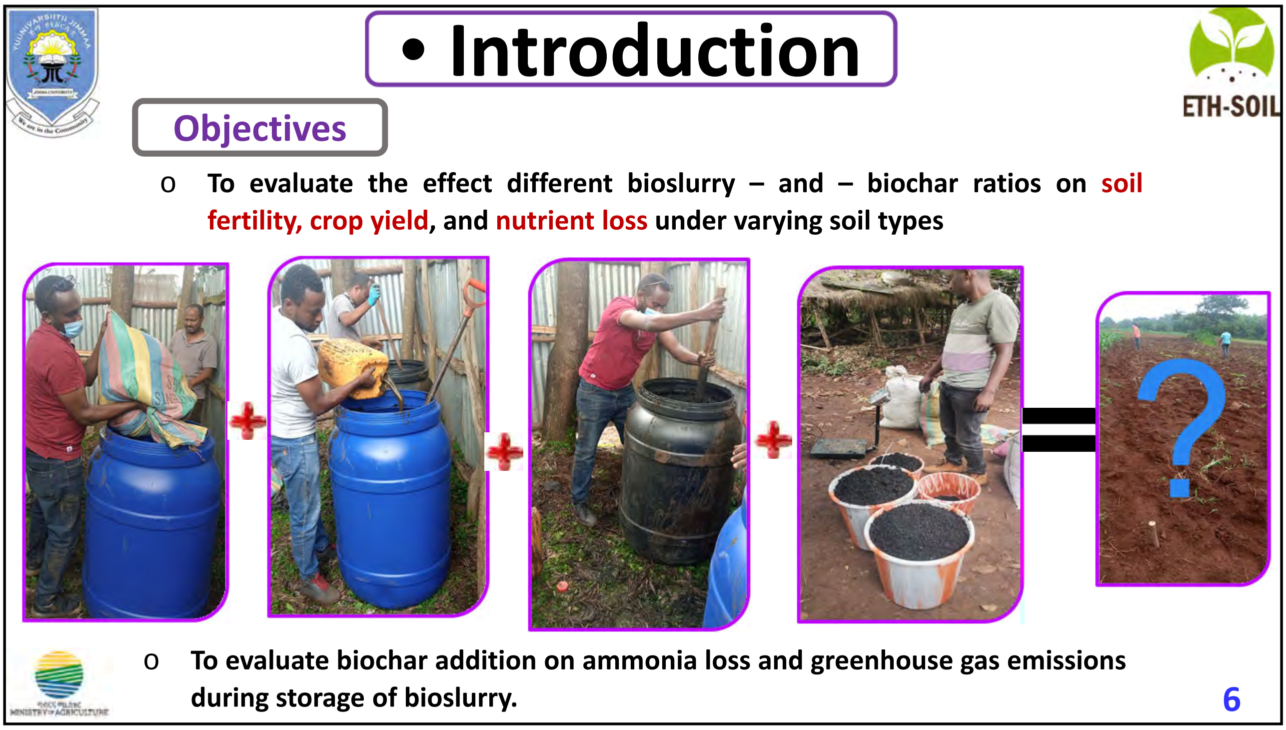
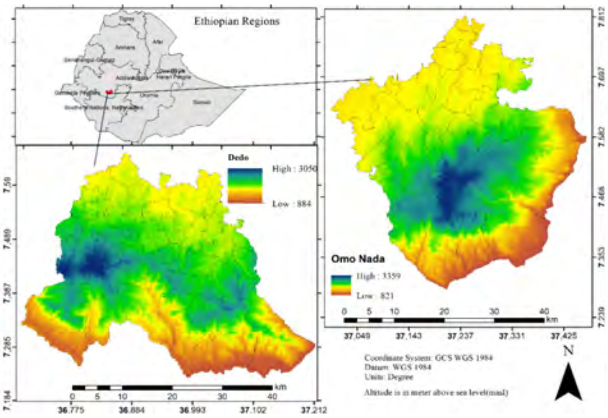

• Introduction
ETH-SOIL
Improve soil properties
Climate change
CH4 and N2O mitigation from soil and carbon sequestration in soil
Enhanced soil porosity, nutrient availability, microbial diversity and reduced degradation
Water/ wastewater treatments
Pesticides, heavy metals (HMs), antibiotics and dyes removal
Energy
Biomass energy, Biogas up-gradation, Biological H2, Bioenergy generation in MFCs and Ions batteries
Soil type
Agroecology
Transportation
Bio-slurry as Bio-fertilizer
Soil fertility
Increase in soil fertility
Increase in crop yield
Soil Health
improves soil structure, water retention and microbial activity
Reduce greenhouse gas emission
Organic waste material management
Cost Effective
Low cost source and high quality fertilizers to farmers
Climate Resilience
Help crops withstand unfavourable conditions
More crop productivity
Designing technologies to ensure efficient utilization of nutrient-rich agricultural byproducts as a fertilizer is therefore urgently needed
5

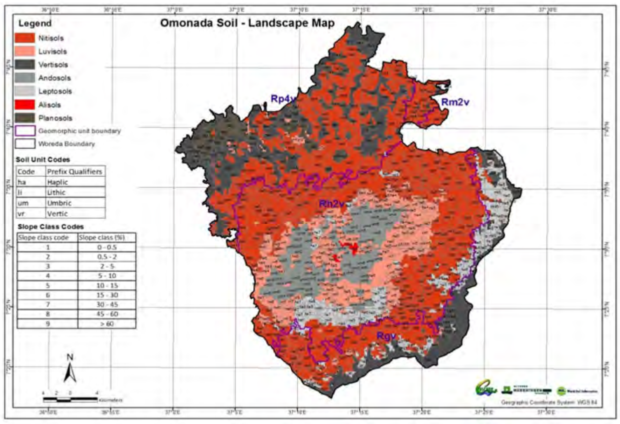

• Introduction
ETH-SOIL
Objectives
To evaluate the effect different bioslurry – and – biochar ratios on soil fertility, crop yield, and nutrient loss under varying soil types
To evaluate biochar addition on ammonia loss and greenhouse gas emissions during storage of bioslurry.
6

• Methodology

ETH-SOIL

The study sites





- The high variability in **soil types** and **landscapes**
- High **nutrient depletion** and a **pH value of < 6.0**
- **Mixed-crop–-livestock farming systems**

7

• Methodology

ETH-SOIL

Materials

Site & Farmers selection

- **Two Sites**
- **Three Locations(LL,ML,HI)**
- **Five farmers (female and male)**
- **Total of 30 farmers (15/site and 5/location)**

Treatments & Design

- **Six treatments**
  - **Bioslurry alone**
  - **1BS:1BC (32liter v/32Kg w)**
  - **1BS:2BC (32liter v/16Kg w)**
  - **1BS:4BC (32liter v/8Kg w)**
  - **Recommend rate**
  - **Control**
- **4 × 4 m plots**
- **RCBD and Farmers used as a replication**
- **Wheat (150kg/ha)** and **15 (kg /ha) Teff**
- **1680 kg of biochar**
- **3840 liters of bioslurry**
- **4560 kg of biofertilizer blend (BBF)**

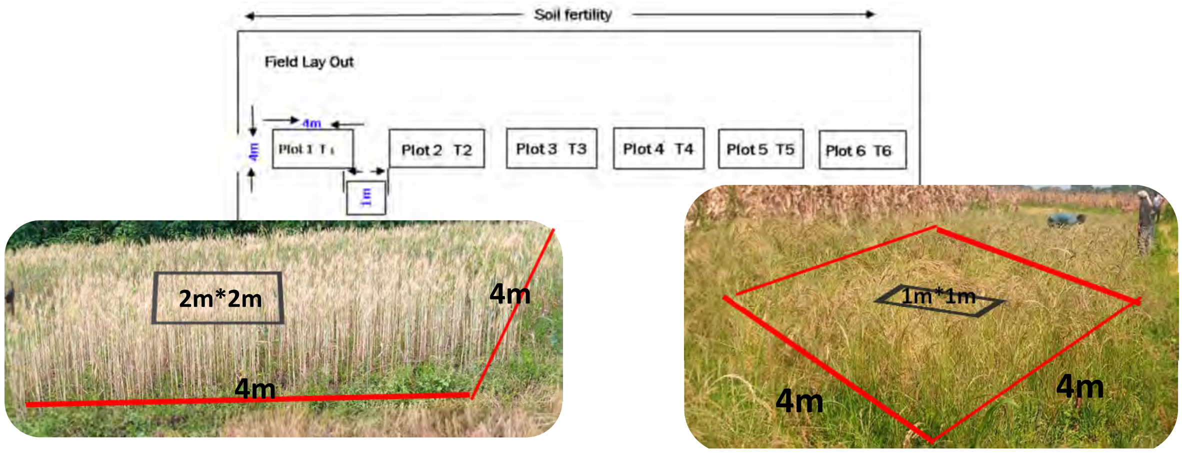
Data Collected

- **Soil before and after**
- **Fresh biomass (tone/ha)**
- **Dry biomass (tone/ha)**
- **Grain yield (tone/ha**

8

Result

Harvesting of Teff and Wheat



- 3m*3m for TFAGBY
- 2m*2m for TDAGBY and TGrBY and further tissue analysis

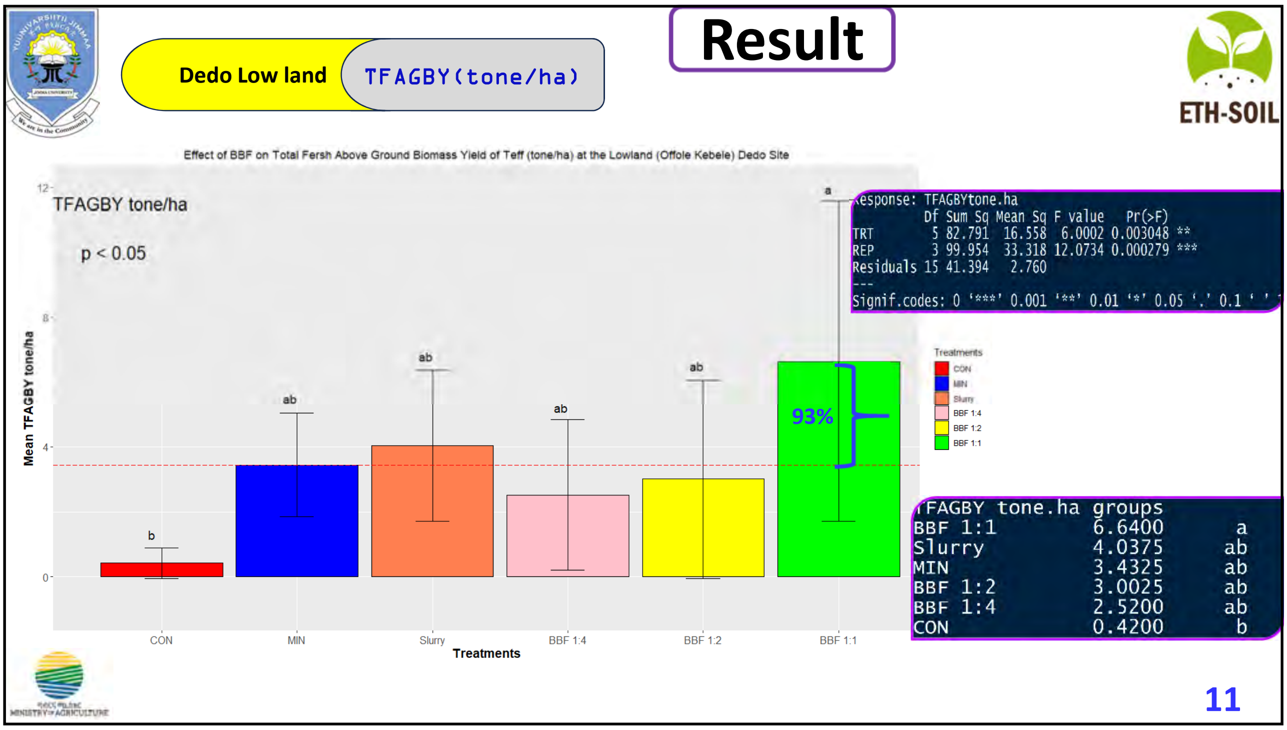
- 3m*3m for TFAGBY
- 1m*1m for TFAGBY and TGrBY and further tissue analysis

9

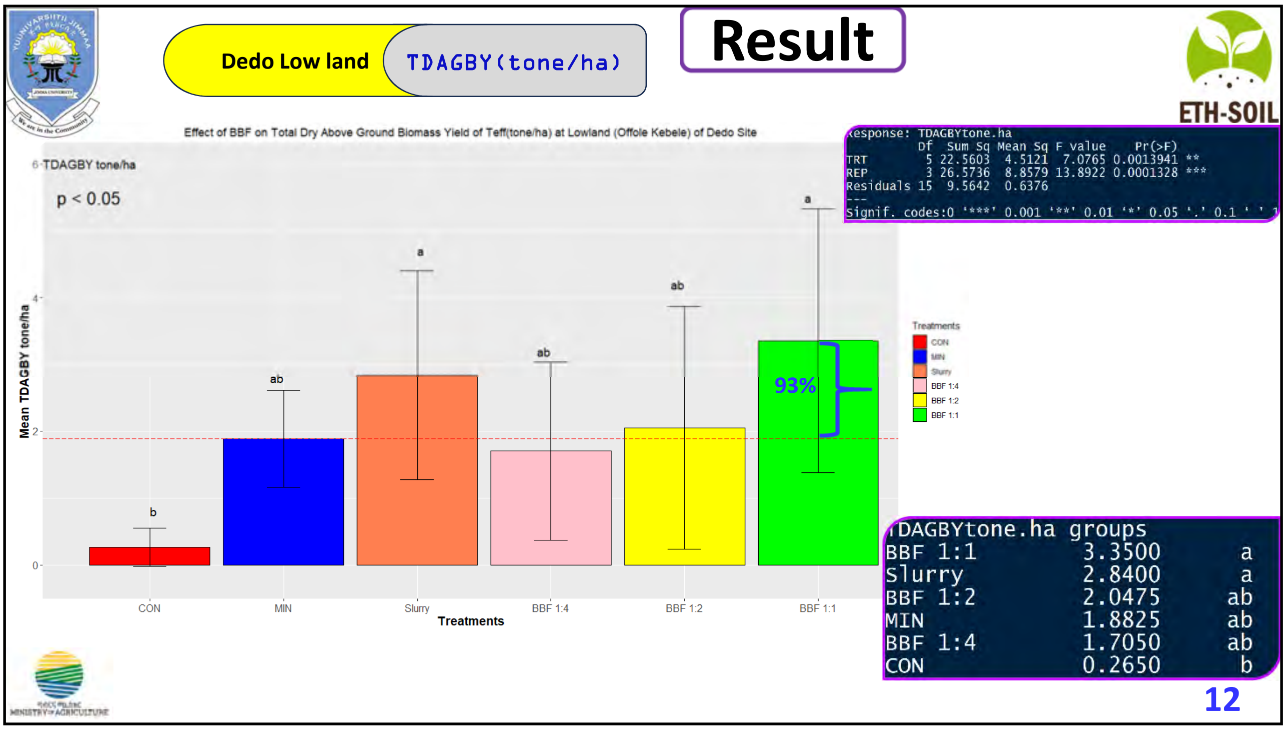
Result

Teff — Low and Mid land

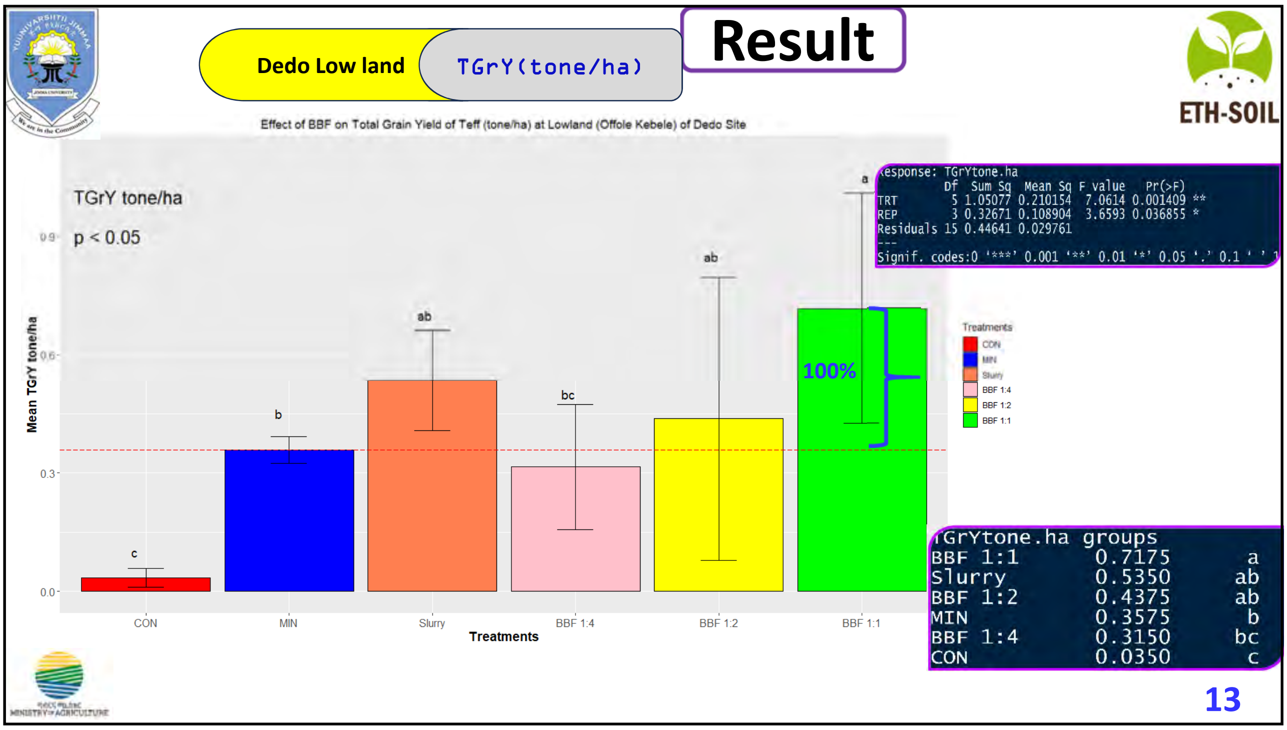
10

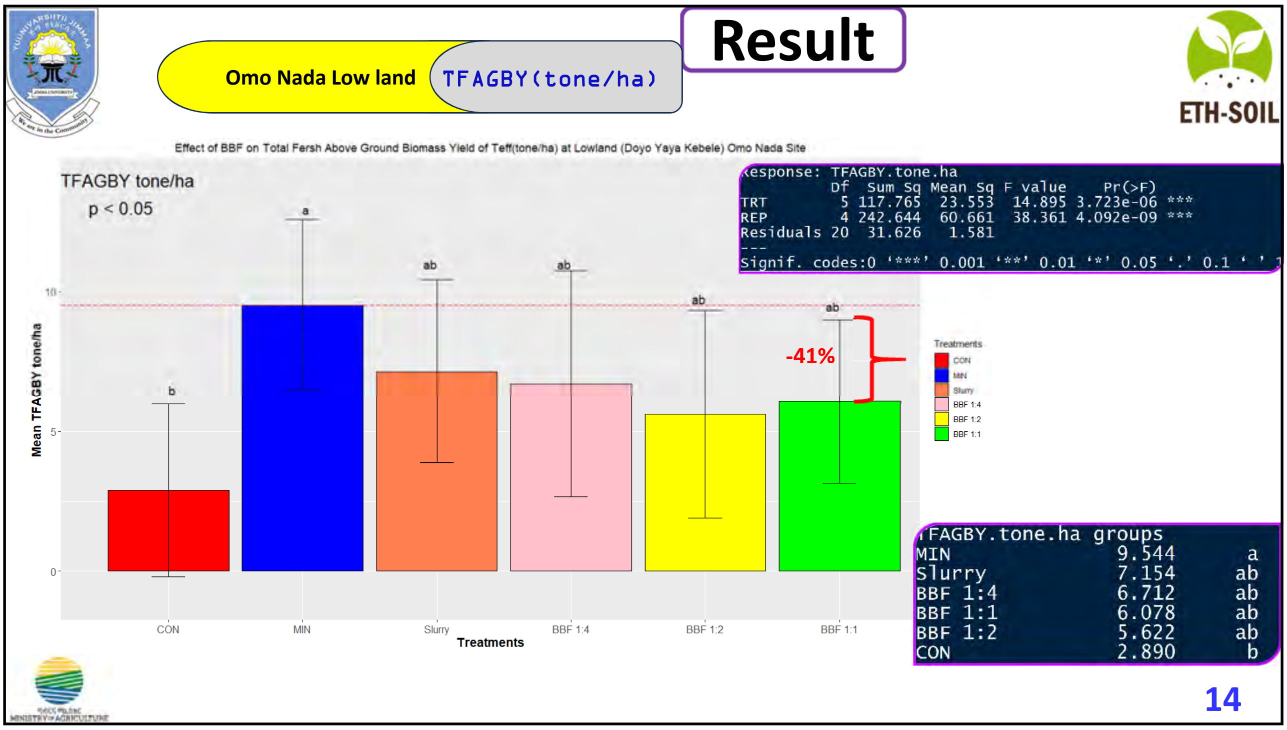

Dedo Low land
TFAGBY(tone/ha)
Result
ETH-SOIL
Effect of BBF on Total Fersh Above Ground Biomass Yield of Teff (tone/ha) at the Lowland (Offole Kebele) Dedo Site
TFAGBY tone/ha
p < 0.05
Mean TFAGBY tone/ha
Treatments
CON
MIN
Slurry
BBF 1:4
BBF 1:2
BBF 1:1
93%
Response: TFAGBYtone.ha
Df Sum Sq Mean Sq F value Pr(>F)
TRT 5 82.791 16.558 6.0002 0.003048 **
REP 3 99.954 33.318 12.0734 0.000279 ***
Residuals 15 41.394 2.760

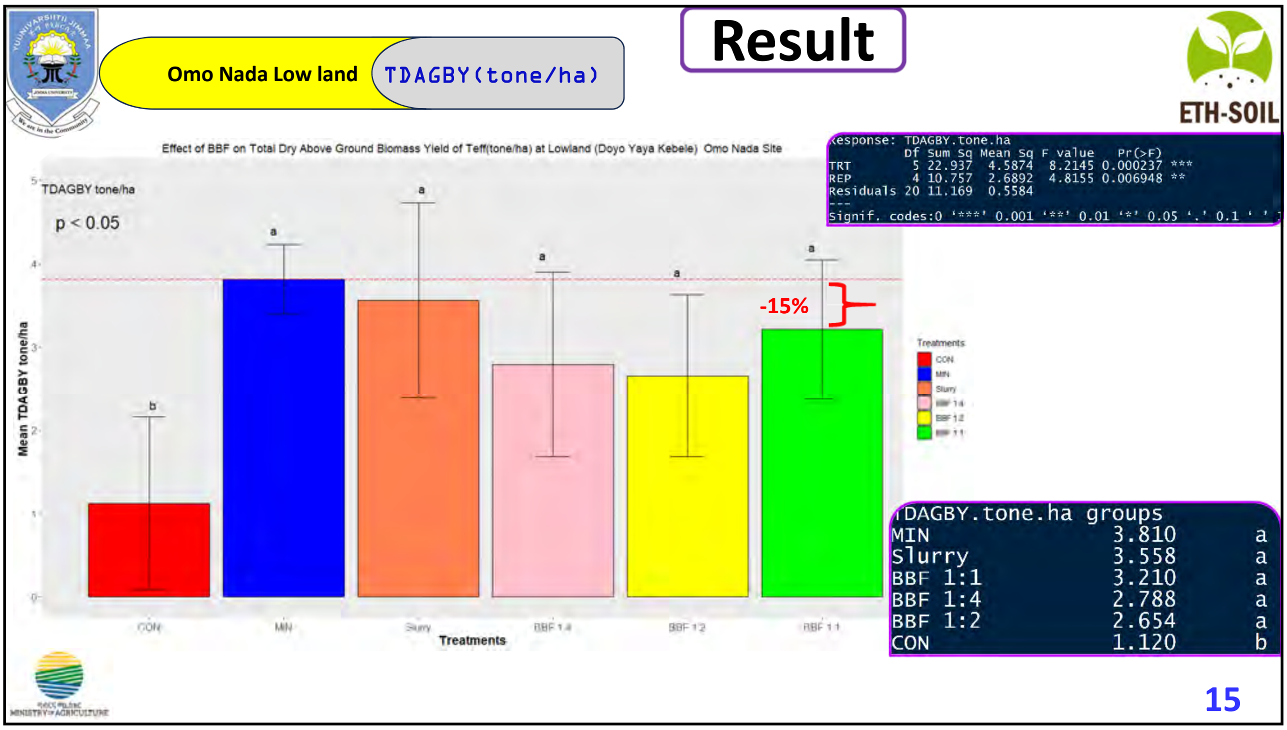
Signif.codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' '
TFAGBY tone.ha groups
BBF 1:1 6.6400 a
Slurry 4.0375 ab
MIN 3.4325 ab
BBF 1:2 3.0025 ab
BBF 1:4 2.5200 ab
CON 0.4200 b
11


Dedo Low land
TDAGBY(tone/ha)
Result
ETH-SOIL
Effect of BBF on Total Dry Above Ground Biomass Yield of Teff(tone/ha) at Lowland (Offole Kebele) of Dedo Site
TDAGBY tone/ha
p < 0.05
Mean TDAGBY tone/ha
Treatments
CON
MIN
Slurry
BBF 1:4
BBF 1:2
BBF 1:1
93%
Response: TDAGBYtone.ha
Df Sum Sq Mean Sq F value Pr(>F)
TRT 5 22.5603 4.5121 7.0765 0.0013941 **
REP 3 26.5736 8.8579 13.8922 0.0001328 ***
Residuals 15 9.5642 0.6376

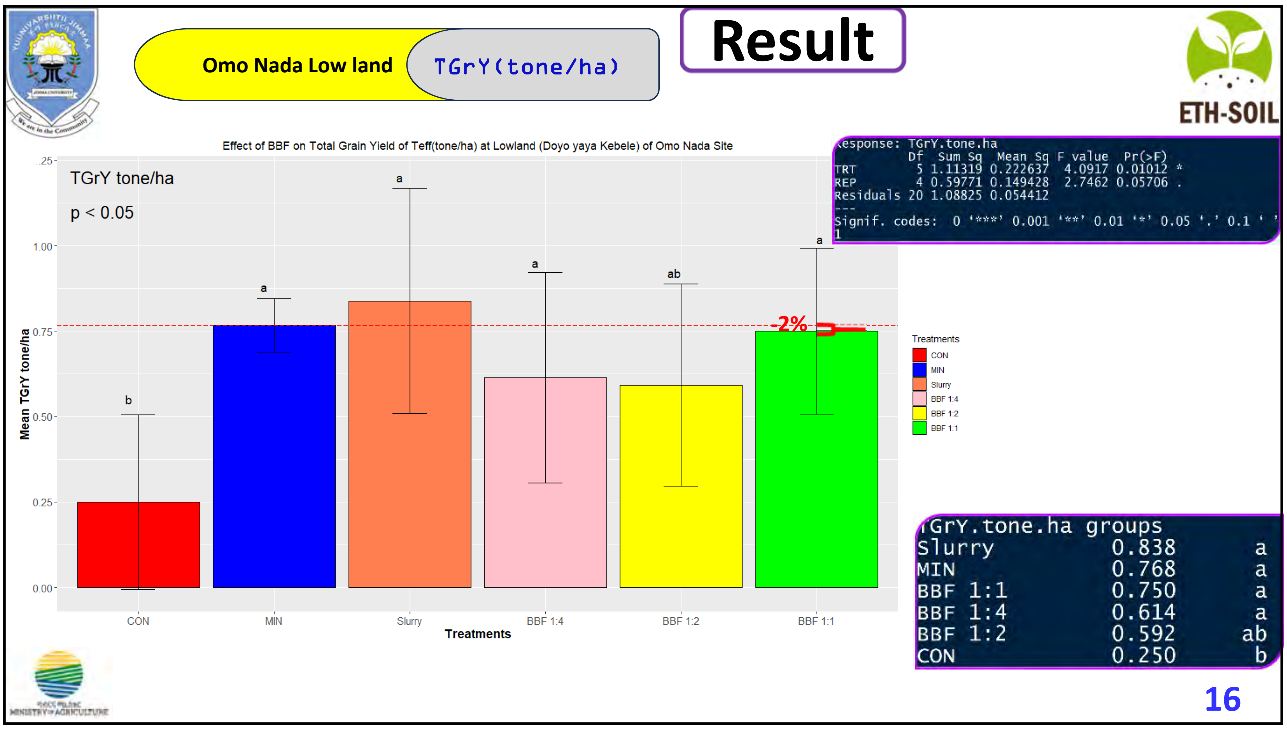
Signif. codes:0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' '
TDAGBYtone.ha groups
BBF 1:1 3.3500 a
Slurry 2.8400 a
BBF 1:2 2.0475 ab
MIN 1.8825 ab
BBF 1:4 1.7050 ab
CON 0.2650 b
12


Dedo Low land
TGrY(tone/ha)
Result
ETH-SOIL
Effect of BBF on Total Grain Yield of Teff (tone/ha) at Lowland (Offole Kebele) of Dedo Site
TGrY tone/ha
p < 0.05
Mean TGrY tone/ha
Treatments
CON
MIN
Slurry
BBF 1:4
BBF 1:2
BBF 1:1
100%
Response: TGrYtone.ha
Df Sum Sq Mean Sq F value Pr(>F)
TRT 5 1.05077 0.210154 7.0614 0.001409 **
REP 3 0.32671 0.108904 3.6593 0.036855 *
Residuals 15 0.44641 0.029761
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
TGrYtone.ha groups
BBF 1:1 0.7175 a
Slurry 0.5350 ab
BBF 1:2 0.4375 ab
MIN 0.3575 b
BBF 1:4 0.3150 bc
CON 0.0350 c
13

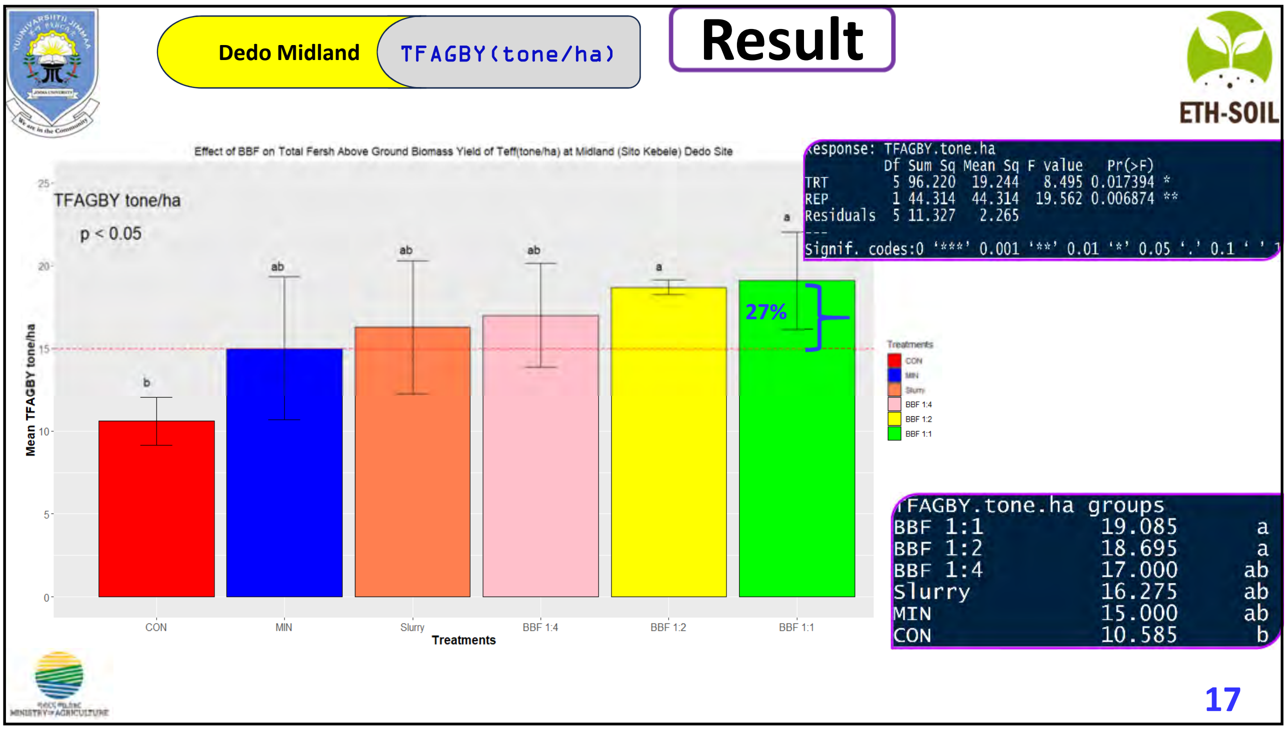

Omo Nada Low land
TFAGBY(tone/ha)
Result
ETH-SOIL
Effect of BBF on Total Fersh Above Ground Biomass Yield of Teff(tone/ha) at Lowland (Doyo Yaya Kebele) Omo Nada Site
TFAGBY tone/ha
p < 0.05
Mean TFAGBY tone/ha
Treatments
CON
MIN
Slurry
BBF 1:4
BBF 1:2
BBF 1:1
-41%
Response: TFAGBY.tone.ha
Df Sum Sq Mean Sq F value Pr(>F)
TRT 5 117.765 23.553 14.895 3.723e-06 ***
REP 4 242.644 60.661 38.361 4.092e-09 ***
Residuals 20 31.626 1.581
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
TFAGBY.tone.ha groups
MIN 9.544 a
Slurry 7.154 ab
BBF 1:4 6.712 ab
BBF 1:1 6.078 ab
BBF 1:2 5.622 ab
CON 2.890 b
14

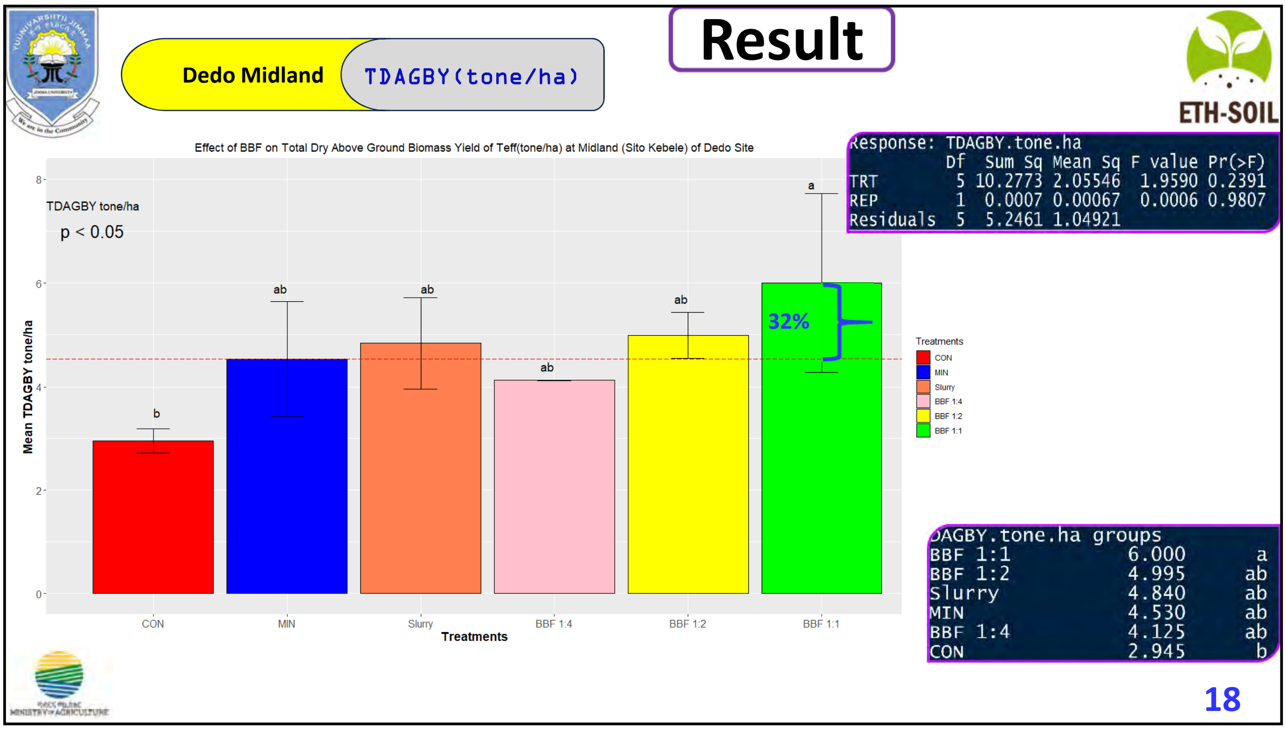

Omo Nada Low land
TDAGBY(tone/ha)
Result
ETH-SOIL
Effect of BBF on Total Dry Above Ground Biomass Yield of Teff(tone/ha) at Lowland (Doyo Yaya Kebele) Omo Nada Site
TDAGBY tone/ha
p < 0.05
Mean TDAGBY tone/ha
-15%
Treatments
CON
MIN
Slurry
BBF 1:4
BBF 1:2
BBF 1:1
Response: TDAGBY.tone.ha
Df Sum Sq Mean Sq F value Pr(>F)
TRT 5 22.937 4.5874 8.2145 0.000237 ***
REP 4 10.757 2.6892 4.8155 0.006948 **
Residuals 20 11.169 0.5584

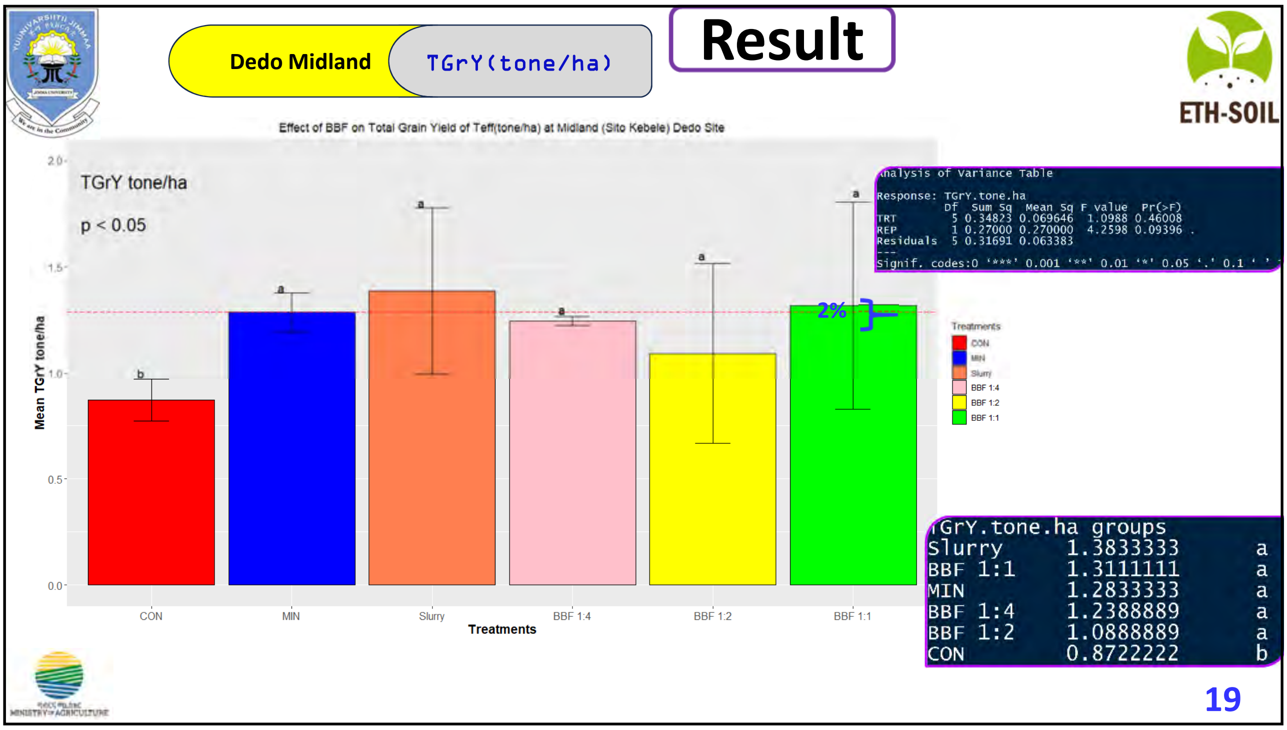
Signif. codes:0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' '
TDAGBY.tone.ha groups
MIN 3.810 a
Slurry 3.558 a
BBF 1:1 3.210 a
BBF 1:4 2.788 a
BBF 1:2 2.654 a
CON 1.120 b
15

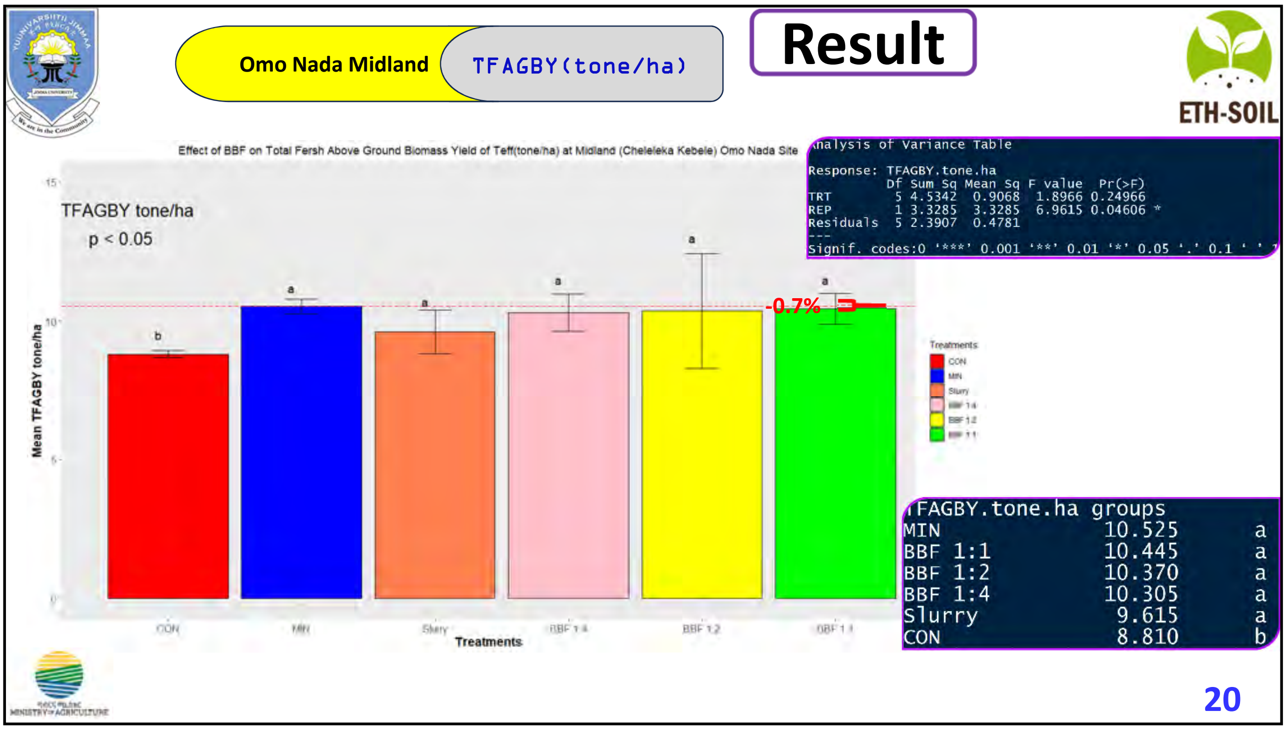

Omo Nada Low land
TGrY(tone/ha)
Result
ETH-SOIL
Effect of BBF on Total Grain Yield of Teff(tone/ha) at Lowland (Doyo yaya Kebele) of Omo Nada Site
TGrY tone/ha
p < 0.05
Mean TGrY tone/ha
-2%
Treatments
CON
MIN
Slurry
BBF 1:4
BBF 1:2
BBF 1:1
Response: TGrY.tone.ha
Df Sum Sq Mean Sq F value Pr(>F)
TRT 5 1.11319 0.222637 4.0917 0.01012 *
REP 4 0.59771 0.149428 2.7462 0.05706 .
Residuals 20 1.08825 0.054412

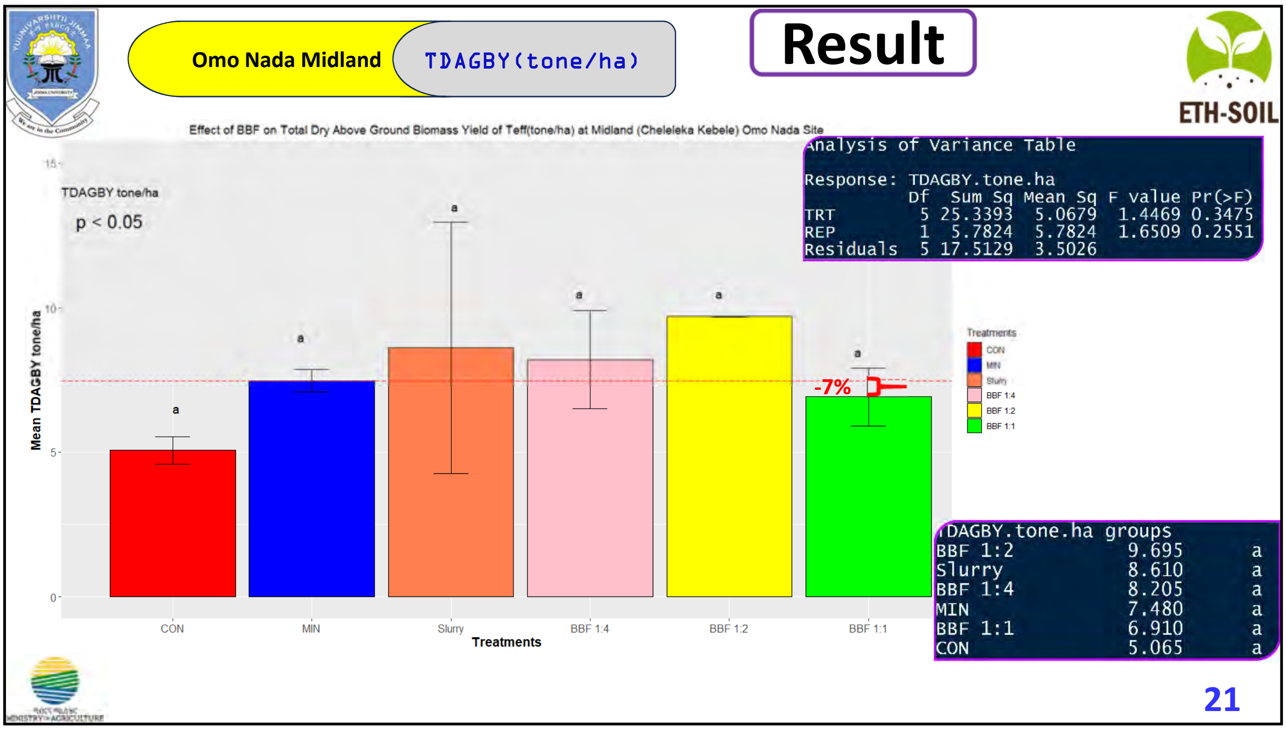
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
TGrY.tone.ha groups
Slurry 0.838 a
MIN 0.768 a
BBF 1:1 0.750 a
BBF 1:4 0.614 a
BBF 1:2 0.592 ab
CON 0.250 b
16

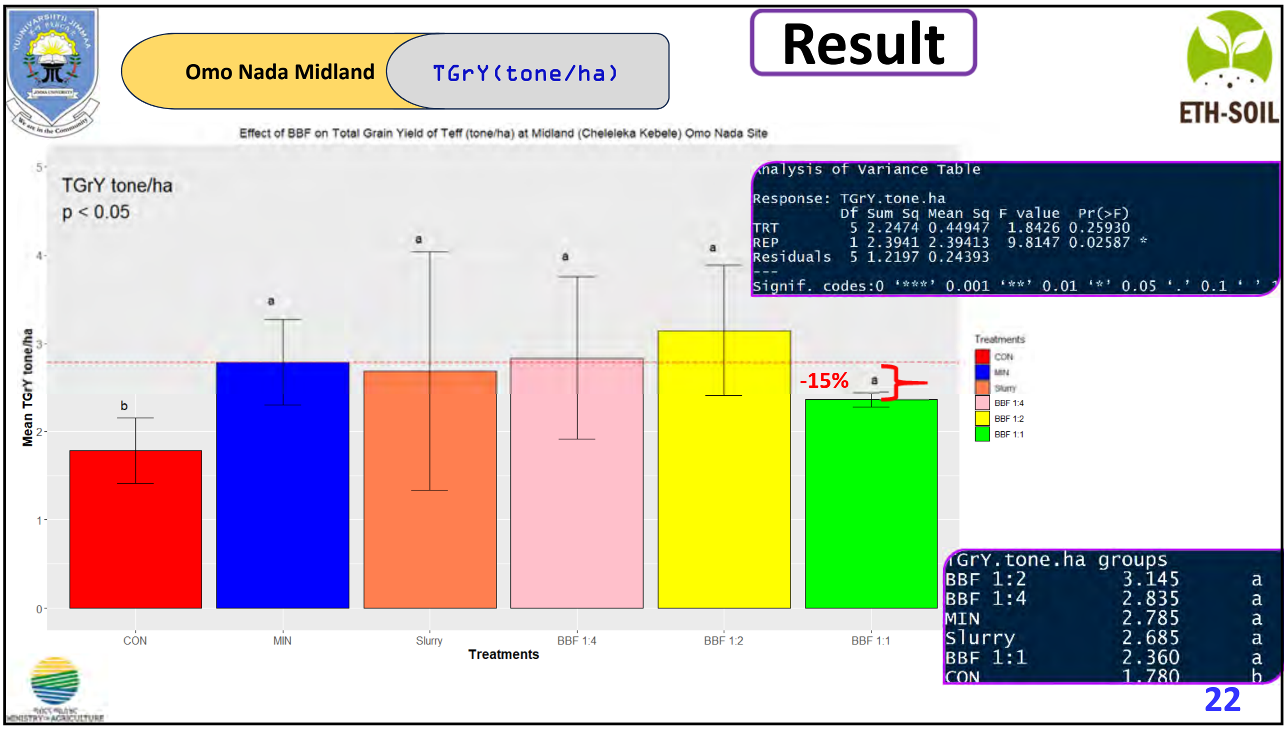

Dedo Midland
TFAGBY(tone/ha)
Result
ETH-SOIL
Effect of BBF on Total Fersh Above Ground Biomass Yield of Teff(tone/ha) at Midland (Sito Kebele) Dedo Site
TFAGBY tone/ha
p < 0.05
Mean TFAGBY tone/ha
Treatments
CON
MIN
Slurry
BBF 1:4
BBF 1:2
BBF 1:1
27%
Response: TFAGBY.tone.ha
Df Sum Sq Mean Sq F value Pr(>F)
TRT 5 96.220 19.244 8.495 0.017394 *
REP 1 44.314 44.314 19.562 0.006874 **
Residuals 5 11.327 2.265
Signif. codes:0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
TFAGBY.tone.ha groups
BBF 1:1 19.085 a
BBF 1:2 18.695 a
BBF 1:4 17.000 ab
Slurry 16.275 ab
MIN 15.000 ab
CON 10.585 b
17


Dedo Midland
TDAGBY(tone/ha)
Result
ETH-SOIL
Effect of BBF on Total Dry Above Ground Biomass Yield of Teff(tone/ha) at Midland (Sito Kebele) of Dedo Site
TDAGBY tone/ha
p < 0.05
Mean TDAGBY tone/ha
Treatments
CON
MIN
Slurry
BBF 1:4
BBF 1:2
BBF 1:1
32%
Response: TDAGBY.tone.ha
Df Sum Sq Mean Sq F value Pr(>F)
TRT 5 10.2773 2.05546 1.9590 0.2391
REP 1 0.0007 0.00067 0.0006 0.9807
Residuals 5 5.2461 1.04921
TDAGBY.tone.ha groups
BBF 1:1 6.000 a
BBF 1:2 4.995 ab
Slurry 4.840 ab
MIN 4.530 ab
BBF 1:4 4.125 ab
CON 2.945 b
18


Dedo Midland
TGrY(tone/ha)
Result
ETH-SOIL
Effect of BBF on Total Grain Yield of Teff(tone/ha) at Midland (Sito Kebele) Dedo Site
TGrY tone/ha
p < 0.05
Mean TGrY tone/ha
Treatments
CON
MIN
Slurry
BBF 1:4
BBF 1:2
BBF 1:1
2%
Analysis of Variance Table
Response: TGrY.tone.ha
Df Sum Sq Mean Sq F value Pr(>F)
TRT 5 0.34823 0.069646 1.0988 0.46008
REP 1 0.27000 0.270000 4.2598 0.09396 .
Residuals 5 0.31691 0.063383
TGrY.tone.ha groups
Slurry 1.3833333 a
BBF 1:1 1.3111111 a
MIN 1.2833333 a
BBF 1:4 1.2388889 a
BBF 1:2 1.0888889 a
CON 0.8722222 b
19

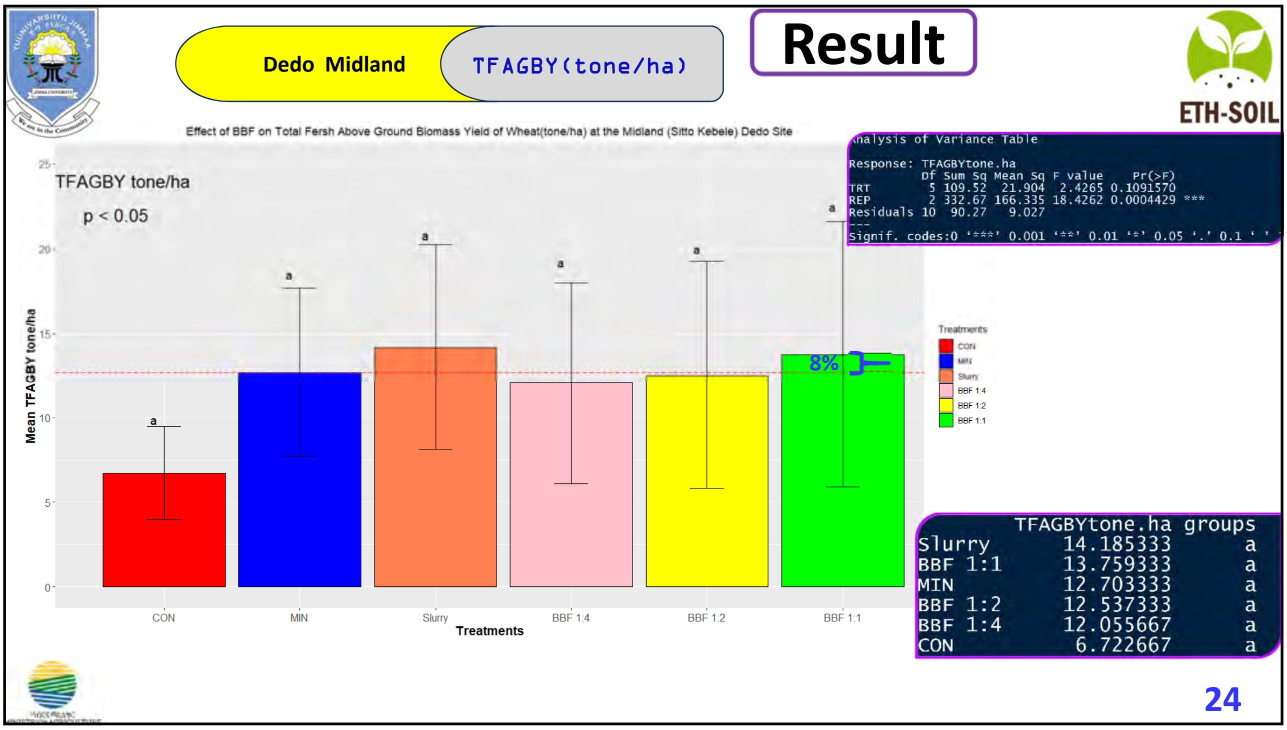

Omo Nada Midland
TFAGBY(tone/ha)
Result
ETH-SOIL
Effect of BBF on Total Fersh Above Ground Biomass Yield of Teff(tone/ha) at Midland (Cheleleka Kebele) Omo Nada Site
TFAGBY tone/ha
p < 0.05
Mean TFAGBY tone/ha
Treatments
-0.7%
Analysis of Variance Table
Response: TFAGBY.tone.ha
Df Sum Sq Mean Sq F value Pr(>F)
TRT 5 4.5342 0.9068 1.8966 0.24966
REP 1 3.3285 3.3285 6.9615 0.04606 *
Residuals 5 2.3907 0.4781
TFAGBY.tone.ha groups
MIN 10.525 a
BBF 1:1 10.445 a
BBF 1:2 10.370 a
BBF 1:4 10.305 a
Slurry 9.615 a
CON 8.810 b
20

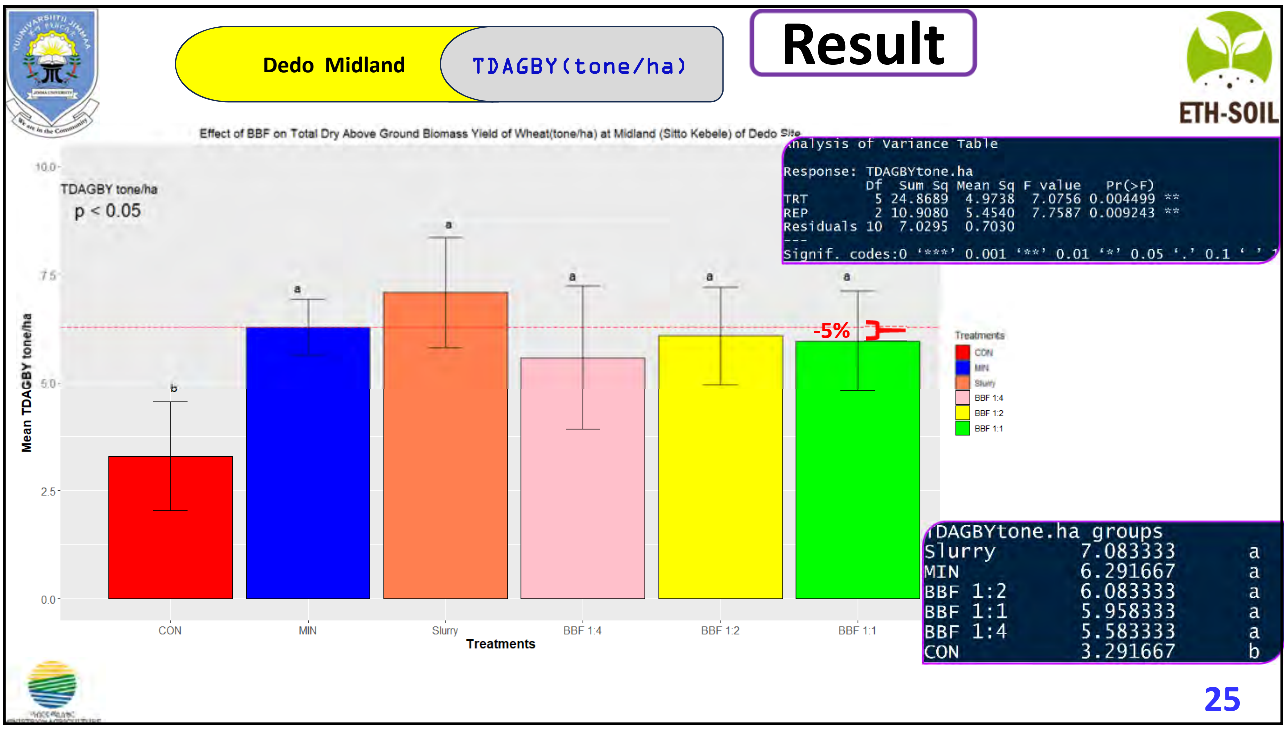

Omo Nada Midland
TDAGBY(tone/ha)
Result
ETH-SOIL
Effect of BBF on Total Dry Above Ground Biomass Yield of Teff(tone/ha) at Midland (Cheleleka Kebele) Omo Nada Site
TDAGBY tone/ha
p < 0.05
Analysis of Variance Table
Response: TDAGBY.tone.ha
Df Sum Sq Mean Sq F value Pr(>F)
TRT 5 25.3393 5.0679 1.4469 0.3475
REP 1 5.7824 5.7824 1.6509 0.2551
Residuals 5 17.5129 3.5026
-7%
Mean TDAGBY tone/ha
Treatments
CON
MIN
Slurry
BBF 1:4
BBF 1:2
BBF 1:1
TDAGBY.tone.ha groups
BBF 1:2 9.695 a
Slurry 8.610 a
BBF 1:4 8.205 a
MIN 7.480 a
BBF 1:1 6.910 a
CON 5.065 a
21

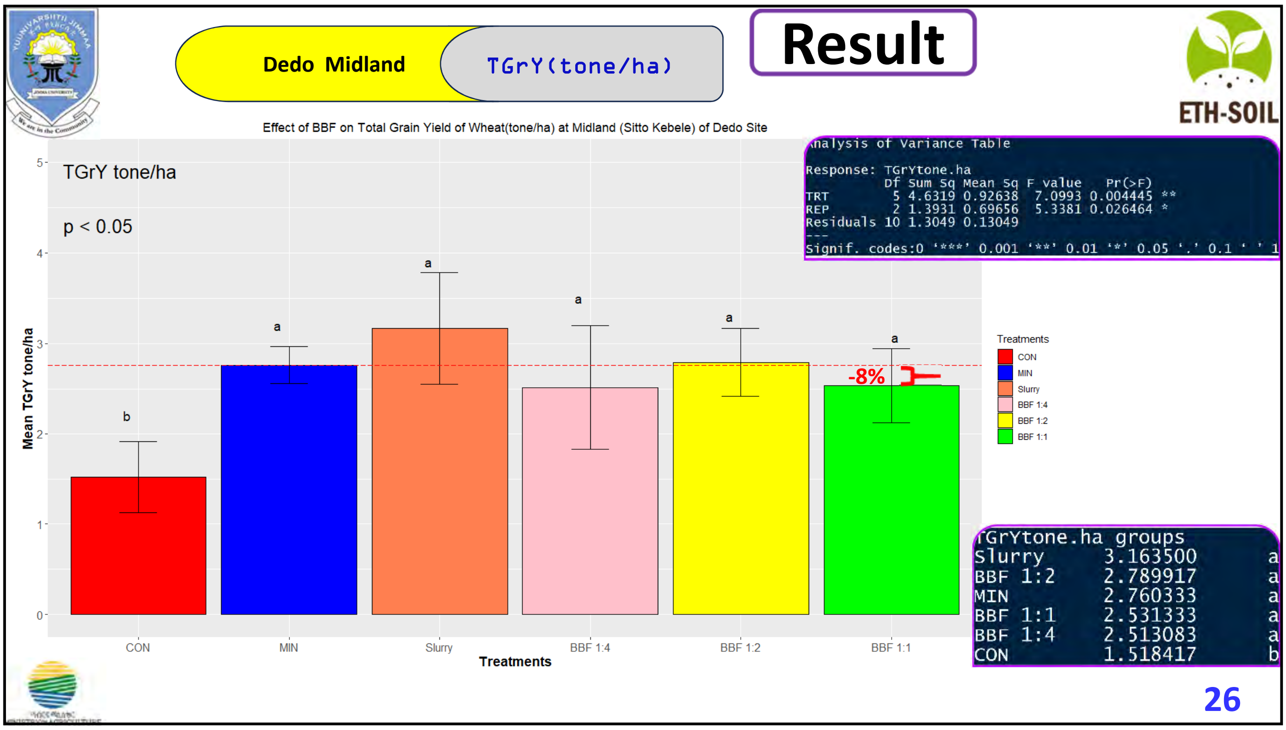

Omo Nada Midland
TGrY(tone/ha)
Result
ETH-SOIL
Effect of BBF on Total Grain Yield of Teff (tone/ha) at Midland (Cheleleka Kebele) Omo Nada Site
TGrY tone/ha
p < 0.05
Analysis of Variance Table
Response: TGrY.tone.ha
Df Sum Sq Mean Sq F value Pr(>F)
TRT 5 2.2474 0.44947 1.8426 0.25930
REP 1 2.3941 2.39413 9.8147 0.02587 *
Residuals 5 1.2197 0.24393

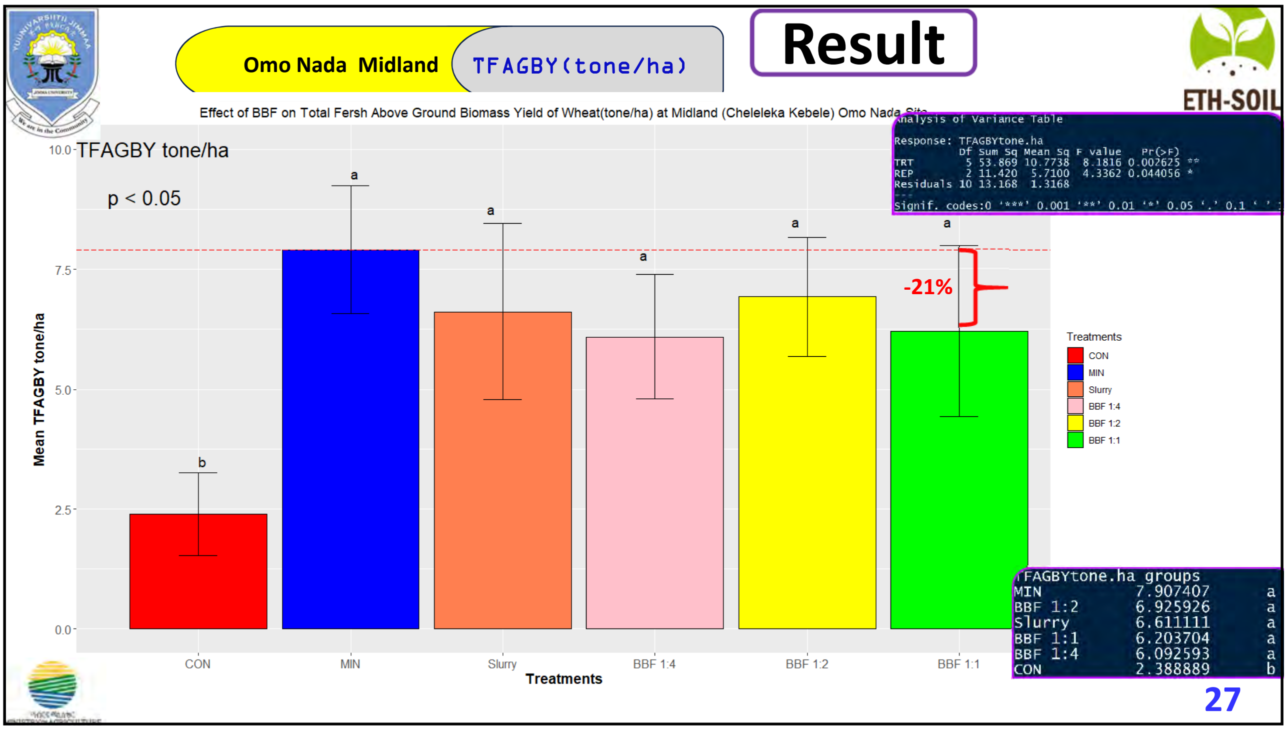
Signif. codes:0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
-15%
Mean TGrY tone/ha
Treatments
CON
MIN
Slurry
BBF 1:4
BBF 1:2
BBF 1:1
TGrY.tone.ha groups
BBF 1:2 3.145 a
BBF 1:4 2.835 a
MIN 2.785 a
Slurry 2.685 a
BBF 1:1 2.360 a
CON 1.780 b
22


Wheat
Mid land
Result
ETH-SOIL
23

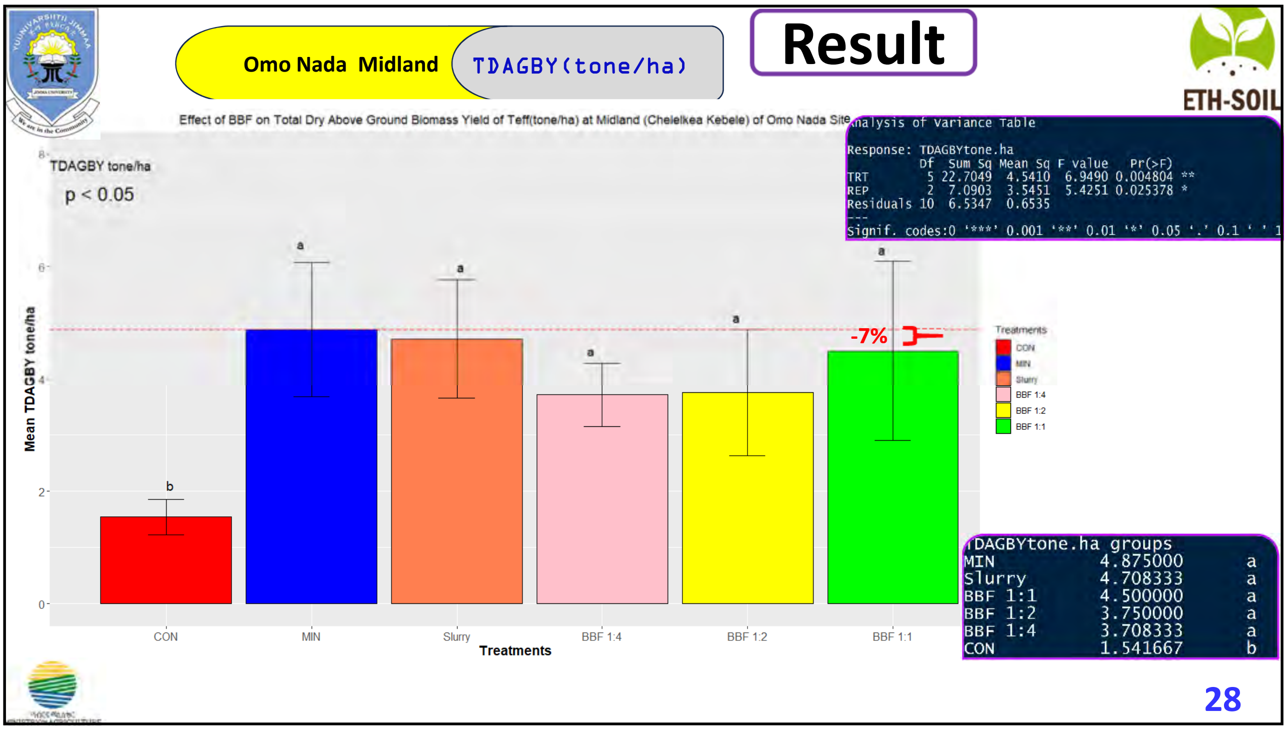

Dedo Midland
TFAGBY(tone/ha)
Result
ETH-SOIL
Effect of BBF on Total Fersh Above Ground Biomass Yield of Wheat(tone/ha) at the Midland (Sitto Kebele) Dedo Site
TFAGBY tone/ha
p < 0.05
Mean TFAGBY tone/ha
Treatments
CON
MIN
Slurry
BBF 1:4
BBF 1:2
BBF 1:1
8%
Analysis of Variance Table
Response: TFAGBYtone.ha
Df Sum Sq Mean Sq F value Pr(>F)
TRT 5 109.52 21.904 2.4265 0.1091570
REP 2 332.67 166.335 18.4262 0.0004429 ***
Residuals 10 90.27 9.027
Signif. codes:0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' '
TFAGBYtone.ha groups
Slurry 14.185333 a
BBF 1:1 13.759333 a
MIN 12.703333 a
BBF 1:2 12.537333 a
BBF 1:4 12.055667 a
CON 6.722667 a
24


Dedo Midland
TDAGBY(tone/ha)
Result
ETH-SOIL
Effect of BBF on Total Dry Above Ground Biomass Yield of Wheat(tone/ha) at Midland (Sitto Kebele) of Dedo Site
TDAGBY tone/ha
p < 0.05
Mean TDAGBY tone/ha
Treatments
CON
MIN
Slurry
BBF 1:4
BBF 1:2
BBF 1:1
-5%
Analysis of Variance Table
Response: TDAGBYtone.ha
Df Sum Sq Mean Sq F value Pr(>F)
TRT 5 24.8689 4.9738 7.0756 0.004499 **
REP 2 10.9080 5.4540 7.7587 0.009243 **
Residuals 10 7.0295 0.7030
Signif. codes:0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
TDAGBYtone.ha groups
Slurry 7.083333 a
MIN 6.291667 a
BBF 1:2 6.083333 a
BBF 1:1 5.958333 a
BBF 1:4 5.583333 a
CON 3.291667 b
25

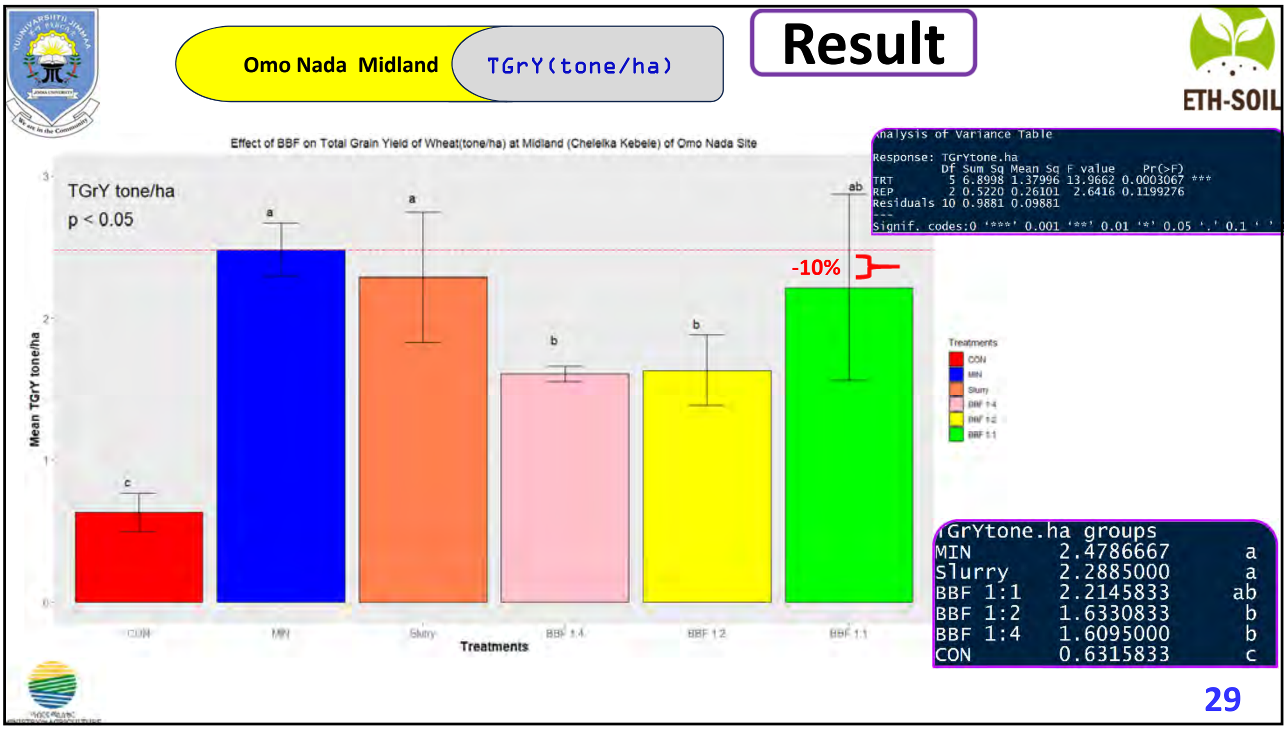

Dedo Midland
TGrY(tone/ha)
Result
ETH-SOIL
Effect of BBF on Total Grain Yield of Wheat(tone/ha) at Midland (Sitto Kebele) of Dedo Site
TGrY tone/ha
p < 0.05
Mean TGrY tone/ha
Treatments
CON
MIN
Slurry
BBF 1:4
BBF 1:2
BBF 1:1
-8%
Analysis of Variance Table
Response: TGrYtone.ha
Df Sum Sq Mean Sq F value Pr(>F)
TRT 5 4.6319 0.92638 7.0993 0.004445 **
REP 2 1.3931 0.69656 5.3381 0.026464 *
Residuals 10 1.3049 0.13049
Signif. codes:0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
TGrYtone.ha groups
Slurry 3.163500 a
BBF 1:2 2.789917 a
MIN 2.760333 a
BBF 1:1 2.531333 a
BBF 1:4 2.513083 a
CON 1.518417 b
26



Omo Nada Midland
TFAGBY(tone/ha)
Result
ETH-SOIL
Effect of BBF on Total Fersh Above Ground Biomass Yield of Wheat(tone/ha) at Midland (Cheleleka Kebele) Omo Nada Site
TFAGBY tone/ha
p < 0.05
Mean TFAGBY tone/ha
-21%
Treatments
CON
MIN
Slurry
BBF 1:4
BBF 1:2
BBF 1:1
Analysis of Variance Table
Response: TFAGBYtone.ha
Df Sum Sq Mean Sq F value Pr(>F)
TRT 5 53.869 10.7738 8.1816 0.002625 **
REP 2 11.420 5.7100 4.3362 0.044056 *
Residuals 10 13.168 1.3168
Signif. codes:0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
TFAGBYtone.ha groups
MIN 7.907407 a
BBF 1:2 6.925926 a
Slurry 6.611111 a
BBF 1:1 6.203704 a
BBF 1:4 6.092593 a
CON 2.388889 b
27



Omo Nada Midland
TDAGBY(tone/ha)
Result
ETH-SOIL
Effect of BBF on Total Dry Above Ground Biomass Yield of Teff(tone/ha) at Midland (Chelelkea Kebele) of Omo Nada Site
TDAGBY tone/ha
p < 0.05
Mean TDAGBY tone/ha
-7%
Treatments
CON
MIN
Slurry
BBF 1:4
BBF 1:2
BBF 1:1
Analysis of Variance Table
Response: TDAGBYtone.ha
Df Sum Sq Mean Sq F value Pr(>F)
TRT 5 22.7049 4.5410 6.9490 0.004804 **
REP 2 7.0903 3.5451 5.4251 0.025378 *
Residuals 10 6.5347 0.6535
Signif. codes:0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
TDAGBYtone.ha groups
MIN 4.875000 a
Slurry 4.708333 a
BBF 1:1 4.500000 a
BBF 1:2 3.750000 a
BBF 1:4 3.708333 a
CON 1.541667 b
28

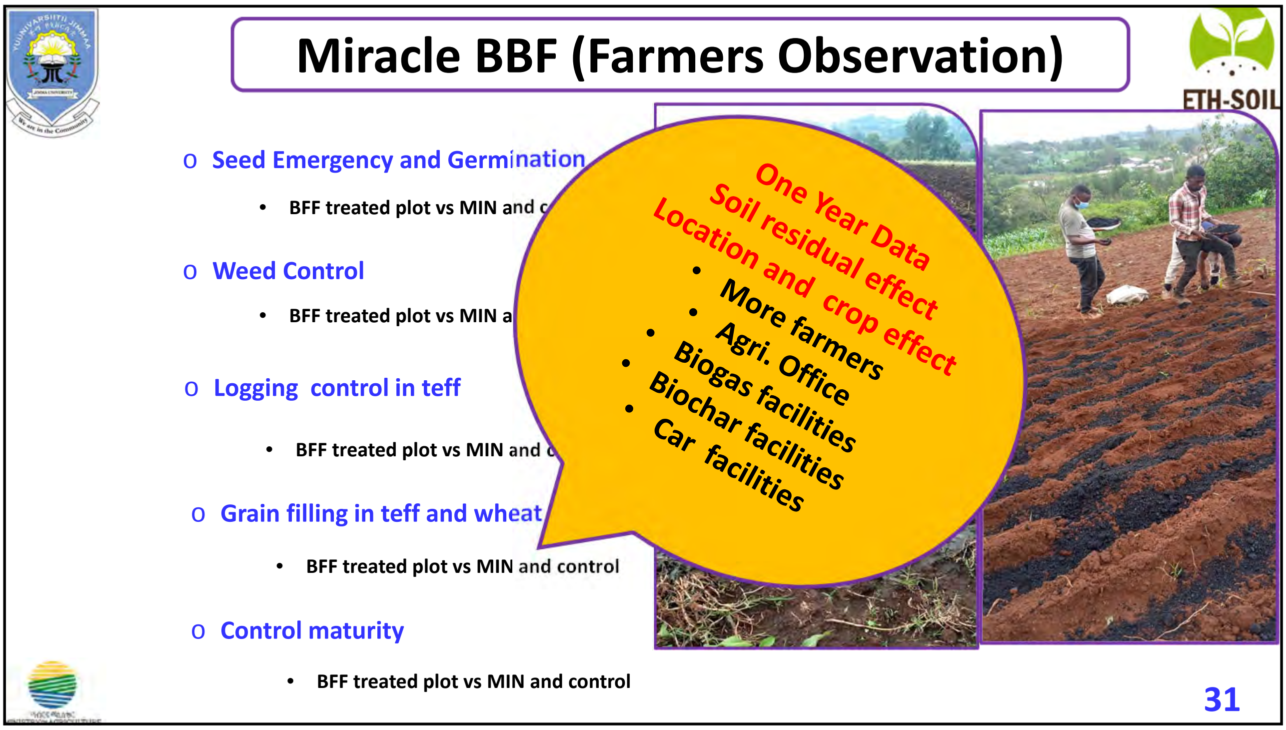


• Conclusion

ETH-SOIL

- The study revealed that there is a variation on response of Biochar Based Biofertilizer (BBF) over location and across different soil and crop type.
    - Omo nada soil more degraded than Dedo soil
- In all the study site the applied Biochar Based Biofertilizer (BBF) has comparable fresh and dry biomass yield for both Teff and Wheat crops as compered with mineral based fertilizer.
- In all the study site the applied Biochar Based Biofertilizer (BBF) has comparable grain yield for both Teff and Wheat crops as compered with mineral based fertilizer.
- A plot treated with Biochar Based Fertilizer (BBF) has comparable grain filling as compered with mineral based fertilizer both Teff and Wheat crops .
- In all the study site the applied Biochar Based Biofertilizer (BBF) has comparable soil characteristics than mineral based fertilizer for both Teff and Wheat fields.

30


Miracle BBF (Farmers Observation)
ETH-SOIL
Seed Emergency and Germination
BFF treated plot vs MIN and c
Weed Control
BFF treated plot vs MIN a
Logging control in teff
BFF treated plot vs MIN and c
Grain filling in teff and wheat
BFF treated plot vs MIN and control
Control maturity
BFF treated plot vs MIN and control
One Year Data
Soil residual effect
Location and crop effect
More farmers
Agri. Office
Biogas facilities
Biochar facilities
Car facilities
31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Thank You
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Integrated use of coffee husk biochar and vermin/compost smallholder farms in Sidama Region, Southern Ethiopia

College of Agriculture, Hawassa University

Team members:
Shimelis Gizachew (PhD),
Bishri Mohammed (MSc)
Tigist Yimer (PhD)
Yonas Berhanu (PhD)

2nd Soil Symposium, Adama
March 6-7, 2025

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1

Background

- Continuous decline in agricultural productivity, particularly in the highlan… regions of Ethiopia
- Contributing factors:
  - Soil erosion,
  - Soil organic carbon and nutrient depletion,
  - rapidly increasing human and livestock population,
  - soil acidity,
  - low agricultural input use and
  - climate change

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2

Background…

- Organic amendments prepared from:
  - ✓ locally available and underutilized biomass can be used as a soil amendment and
  - ✓ potentially an important alternative/supplement to inorganic fertilization
- Biochar can be used in combination with other organic fertilizers including:
  - Biofertilizers,
  - compost,
  - vermicompost and others

3

Coffee husk?

Sidama region

- One of the major coffee producing regions
- Large amount of coffee husk/pulp generated
- Coffee husk has no alternative uses and damped in the environment
- Pollution threats to soils and surface/ground water

Objectives

✓ To study the effects of different rates of biochar, vermicompost, mineral fertilizers and their integrated use on yields of **Wheat** and **Maize** and selected soil properties in Sidama region

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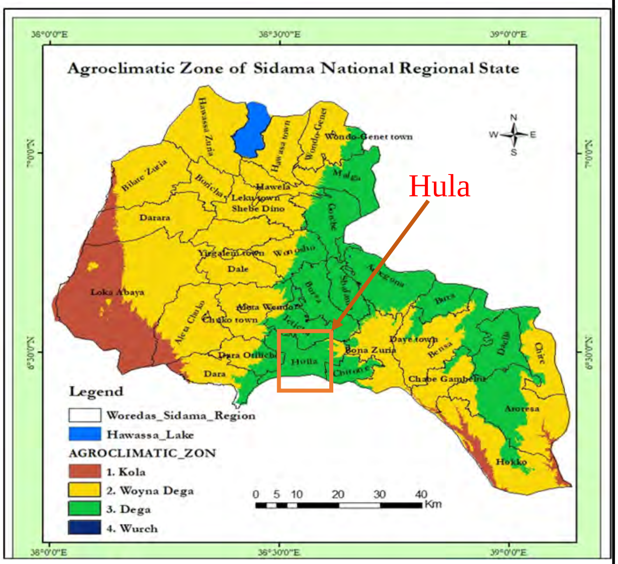
Experimental site and participant farmers selections

- Hula district in Sidama region
  - Altitude: mostly highland
  - Soil acidity, soil erosion and nutrient depletion ➔ common
  - **Wheat**, barley, faba bean commonly grown
- Farmers selected based on:
  - Willingness
  - Ownership of suitable plots
- 10 farmers (**4 or 6 treatments**)
- One FTC was selected to undertake full set of **treatments (12/15)** with replicates



(Tesfaye, 2005)

6

#	Treatment	Experimental design
	Wheat (Hula, Highland, ≈2700 masl)	
1	W-F	RCBD (run for 2 seasons, 2023 and 2024)
2	**W+F**	
3	W+BC (4.5 t/ha)	
4	**W+F+BC (4 t/ha)**	
5	W+BC (8 t/ha)	
6	W+F+BC (8 t/ha)	
7	**W+VC (4.5 t/ha)**	
8	W+F+VC (4.5 t/ha)	
9	**W+BC (4 t/ha)+VC (4.5 t/ha)**	
10	W+F+BC (4t/ha)+VC(4.5 t/ha)	
11	W+BC (8 t/ha)+VC (4.5 t/ha)	
12	W+F+BC(8t/ha)+VC (4.5 t/ha)	

7

#	Treatment	Experimental design
	Maize (Hula, Highland, 2300 masl)	
1	Negative control (-F)	RCBD
2	**+F**	
3	**5BC+F**	
4	5VC	5t ha^{-1} VC, 5 t ha^{-1} TC (+60% mineral fertilizer)
5	5VC+BC (15%)	
6	5VC+BC (30%)	
7	5TC	
8	5TC+BC (15%)	
9	5TC+BC (30%)	
10	**10VC**	10t ha^{-1} VC, 10 t ha^{-1} TC (+40% mineral fertilizer)
11	10VC+BC (15%)	
12	**10VC+BC (30%)**	
13	**10TC**	
14	10TC+BC (15%)	
15	**10TC+BC (30%)**	

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Field trials and test crops

Test Crops	2023		Status	2024		Status
Wheat	On farm	FTC	Completed	On farm	FTC	Completed
	4 plots x 10 farmers' plots	**12 plots*3** replicates		**4 plots** x **10** farmers' plots	**12 plots * 3** replicates	
Plot area = 12 m^2 for all treatments						
Maize				**6 plots * 10** farmers' plots	**15 plots * 3** replicates	Completed

9

Biochar preparation

Pyrolysis

- The double barrel/biochar kiln used for pyrolyzing the feedstock (coffee husk)

Biochar Quality?

				Probennummer		123036912	
Parameter	Lab.	Akkr.	Methode	BG	Einheit	anl	wf
Eigenschaften der Pflanzenkohle							
Gesamtwassergehalt	FR	F5	DIN 51718: 2002-06	0,1	Ma.-%	7,6	-
Organ. Schadstoffe a. d. Toluolextrakt n. DIN EN 16181:2019-08(Extrakt.-verf. 2)							
Naphthalin	FR	F5	DIN EN 16181:2019-08	0,1	mg/kg	-	1,0
Acenaphthylen	FR	F5	DIN EN 16181:2019-08	0,1	mg/kg	-	< 0,1
Acenaphthen	FR	F5	DIN EN 16181:2019-08	0,1	mg/kg	-	< 0,1
Fluoren	FR	F5	DIN EN 16181:2019-08	0,1	mg/kg	-	0,1
Phenanthren	FR	F5	DIN EN 16181:2019-08	0,1	mg/kg	-	0,5
Anthracen	FR	F5	DIN EN 16181:2019-08	0,1	mg/kg	-	0,1
Fluoranthen	FR	F5	DIN EN 16181:2019-08	0,1	mg/kg	-	0,2
Pyren	FR	F5	DIN EN 16181:2019-08	0,1	mg/kg	-	0,2
Benzo[a]anthracen	FR	F5	DIN EN 16181:2019-08	0,1	mg/kg	-	< 0,1
Chrysen	FR	F5	DIN EN 16181:2019-08	0,1	mg/kg	-	< 0,1
Benzo[b]fluoranthen	FR	F5	DIN EN 16181:2019-08	0,1	mg/kg	-	< 0,1
Benzo[k]fluoranthen	FR	F5	DIN EN 16181:2019-08	0,1	mg/kg	-	< 0,1
Benzo[a]pyren	FR	F5	DIN EN 16181:2019-08	0,1	mg/kg	-	< 0,1
Indeno[1,2,3-cd]pyren	FR	F5	DIN EN 16181:2019-08	0,1	mg/kg	-	< 0,1
Dibenzo[a,h]anthracen	FR	F5	DIN EN 16181:2019-08	0,1	mg/kg	-	< 0,1
Benzo[ghi]perylen	FR	F5	DIN EN 16181:2019-08	0,1	mg/kg	-	< 0,1
Summe 8 EFSA-PAK exkl. BG	FR	F5	DIN EN 16181:2019-08		mg/kg	-	n. b.) [1]
Summe 16 EPA-PAK exkl. BG	FR	F5	DIN EN 16181:2019-08		mg/kg	-	2,1

11

Vermicompost preparation

- Vermicompost was prepared from coffee husk and avocado waste at College of Agriculture
- Equal proportions of the avocado waste and coffee husk were used as feedstock
- Manure was also added to the mix
- A sample of the vermicompost was analyzed for pH, EC, TN, OC and moisture content

Vermicompost used for the experiments

#	Total N (%)	Organic carbon (%)	C:N	pH-H_2O	EC (ds/cm)
1	1.61	17.35	10.77	7.66	0.6
2	1.64	17.96	10.97	-	

Baseline Soil properties (Wheat, Hanko molicha kebele, Hula district)

parameter	Farm1	Farm2	Farm3	Farm4	Farm5	Farm6	Farm7	Farm8	Farm9	Farm10
%Sand	59	61	57	51	43	43	49	55	59	59
%Silt	18	22	22	30	28	22	24	20	16	20
%Clay	23	17	21	19	29	35	27	25	25	21
%OC	1.56	2.73	2.14	2.73	2.53	2.73	2.65	2.73	2.53	2.53
Av.P(ppm)	5.34	5.31	7.19	11.13	15.82	6.36	5.96	6.07	10.02	17.53
Total N(%)	0.16	0.13	0.11	0.13	0.1	0.13	0.13	0.11	-	-
pH-H_2O	4.4	4.5	4.5	4.7	5.1	4.6	4.7	4.6	4.8	5.1
Ex. Acid. (meq/100g)	0.64	0.48	0.4	0.88	0.56	0.4	0.48	0.64	0.64	0.56

FTC

%Sand	%Silt	%Clay	%OC	Av.P (ppm)	Ex. Acid. (meq/100g)	pH-H_2O
44.96	26	29.04	2.73	11.46	0.56	6.1

Baseline Soil properties (Maize, Luda kebele, Hula district)

parameter	Farm1	Farm2	Farm3	Farm4	Farm5	Farm6	Farm7	Farm8	Farm9	Farm10
%Sand	32.4	26.4	30.4	30.4	32.4	24.4	28.4	30.4	44.4	28.4
%Silt	22	26	26	24	18	22	22	22	26	18
%Clay	45.6	47.6	43.6	45.6	49.6	53.6	49.6	47.6	29.6	53.6
%OC	2.24	1.46	1.56	1.95	2.73	3.9	2.73	2.44	1.85	3.31
Av.P(ppm)	11.48	12.45	8.97	10.22	12.8	18.03	16.49	13.50	8.62	12.24
Total N(%)	0.1	0.09	0.1	0.08	0.09	0.09	0.09	0.09	0.07	0.08
pH-H_2O	5.63	5.43	5.12	5.25	5.69	5.68	5.61	5.46	5.16	5.26
Ex. Acid. (meq/100g)	0.4	0.48	0.72	0.4	0.4	0.32	0.24	0.64	0.32	0.96

FTC

%Sand	%Silt	%Clay	%OC	Av.P (ppm)	pH-H_2O	Ex.acid. (meq/100g)	Total N(%)
32.4	18	49.8	2.73	16.8	5.12	0.24	0.09

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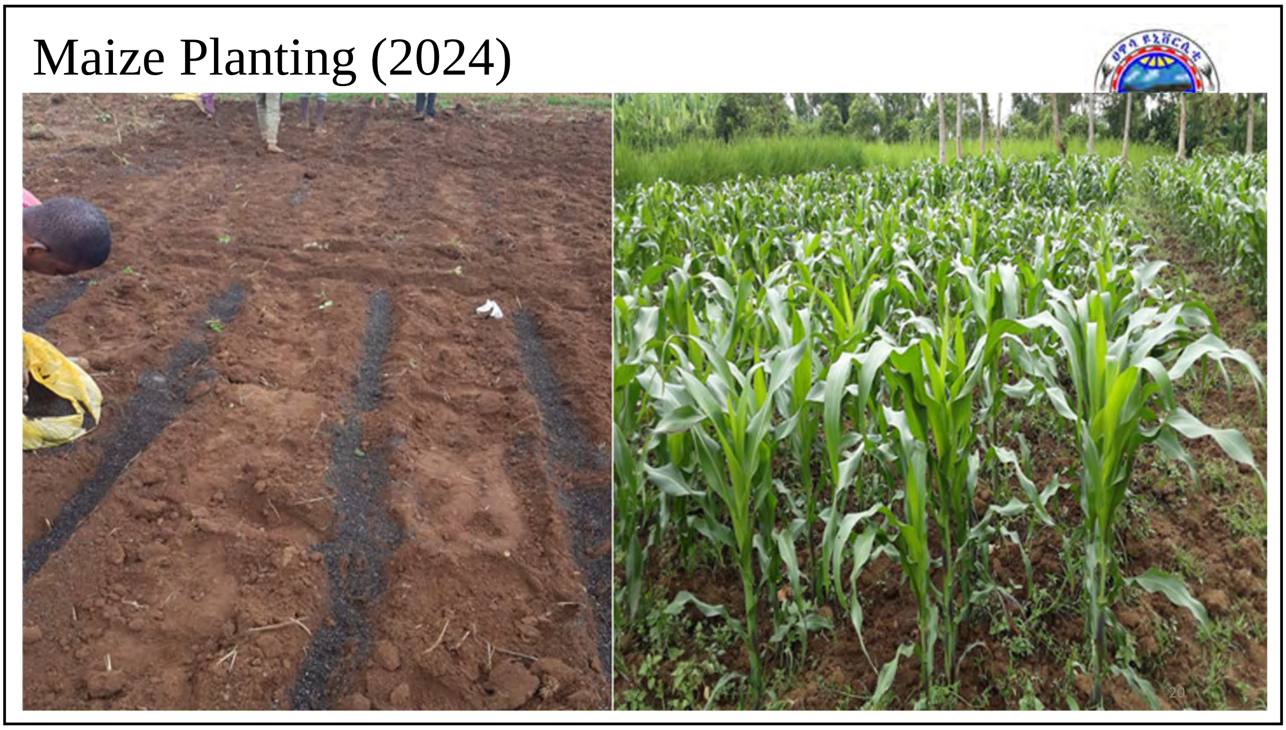
Maize Planting (2024)

Planting


Wheat fields in FTC (Hula, 2024)
19


Maize Planting (2024)

Preliminary Results

- ✓ Effect on Wheat Biomass and grain yield?
- ✓ Effect on soil properties?

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Treatment (2023)	BY (t/ha)	GY (t/ha)
C	6.63^{E}	1.78^{C}
+F	9.07^{DEC}	2.79^{BAC}
BC1	7.33^{E}	1.97^{BC}
BC1+F	12.13^{BDAC}	2.54^{BC}
BC2	7.77^{DE}	1.69^{C}
BC2+F	10.53^{BDEC}	2.41^{BC}
VC	10.53^{BDEC}	2.69^{BAC}
VC+F	13.13^{BAC}	2.84^{BAC}
BC1+VC	9.87^{BDEC}	2.30^{BC}
BC1+VC+F	15.47^{A}	4.31^{A}
BC2+VC	9.50^{BDEC}	2.33^{BC}
BC2+VC+F	13.67^{BA}	3.52^{BA}
LSD,5%	4.45	1.67
CV (%)	25.13	38.08

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Effect of BBF on yields of wheat (2024)

Treatment (2024)	BY (t/ha)	GY (t/ha)
C	7.3cd	2.9cd
+F	8.6dc	3.4bdc
+4BC	10.7bac	4.0ba
+F+4BC	12.2ba	5.0ba
+8BC	6.1dd	2.4d
+F+8BC	11.8ba	4.9bac
+VC	10.0bac	4.5bac
+F+VC	12.9a	5.5ba
+4BC+VC	12.0a	4.8bac
+F+4BC+VC	13.4a	5.7a
+8BC+VC	12.8a	5.2ba
+F+8BC+VC	10.3bac	4.2abcd
CV	23	28
LSD	4.1	2.1

24

Effect of BBF on growth and yields of Maize (2024)

	Treatment	plant height (m)	Grain yield (t/ha)	BMY (t/ha)
1	M+F	2.2ba	4.0b	12.6
2	M+F+BC	2.0b	5.9a	10.4
3	M+10VC	2.3a	5.9a	12.2
4	M+10VC+30%BC	2.3a	5.1ab	13.2
5	M+10C	2.1b	6.3a	12.1
6	M+10C+30%BC	2.1b	4.9ab	9.9
CV		7	30	32
LSD		0.14	1.45	ns

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Effect of BBF on soil properties after one growing season (Wheat, FTC, 2023)

#	Treatments	OC (%)	pH-H2O
1	C	1.55±0.24[a]	6.05±0.26[NS]
2	+F	1.89±0.4[ae]	6.03±0.28[NS]
3	+4BC	2.0±0.07[ace]	6.09±0.35[NS]
4	+8BC	2.18±0.04[cef]	6.08±0.33[NS]
5	+F+4BC	2.44±0.4[bcf]	5.73±0.09[NS]
6	+F+8BC	2.78±0.13[bd]	5.92±0.50[NS]
7	VC	2.98±0.20[d]	6.21±0.17[NS]
8	VC+F	2.15±0.36[cef]	6.51±0.43[NS]
9	VC+4BC	2.53±0.32[bcdf]	6.33±0.72[NS]
10	VC+8BC	2.56±0.29[bdf]	6.47±0.26[NS]
11	VC+4BC+F	1.88±0.05[ae]	6.38±0.44[NS]
12	VC+8BC+F	2.28±0.12[bcef]	6.16±0.40[NS]
CV (%)		29.03	7.50
$LSD_{0.05}$		0.53	0.78

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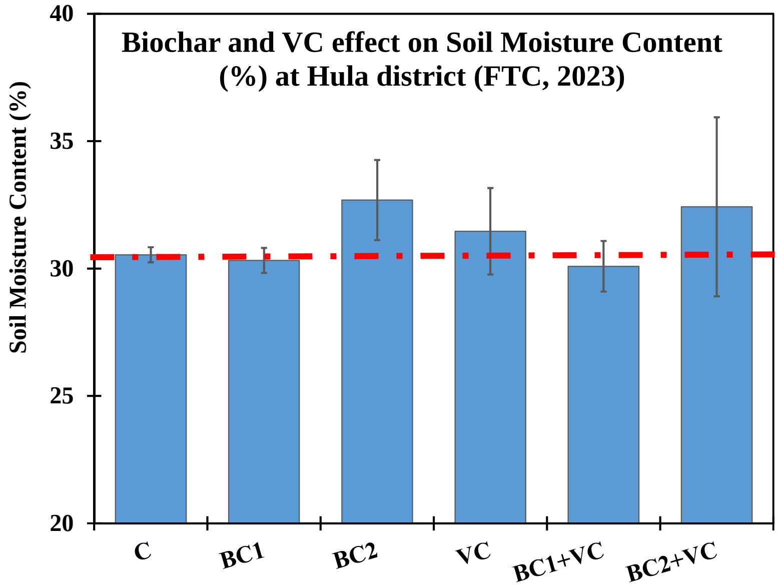
Effect on Soil moisture content?



✓ 8 t/ha Biochar seems to improve soil moisture content

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Preliminary Conclusions

✓ Yield benefits of BBF already in a growing season (Maize) as well as wheat (2 seasons) when used integrated with mineral fertilizer and vermin/compost

✓ Marginal improvements in soil moisture content with BBF application

✓ Trends of on increasing OC and soil pH with BBF amendment

✓ There is significant interest from farmers in the study area for wider use of biochar and organic fertilizers

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Activities to popularize biochar benefits….

- **Farmers' training** to raise awareness about the benefits and preparation of biochar and vermicompost

Field day

Thank you!

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Challenges encountered

- ✓ Late planting
- ✓ Wheat seed availability
- ✓ Pests and diseases

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Panel discussion: Grant holders 1st Call

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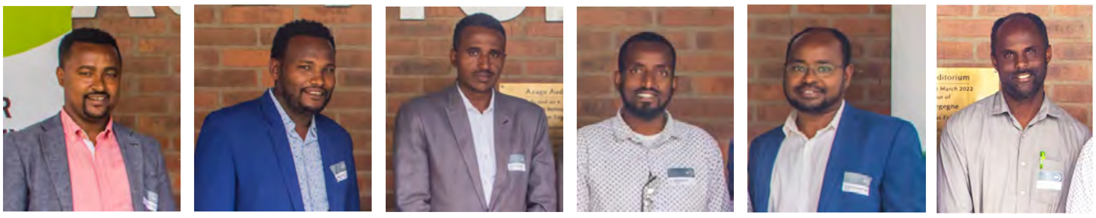
ETH-SOIL

3rd Soil Symposium | 6th of March 2025 | Naflet Hotel, Adama

Panel discussion

ETH-SOIL



Dr. Shimelis Gizechew (Hawassa University)
Wondimu Tamrat (Wachemo University)
Tilahun Abera (Batu Soil Research Center)
Dr. Milkiyas Ahmed (Jimma University)
Dr. Yackob Alemayehu (Dilla University)
Dr. Abebe Nigussie (Jimma University)

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3

7.3 Evaluation of biochar-treated amendments for their agronomic effectiveness in acidic soils: Assessing the production process and product quality, Dr. Yackob Alemayehu, Dilla University

Evaluation of biochar-treated amendments for their agronomic effectiveness in acidic soils: (Part I) Assessing the production process and product quality

Researchers team:

Yackob Alemayehu[1] | Temesgen Kebede[1] | Habtamu Berihun[1] | Negussie Zeray[1]
Dereje Andualem[1] | Abebe Nigussie[2] | Milkyas Ahmed[2] | Zeleke Wondimu[2]

[1] Dilla University

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1

Goals and objectives of the project:

2

The overall goal of project.

- to develop effective biochar-based nutrient-rich fertilizers from locally-available biowastes that improve soil health and maize/barley productivity while reducing production costs and environmental impacts

Objectives:

a) to evaluate the effect of biochar addition on the activity of earthworms and the obtained vermicompost.

b) to investigate whether enrichment agent (with biochar) during the process has added value to the quality of vermicompost product of coffee processing waste.

c) to evaluate the effect biochar on the fertilizer properties of MLF

d) to investigate the effects of biochar-assisted enriched preparations (VC and MLF) on growth, and nutrient use of maize and barley crops and nutrient availability in acidic soil

2

Biochar preparation

Biochar: coffee pulp collected from a local wet-dry coffee processing units….air-dried …

- Jimma: produced under a slow-pyrolysis process in O_2-limited furnace after cooling the produced biochar
- Dilla: using a locally-made pyrolysis unit.
- appropriate for farmers to produce biochar at a small-scale level.
  - the impurities removed, crushed into a fine powder.
- samples characterized for pH, fixed C, bulk density, ash yield, total N

3

Experiment I: testing biochar dose on the activity of earthworms…

4

Preparation of mixtures for bin vermicomposting (CPW: CM 3:1)

Trt	Biochar%	Biochar wt (g)	Biowaste dry(g)	Total wt (g)
1	0	0	1200	1200
2	3	36	1164	1200
3	6	72	1128	1200
4	9	108	1092	1200
5	12	144	1056	1200
6	15	180	1020	1200
7	20	240	960	1200
8	25	300	900	1200

Coffee processing waste (CPW) — Poultry litter (PL), & CM — Biochar (CHB)

Experiment I: testing biochar dose on the activity of earthworms…

Measurements *Eisenia fetida* activities

- Growth, reproduction, and biomass production at 0, 20, 35, 55, 75-d…):

Counting – washing/blotting with filter paper – weighing

- **reproduction** (in terms of number of cocoons, juveniles, and adult)
- **biomass** (weight gain)
- **growth rate(mg/worm/day**
- conversion rate of waste to vermicompost

Lab-level vermicomposting: testing biochar effect on the activity of earthworms

Experiment II: Enrichment study: vermibed level vermicomposting

6

- CPW as the main component (>50) is mixed with cow dung and/or poultry litter in different proportions in the absence and presence of biochar
- earthworms (Eisenia fetida) - 1.6 kg/m^2 stocking density

Table 2: Combinations of composting substrates

Code	% Proportion of mixtures (w/w, dry weight)			Biochar (9%)	Ratio
	CPW	Cow dung	Poultry litter		
CPW single	100	0	0	Without	-
CPW:CD	75	25	0	Without	3:1:0
CPW:CD:PL	62.5	25	12.5	Without	2.5:1:0.5
CPW:PL	50	25	25	Without	2:1:1
CP:CD +B	75	25	0	With	3:1:0 + 9%B
CPW:CD:PL +B	62.5	25	12.5	With	2.5:1:0.5 + 9%B
CPW:PL +B	50	25	25	With	2:1:1 + 9%B

6

Experiment II: Enrichment study: vermibed level vermicomposting….

composting mixtures, preparation and vermicomposting process on vermibeds

Earthworm related studies

Total population and biomass of earthworms at 35, 70d

- **Method**: hand-sorting method (Gong et al.2021)
- **Sample size**: 4 samples per vermibed
- Counting the earthworm population groups: juvenile and adults separately
- values converted into **total population per m²** for each vermibed
- **Biomass of earthworm**: each hand-sorted – washed (DW) - weighed - placed back to vermibed

Sampling core size= 20 × 20 cm

8

Experiment II: Enrichment study: vermibed level vermicomposting…. 9

Sampling and measurements: changes during the period of vermicomposting

- physico-chemical analysis of final vermicompost

- **Physico-chemical analysis**: raw material, initial mixtures, 35, final (70d) vermicompost

Parameter	Method	Instrument used
pH-H2O	1:2.5	
EC	1:5	
TOC	Walkley and Black	
TN	Kjeldahl Method	
Total P	Metavanadate (Colorimetric)	Spectrophotometer
Copper	DTPA-Extraction	ICP-OES
Iron	DTPA-Extraction	ICP-OES
Manganese	DTPA-Extraction	ICP-OES
Boron	DTPA-Extraction	ICP-OES
Zinc	DTPA-Extraction	ICP-OES
Potassium	Mehlich-3	ICP-OES

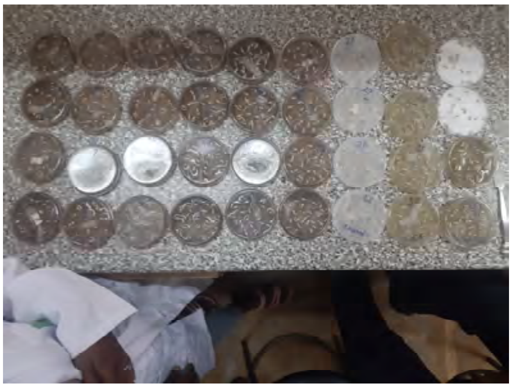
Calculations: using various indices:

- N loss during vermicomposting
- OM loss
- Relative efficiency of nutrient recovery.

9

Seed germination bioassays for phytotoxicity test: 10

- determined to assess the quality of vermicompost
- Aqueous extracts of each was prepared (w/v) using standard preparation protocol (Tiquia, et al. 1996),
- 10-ml of filtered extracts was transferred into petri-dish having a filter paper, 20 seeds placed in 4 replication.
- After 7-days, data on germination rate, root length and shoot length will be collected.
- Relative germination of seed (RSG), relative growth of root (RRG) and germination index (GI)



$$RSG\% = \frac{\text{No. of seeds germinate in trt}}{\text{No. of seeds germinate in control}} x100$$

$$RRG\% = \frac{\text{Average root elongation for trt}}{\text{Average root elongation for control}} x100$$

$$GI\% = \frac{RSG}{RRG} x100$$

Results

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Summarized findings of experiment I

biochar effect on worm activity and property of VC

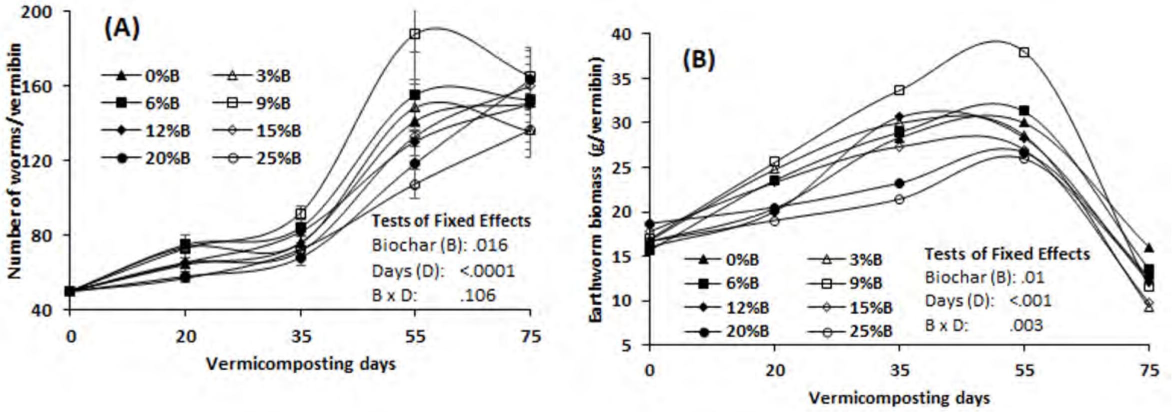


Fig.1. Temporal changes in the (a) population of adult earthworms *Eisenia fetida*, (b) biomass weight under different biochar doses in coffee waste-based vermicomposting.

Results…

12

Summarized findings of experiment I…

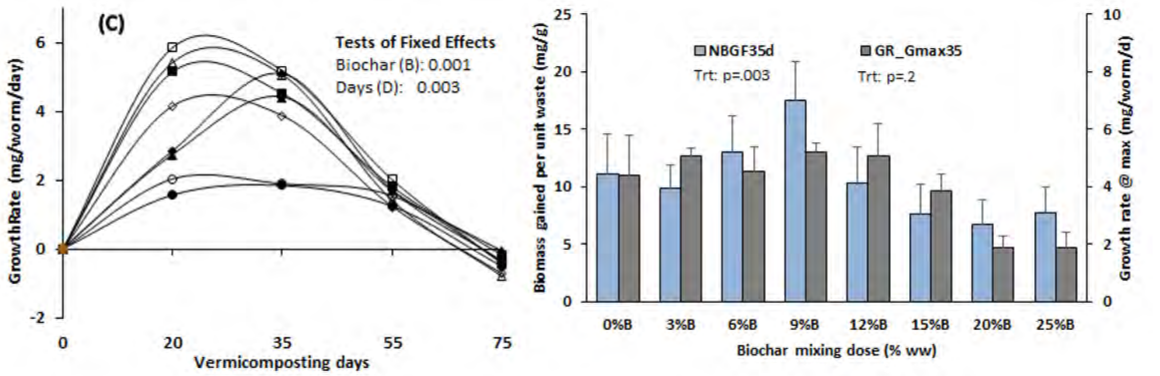


Fig.1. Temporal change in the (a) growth rate, and (b) net biomass gain per unit feed under different biochar doses in coffee waste vermicomposting over the period of 70d. Error bars re[resent standard error (n=4).

9% better biochar level promoted to the subsequent enrichment studies

Results….

13

Summarized findings of experiment I…

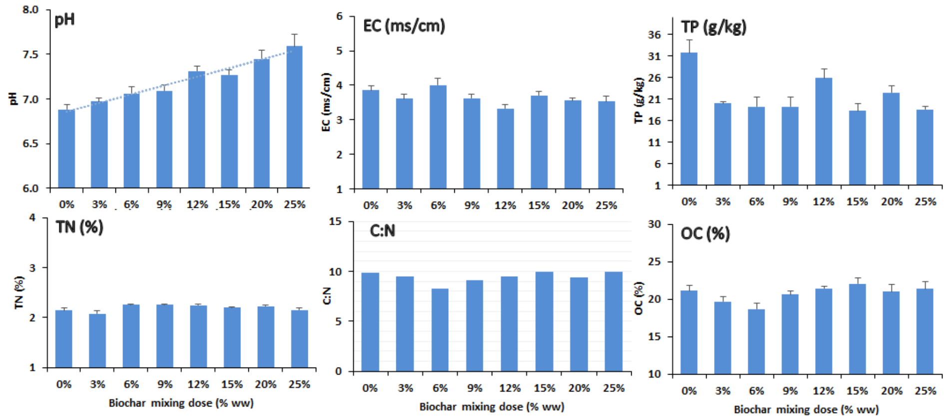


Fig.1. Chemical of final vermicompost products under different biochar doses in coffee waste-based vermicomposting over the period of 70d.

Results….

14

Summarized findings of experiment I…

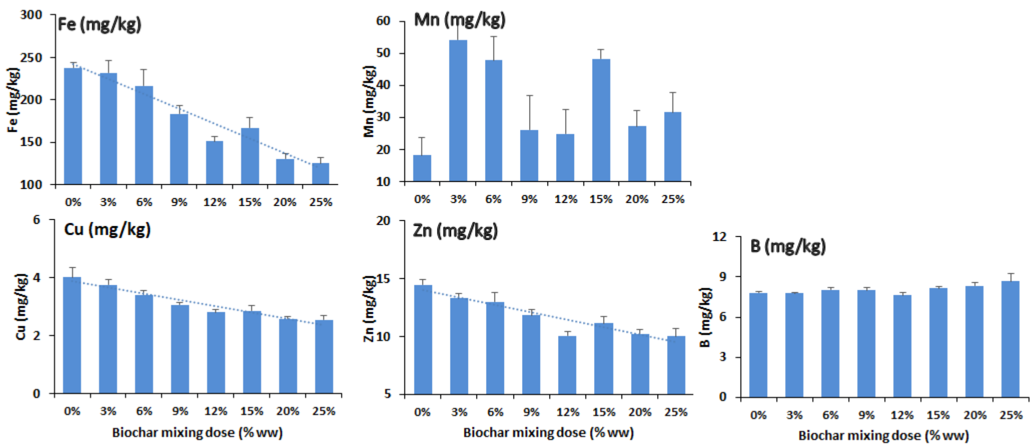
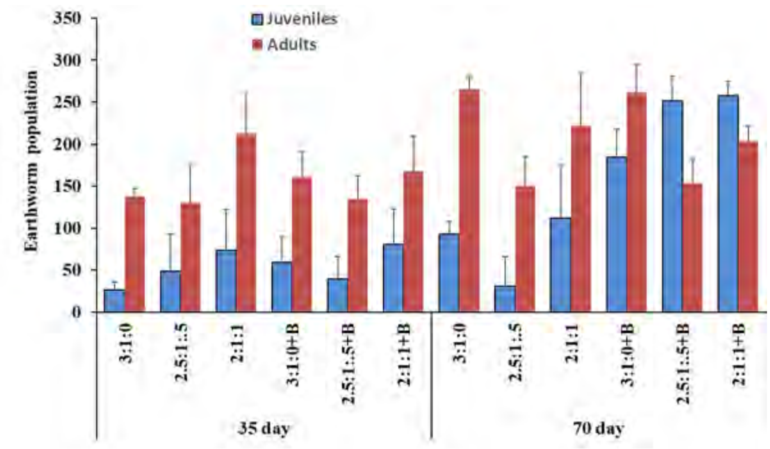


Fig.1. Chemical properties of final vermicompost products under different biochar doses in coffee waste-based vermicomposting over the period of 70d.

Analysis of quality parameters of final vermicompost products:

Results

Experiment II... Enrichment study



Earthworm populations under different N-rich levels with and without biochar during the period of vermicomposting

Error bars represent standard error (n=4).

15

Results

Experiment II... Enrichment study

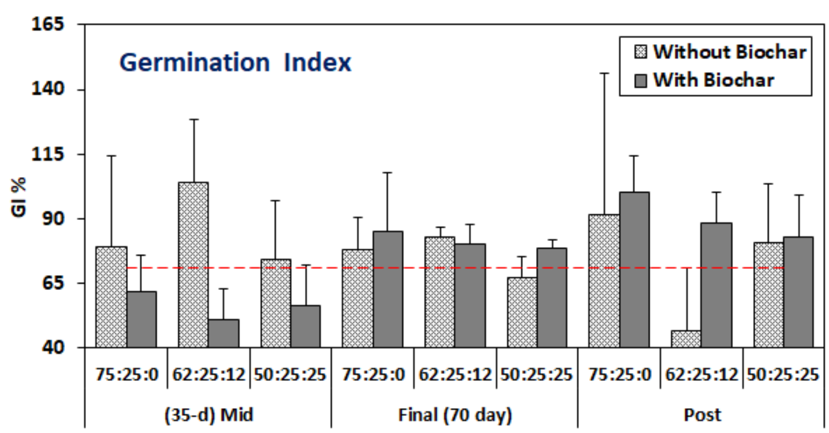


Fig: Germination index (GI) of different N-rich substrate with and without biochar during the period of vermicomposting and 2-weeks after harvesting

16

Panel discussion on: Biochar-based Bio-fertilizer Formulations for Soil Amelioration and Yield Increase

By
Wondimu Tamrat (MSc. Assist prof.)

From Wachemo University

Team members:
Ermias Alayu (PhD)
Mekdes Lulu (PhD)
Girma W/Michael (MSc. Assist prof.)

3rd Soil Symposium: Healthy soil for our prosperity!
6-7th March 2025
Adama, Ethiopia

Background

- Agriculture is vital for ensuring **food security, generating employment, and driving GDP growth,** all of which contribute to sustainable economic development.
- However, its productivity is increasingly **challenged by multiple factors, posing a threat to the sector's long-term sustainability.**
- Among others, severe soil degradation, climate change-induced droughts, continuous and excessive use of chemical fertilizers, **have contributed to declining of soil productivity** (Shreya *et al.*, 2021; Abure, 2022; Premalatha *et al.*, 2023).

2

Background cont'd…

- Specifically, these factors have a negative impact on **soil fertility and crop productivity**, which in turn threatens the long-term sustainability of the sector (Dubale, 2001; Aga, 2011).
- These factors have all contributed to **nutritional and organic matter depletion, soil acidification, and low crop yield**, all of which increase the risk of serious food insecurity (Erango *et al*., 2017; Adimassu *et al*., 2020).
- Despite on going efforts to address soil fertility issues and crop yield through **the use of chemical fertilizers, their ability to sustain long-term soil fertility remains limited** (Pandey and Diwan, 2021).

3

Background cont'd…

- Furthermore, the primary challenge to using inorganic fertilizers is **their high cost and limited accessibility under current conditions**.
- Thus, **developing a sustainable soil fertility management approach that can boost agricultural productivity** to meet both current and future food demands has become a critical concern.
- Among these, **(BBFs) have emerged as a promising alternative for improving soil fertility, boosting crop yields, and addressing the impacts of climate change worldwide** (Amin *et al*., 2016; Das *et al*., 2021; Acharya *et al*., 2023).

4

BBFs: Results from Previous research works

- As a soil amendment, several researchers have evaluated the role of BBFs in **improving soil physicochemical properties such as increasing soil pore space, soil organic matter, and increasing soil pH and availability of essential nutrients, increase nutrient use efficiency** (Achakzai *et al*., 2022; Elshayb *et al*., 2022).

- Thus, improving **overall soil quality**, potentially helping to reduce chemical fertilizer needs over time (Phares *et al*., 2022; Abiola *et al*., 2023; Nepal *et al*., 2023).

5

BBFs: Results from Previous research works…

- Several findings of previous research works indicated that application of BBFs significantly increased **grain yield of corn, vegetables and cereal crops around the world** (Berihun *et al*., 2017; Agbede *et al*., 2019; Achakzai *et al*., 2022; Tufa *et al*., 2022; Abiola *et al*., 2023).

- Relatively few research works conducted in Ethiopia suggested that using biochar based organic fertilizers **boosted the yield of a variety of crops and soil attributes** (Gebremedhin *et al*., 2015; Agegnehu *et al*., 2016; Lulu *et al*., 2022; Demissie *et al*., 2023).

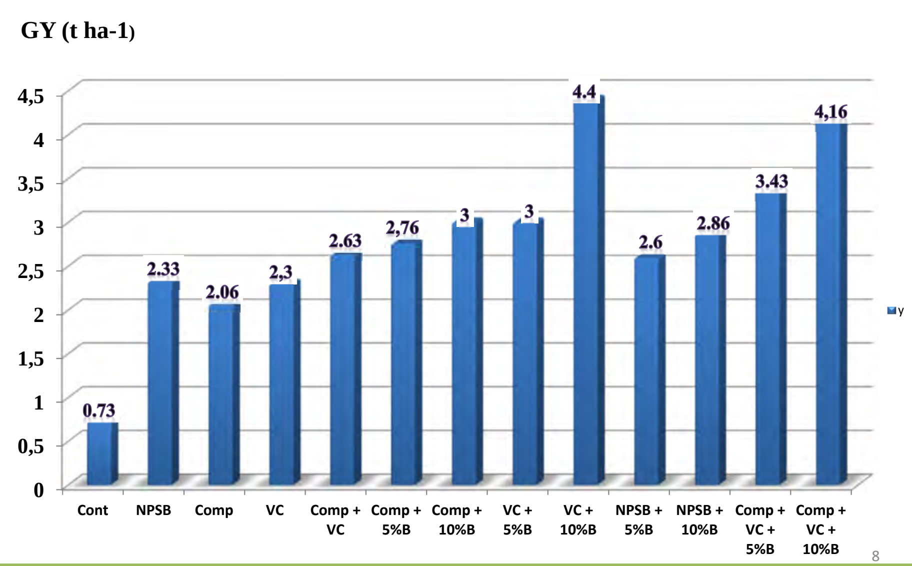
6

BBFs: Results from our research work

- The findings indicated that BBFs notably **improved soil physico-chemical properties and increased food barley crop yield.**
- The results revealed that the application of BBFs had a significant effect on **crop phenology, growth, yield, and yield components of food barley in the study area**.
- Additionally, the farmers' preference indicated that **treatments treated with BBFs performed better than other treatments in all measured parameters.**
- Highlighting the potential BBFs as a **sustainable agricultural intervention for ameliorating soil fertility and enhancing crop yield in the study area.**

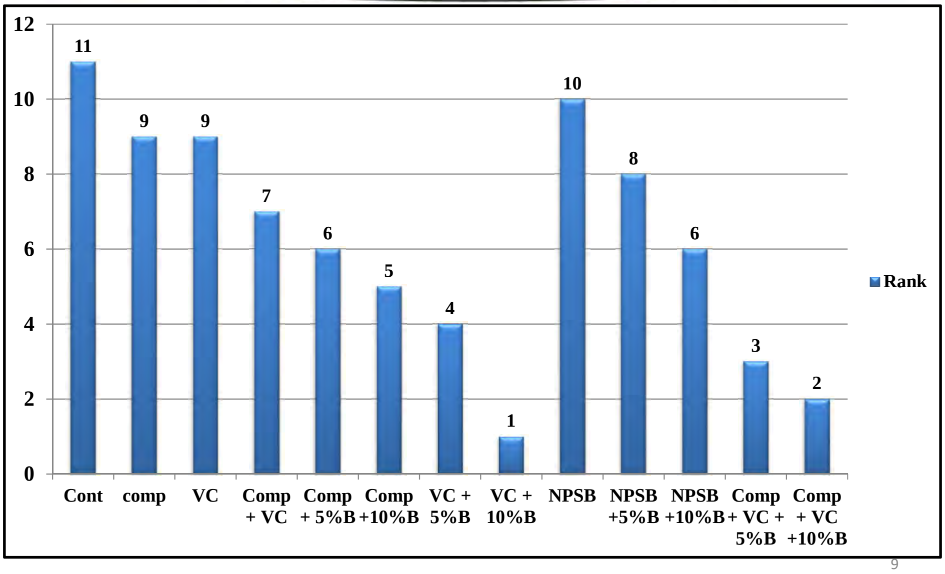
7

Effect of BBFs on food barley yield at Fonko of Hadiya Zone during 2023/2024



8

Farmers' preference evaluation on the impacts of BBFs amendments on food barley productivity at Fonko of Hadiya Zone during 2023/2024



9

BBFs: Challenges and Future Outlook

Challenges

Some of the challenges related to BBFs are:

- Biochar Pyrolysis equipment and temperature variations
- Nutrient composition and content
- Lack of standard formulations (quality variability)
- Huge quantity to use and may be difficult in large scale farming
- Transportation issues.
- Farmer awareness and adoption barriers
- Storage and Handling Issues

10

Future Directions

- Advanced biochar modification for nutrient enrichment
- Developing affordable and efficient biochar production methods
- conducting researches in wide range and residual impact
- Smart application techniques
- Farmer training and awareness programs
- Policy support and Incentives
- Standardization and quality control
- Commercialization and private sector Involvement

11

Closing Thought

- BBFs are a transformative solution for **enhancing soil health and productivity, making their widespread adoption** is crucial for sustainable agriculture.

- Unlike **chemical fertilizers, which solely feed the plant, BBFs feeds both the soil and the plant, fostering long-term soil fertility and crop yield.**

12


Thank you!
13

7.5 Integrated Effect of Biochar and Bio-Slurry Compost with NP Fertilizers on Soil Physicochemical Properties, Climate Change Mitigation, Yield Components and Yield of Sorghum, Reta Worku, Oromia Agricultural Research Institute

Oromia Agricultural Research Institute

Batu Soil Research Center

3rd Soil Symposium

Soil amelioration with biochar

Reta Worku

6-7 March, 2025

Adama

1

Presentation outline

- Activity 1: **Biochar and Bio slurry compost for sustainable production**
- Activity 2: **Large scale Production, formulation and Distribution of BBF**

2

7.5 Integrated Effect of Biochar and Bio-Slurry Compost with NP Fertilizers on Soil Physicochemical Properties, Climate Change Mitigation, Yield Components and Yield of Sorghum, Reta Worku, Oromia Agricultural Research Institute

IQQO
Oromia Agricultural Research Institute
ETH-SOIL

Activity 1: Integrated Effect of Biochar and Bio-Slurry Compost with NP Fertilizers on Soil Properties, Climate Change Mitigation, and Sorghum Yield

❖ **Objective:**

- ❖ Investigate the combined effects of biochar and bio-slurry compost with NP fertilizers on:
  - ✓ Soil physicochemical properties
  - ✓ Climate change mitigation
  - ✓ Sorghum yield components and productivity

3

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Oromia Agricultural Research Institute
ETH-SOIL

Methodology

❖ **Experiment Type:** Pot experiment

❖ **Treatments:**

- Biochar rates: 0, 2, 4, 6 tons/ha
- Bio-slurry compost: 0%, 50%, 100% urea equivalent

❖ **Total Treatments:** 12 combinations

❖ **Where:-** 100% urea equivalent= 39Qt of Bio-slurry compost

4

7.5 Integrated Effect of Biochar and Bio-Slurry Compost with NP Fertilizers on Soil Physicochemical Properties, Climate Change Mitigation, Yield Components and Yield of Sorghum, Reta Worku, Oromia Agricultural Research Institute

Cont…

Table 4: grain Yield (kg/ha) as influenced by interaction effect of biochar and bio-slurry compost

Urea equivalent	**Biochar rate tone /ha**			
Bio-slurry compost	0	2	4	6
0%	1702e	3615ab	3111bcd	3468abc
50%	2655d	3913a	3083bcd	2611d
100%	3560abc	3210bcd	2940cd	3052bcd
LSD(0.05)	217.8			
CV (%)	12.3			

5

Key Findings

Soil Properties:

- **Bio-slurry compost:**
  - Significantly improved soil (OC), (OM), and TN.
- **Biochar:**
  - Minimal impact on soil pH and EC.
  - Reduced phosphorus availability at higher application rates(4-6ton/ha).

Sorghum Growth and Yield:

- **Synergistic effects:** Combining biochar and bio-slurry compost enhanced:
  - Plant height, Panicle length
  - Biomass and grain yield
- **Optimal Treatment:**
  - Achieved the highest grain yield: **3913 kg/ha**
  - 50% bio-slurry compost + 2 tons/ha biochar **and further field experiment will be Recommended**

6

7.5 Integrated Effect of Biochar and Bio-Slurry Compost with NP Fertilizers on Soil Physicochemical Properties, Climate Change Mitigation, Yield Components and Yield of Sorghum, Reta Worku, Oromia Agricultural Research Institute

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Photo taken during implementation

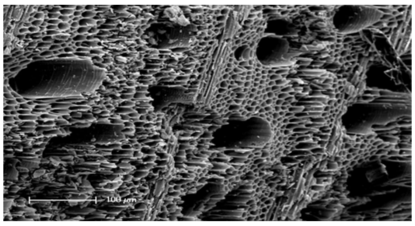
7

IQQO
Oromia Agricultural Research Institute

ETH-SOIL

Activity 2: Large scale Production, formulation and Distribution of BBF in A/T/J/ Kombolcha District, East Shewa, Oromia, Ethiopia

Biochar Overview



- Produced through pyrolysis of biomass.
- Enhances soil health, boosts crop yields,
- and mitigates climate change.
- Improves soil water retention, aeration, and nutrient-holding capacity.
- Reduces fertilizer runoff, promoting sustainable agriculture.

8

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❖ Objective:

- ✓ Rehabilitate highly degraded, food-insecure, and problematic soils.
- ✓ Promote sustainable agricultural practices and climate resilience.
- ✓ Enhance soil fertility and crop productivity through BBF.

9

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Mass production

10

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Milling(3-5cm)

11

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Moisture testing(30-35%)

12

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Compost collection

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Weighing (30%Biochar + 70% compost)


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Co-composting(BBF)
BBF after 15 days
15


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Packed biochar and BBF
16

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Summary of Biochar and BBF Applied

Input Type	Plot Size (m²)	Farmers (No.)	Total Area (m²)	Total in (kg)
Biochar Received	1,225 (35m × 35m)	43	52,675	57,175
	100 (10m × 10m)	45	4,500	
Total	-	**88**	**57,175**	**57,175**
BBF Received	1,225 (35m × 35m)	16	19,600	21,000
	100 (10m × 10m)	14	1,400	
Total	-	**30**	**21,000**	**21,000**

Gender-wise Participation

Gender	Number of Farmers	Percentage
Male	61	69.3%
Female	27	30.7%

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Summary of Grain Yield and Yield Advantage (Farmers' BBF vs. Without BBF)

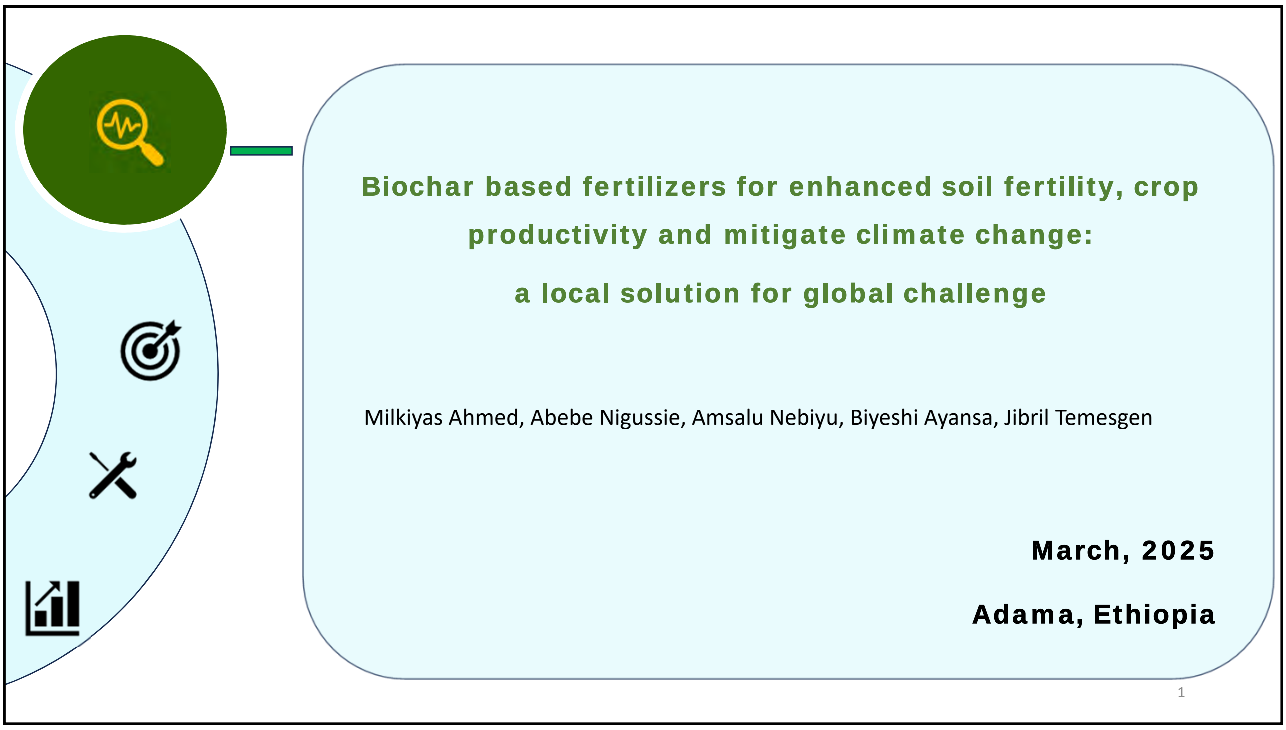
Crop Type	Avg. Grain Yield (With BBF) (kg/ha)	Avg. Grain Yield (Without BBF) (kg/ha)	Yield Advantage (kg/ha)	Yield Advantage (%)
Maize	4,326.53	3,374.69	951.84	**28.2%**
Haricot Bean	2,146.94	1,610.20	536.74	**33.3%**
Wheat	3,102.04	2,140.41	961.63	**44.9%**
Barley	3,600.00	2,304.00	1,296.00	**56.3%**
Potato	108,100.00	79,237.30	28,862.70	**36.4%**

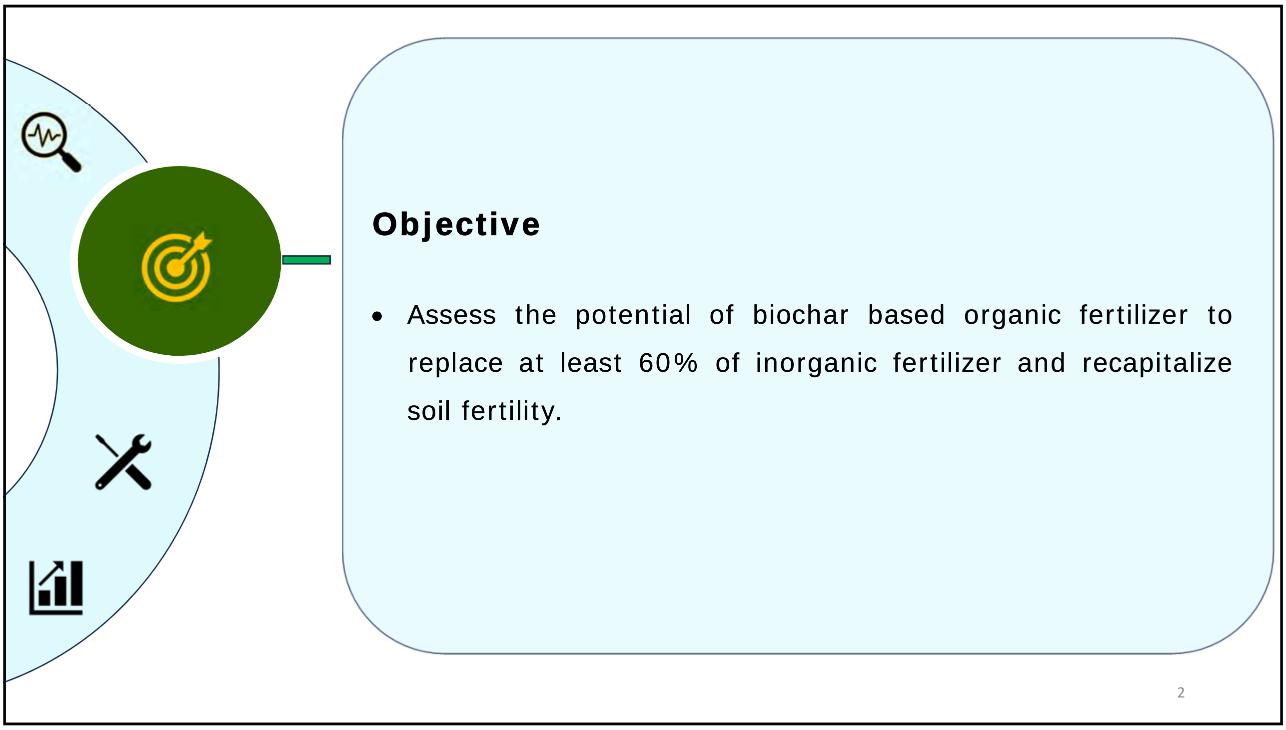
18


With BBF
19

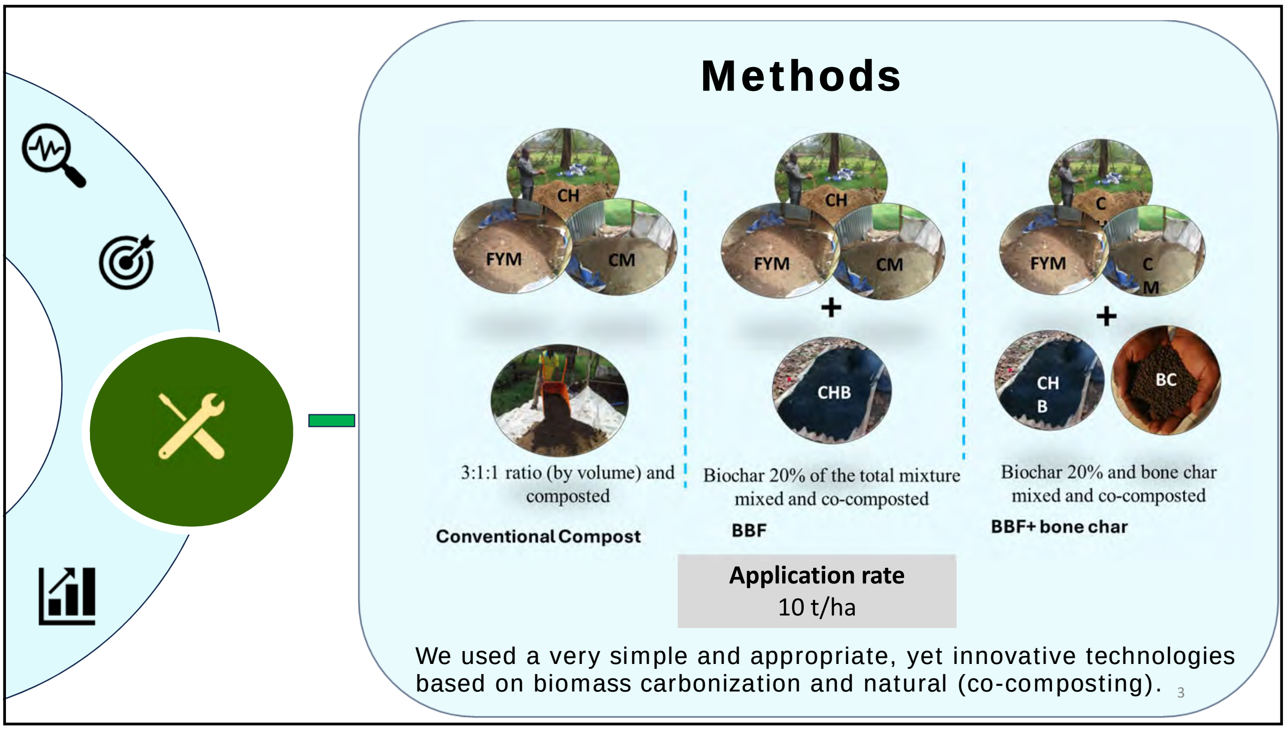

With BBF
With BBF
20

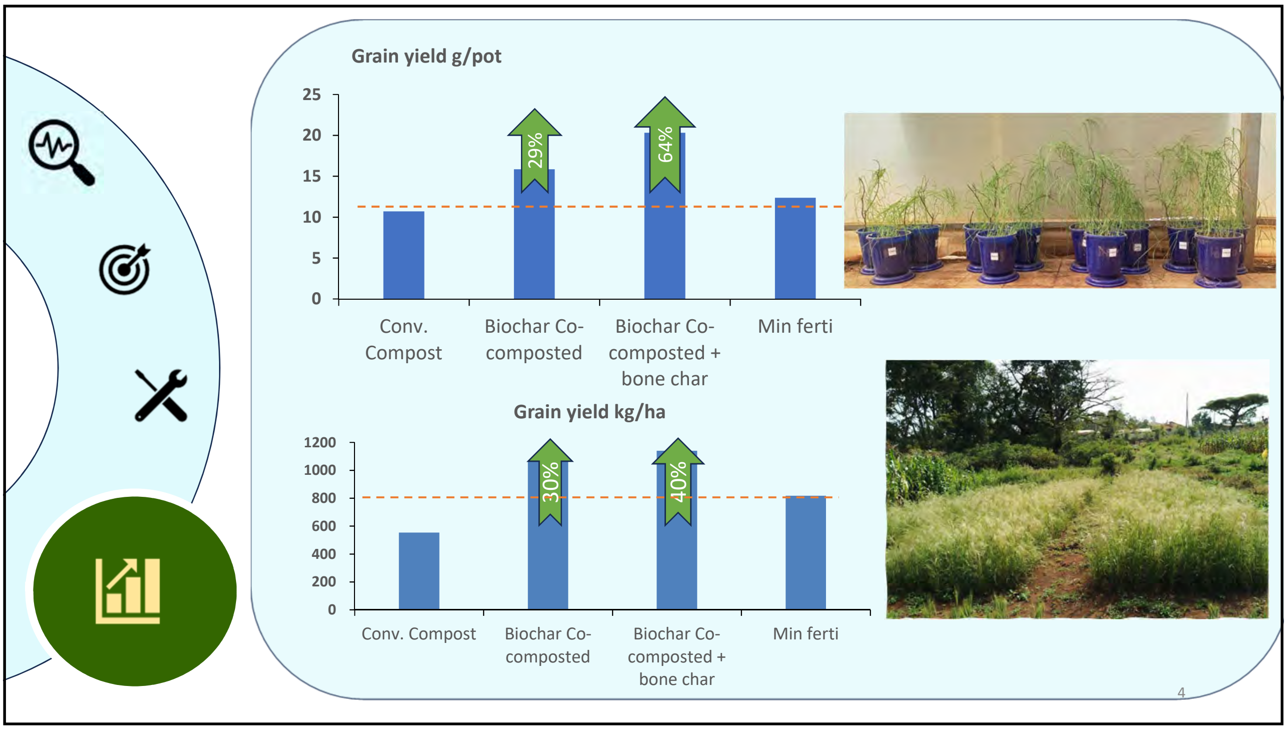

THANK YOU !
21

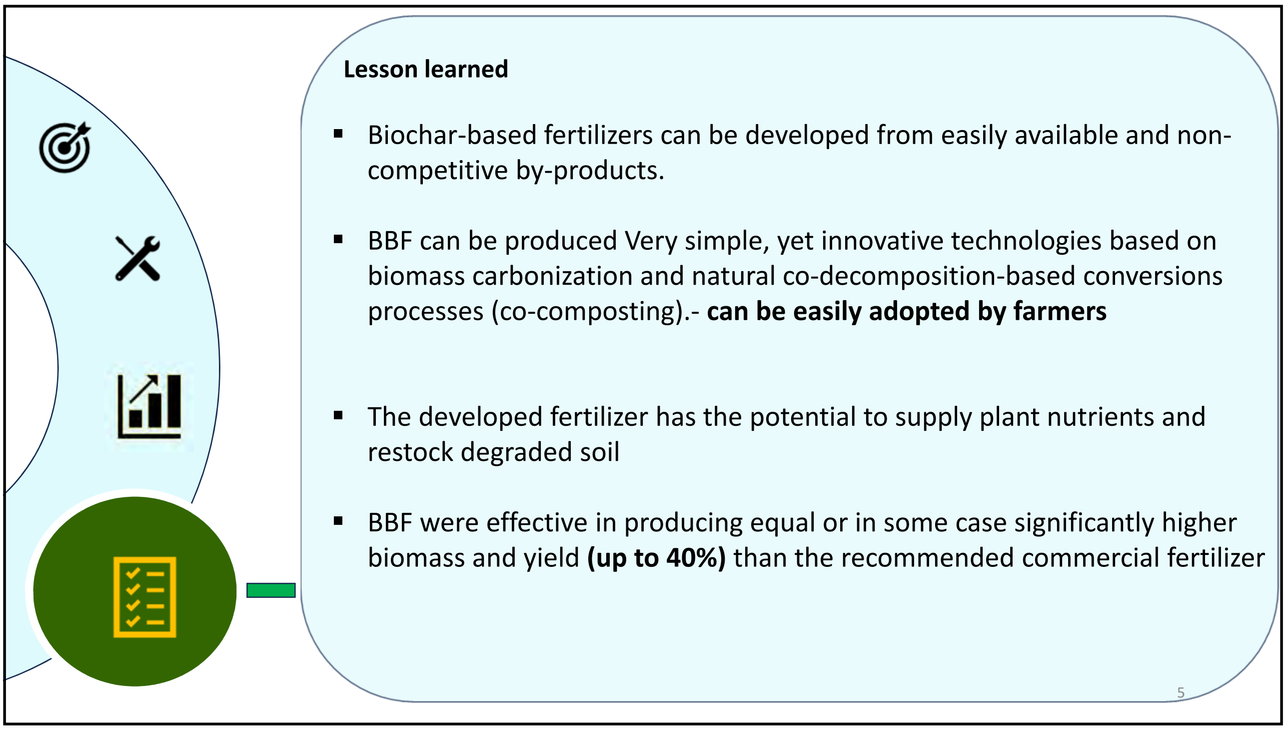

Biochar based fertilizers for enhanced soil fertility, crop productivity and mitigate climate change:
a local solution for global challenge
Milkiyas Ahmed, Abebe Nigussie, Amsalu Nebiyu, Biyeshi Ayansa, Jibril Temesgen
March, 2025
Adama, Ethiopia
1


Objective
• Assess the potential of biochar based organic fertilizer to replace at least 60% of inorganic fertilizer and recapitalize soil fertility.
2

7.6 Biochar-based Fertilizers for enhanced Soil Fertility, Crop Productivity and Mitigate Climate Change: A local Solution for global Challenge, Dr. Milkiyas Ahmed, Jimma University






Lesson learned
▪ Biochar-based fertilizers can be developed from easily available and non-competitive by-products.
▪ BBF can be produced Very simple, yet innovative technologies based on biomass carbonization and natural co-decomposition-based conversions processes (co-composting).- **can be easily adopted by farmers**
▪ The developed fertilizer has the potential to supply plant nutrients and restock degraded soil
▪ BBF were effective in producing equal or in some case significantly higher biomass and yield **(up to 40%)** than the recommended commercial fertilizer
5

7.7 Co-Application of Biochar and Digestate increases Crop Production and Soil Quality: Insight from a two-Year Field Experiment, Dr. Abebe Nigussie, Jimma University

ETH-SOIL

Co-application of biochar and digestate increases crop production and soil quality: Insight from a two-year field experiment

Bezabih Addisu, Abebe Nigussie, Milkiyas Ahmed, Amsalu Nebiyu, Gebyanesh Worku

March, 2025

Adama, Ethiopia

1

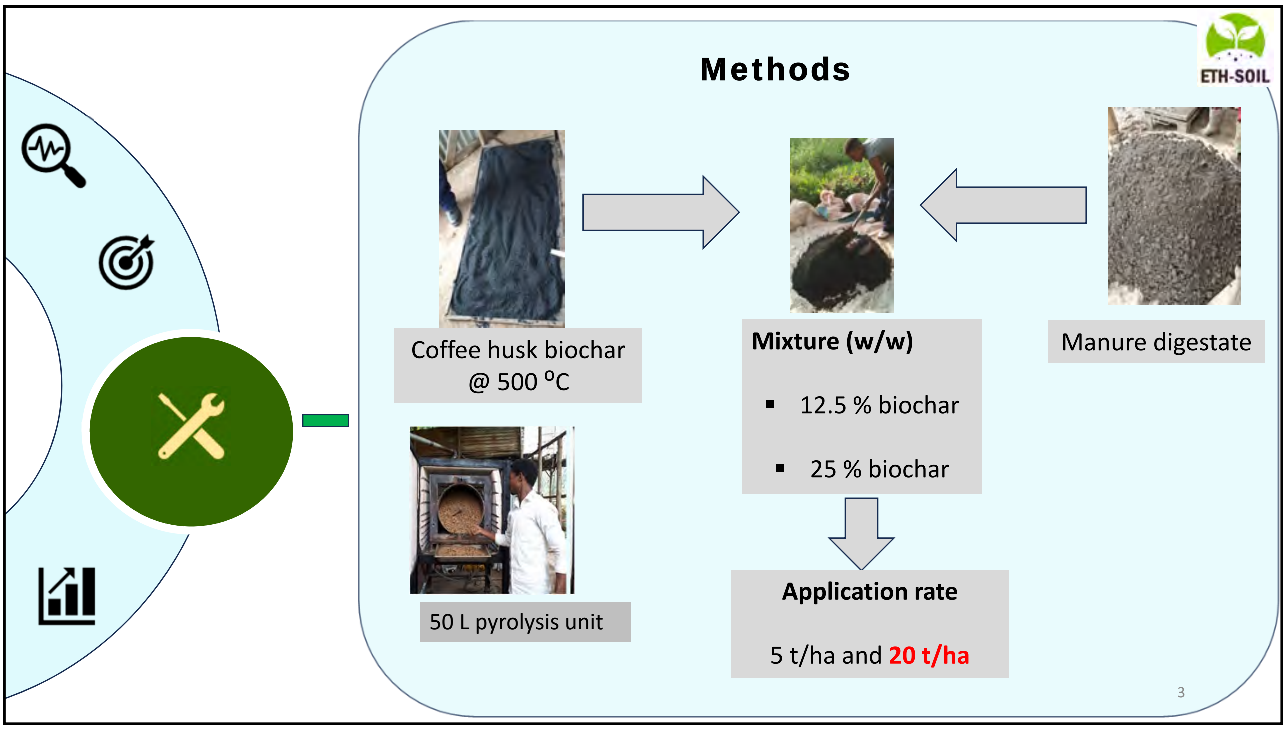
ETH-SOIL

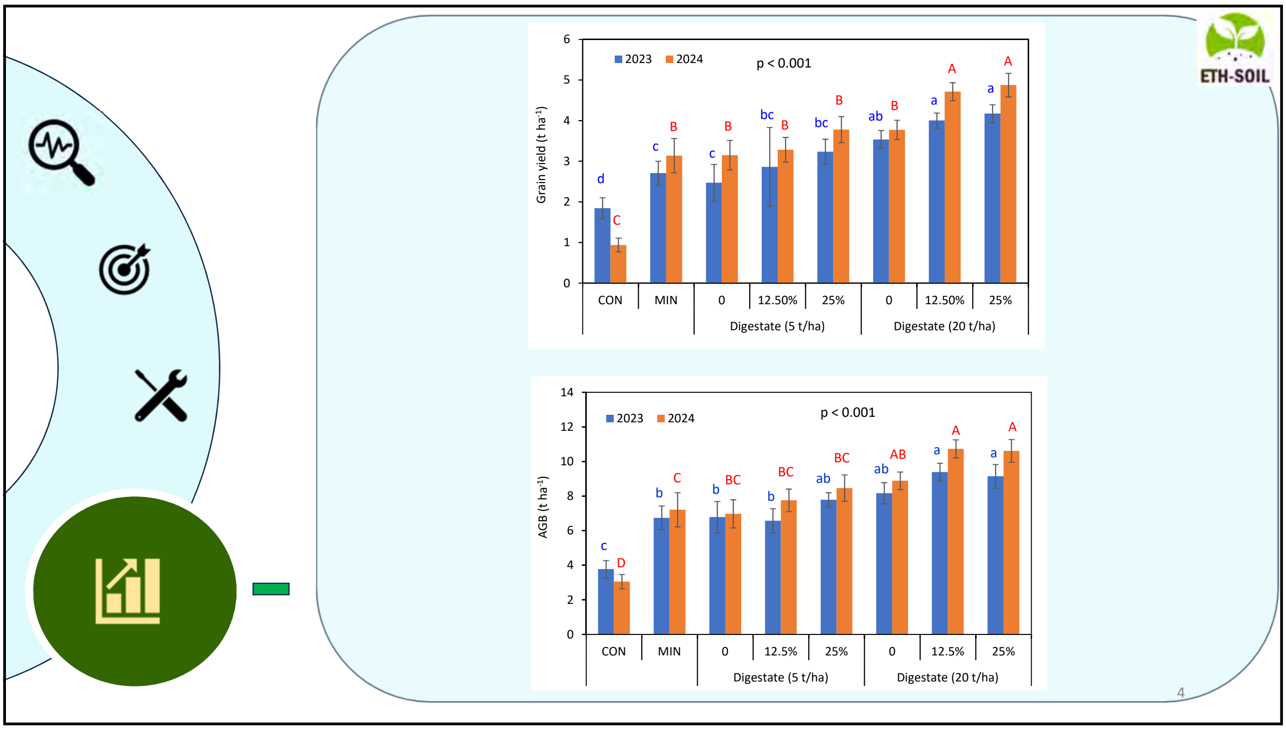
Objective

- To determine the effect of different biochar and digestate mixtures on crop yield and soil quality along varying soil fertility gradients

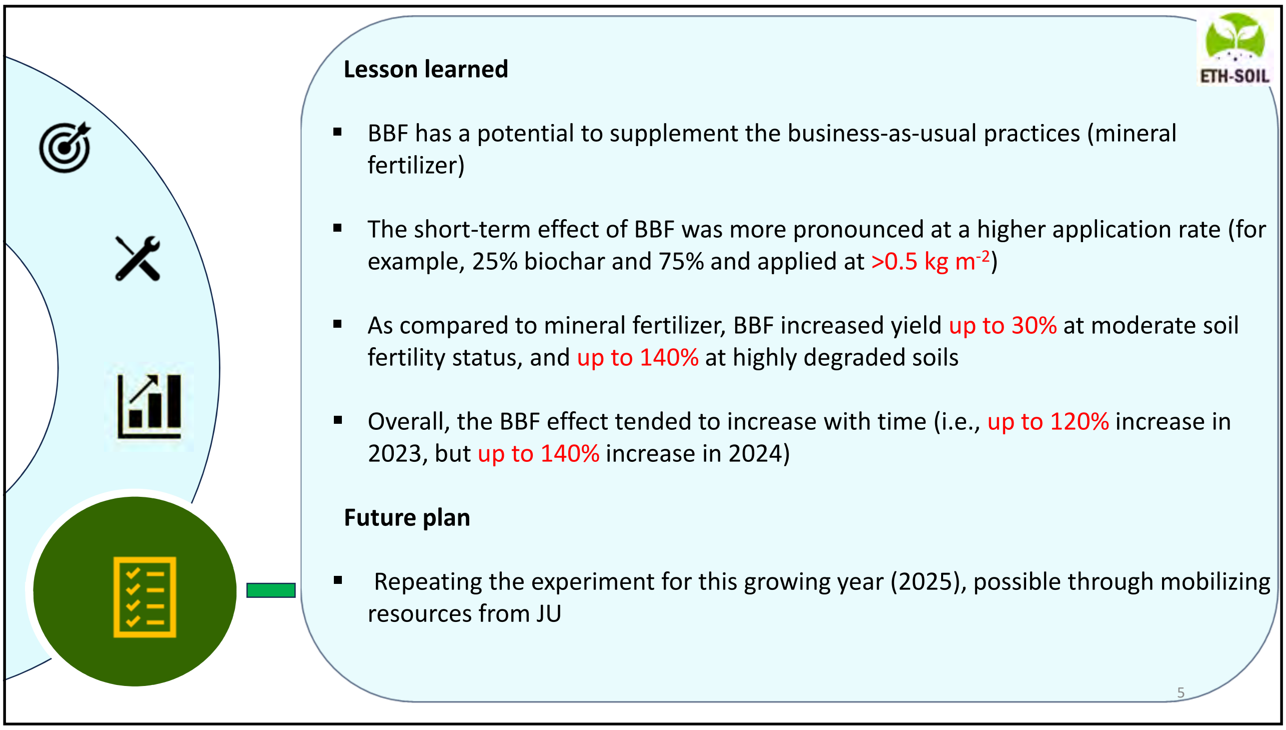
2

7.7 Co-Application of Biochar and Digestate increases Crop Production and Soil Quality: Insight from a two-Year Field Experiment, Dr. Abebe Nigussie, Jimma University





7.7 Co-Application of Biochar and Digestate increases Crop Production and Soil Quality: Insight from a two-Year Field Experiment, Dr. Abebe Nigussie, Jimma University



8.1 Biochar-Based Fertilizer Application Experiences in Oromia Region, Kisi Begna, Oromia Bureau of Agriculture

DBFZ

ETH-SOIL

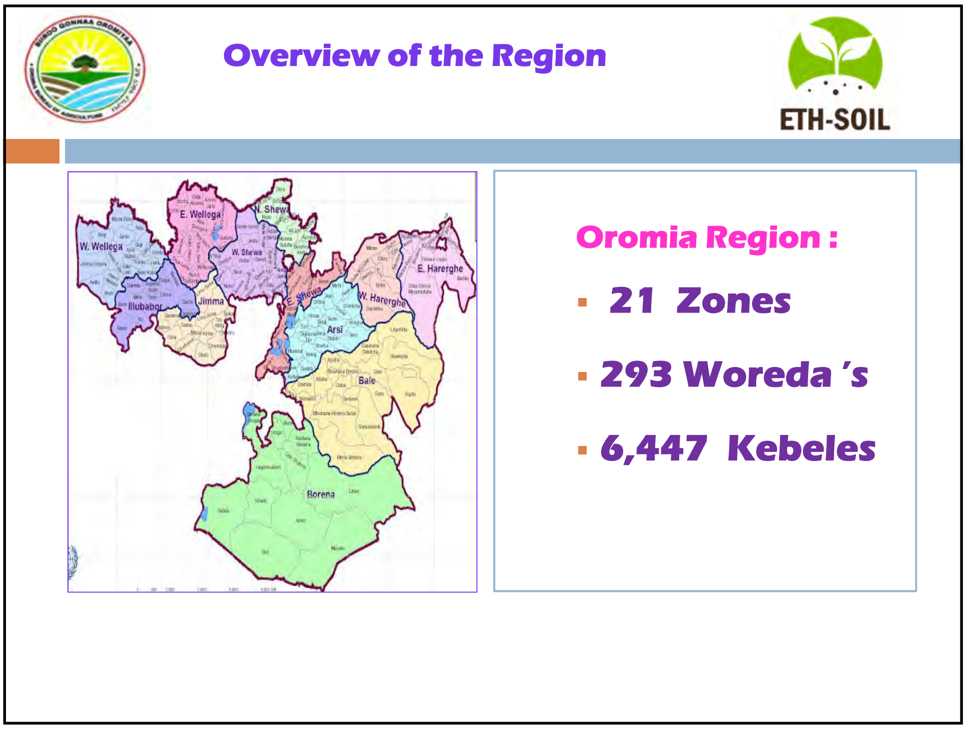
Biochar-Based Fertilizer Application Experiences in Oromia Region

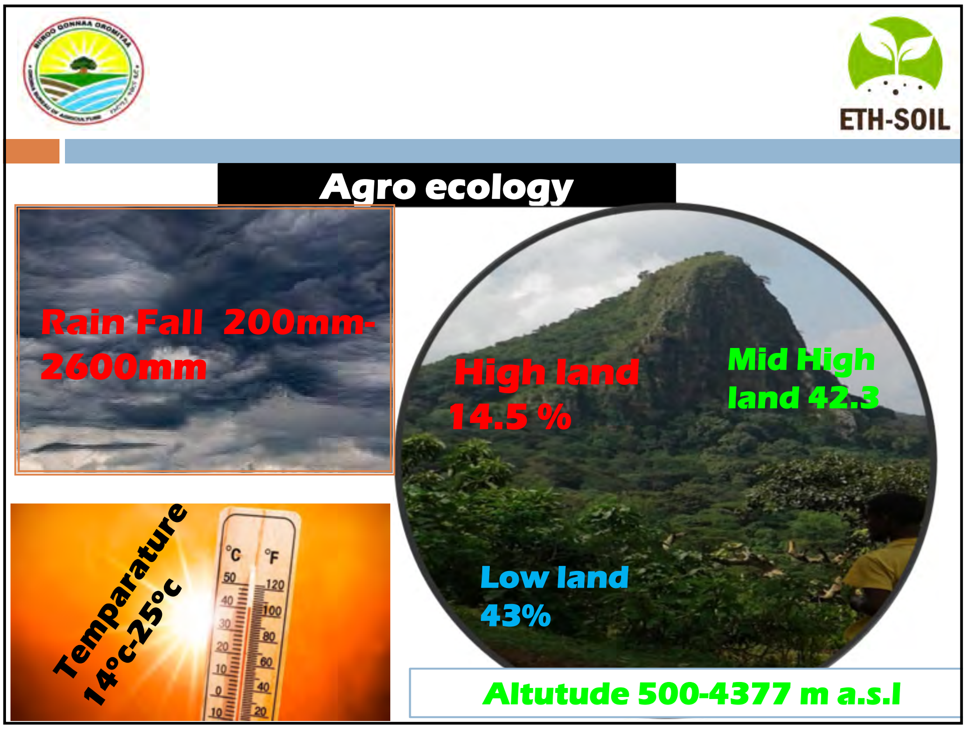
March , 2025

Adama

Contents

ETH-SOIL


Overview of the Region
ETH-SOIL
W. Wellega
E. Wellega
N. Shewa
W. Shewa
Jimma
Illubabor
E. Harerghe
W. Harerghe
Arsi
Bale
Borena
Oromia Region :
21 Zones
293 Woreda 's
6,447 Kebeles


ETH-SOIL
Agro ecology
Rain Fall 200mm-2600mm
Temparature 14°c-25°c
High land 14.5 %
Mid High land 42.3
Low land 43%
Altutude 500-4377 m a.s.l

Introduction

ETH-SOIL

- **The agriculture sector remains a dominant sector in the Ethiopian as well as Oromia regional state economy and an important source of economic growth. More than 80% of the Ethiopian population is dependent on agriculture.**
- **Soil is the most important natural resource for agricultural production.**
- **Soil fertility and health is very crucial in increasing production and productivity and ensuring food security.**

Challenges of Soil Health and Fertility

ETH-SOIL

1. **Soil Erosion**
2. **Soil Degradation**
3. **Loss of Organic Matter**
4. **Nutrient Depletion**
5. **Soil Compaction**
6. **Soil acidity**
7. **Salinization**

Management of Soil Health

ETH-SOIL

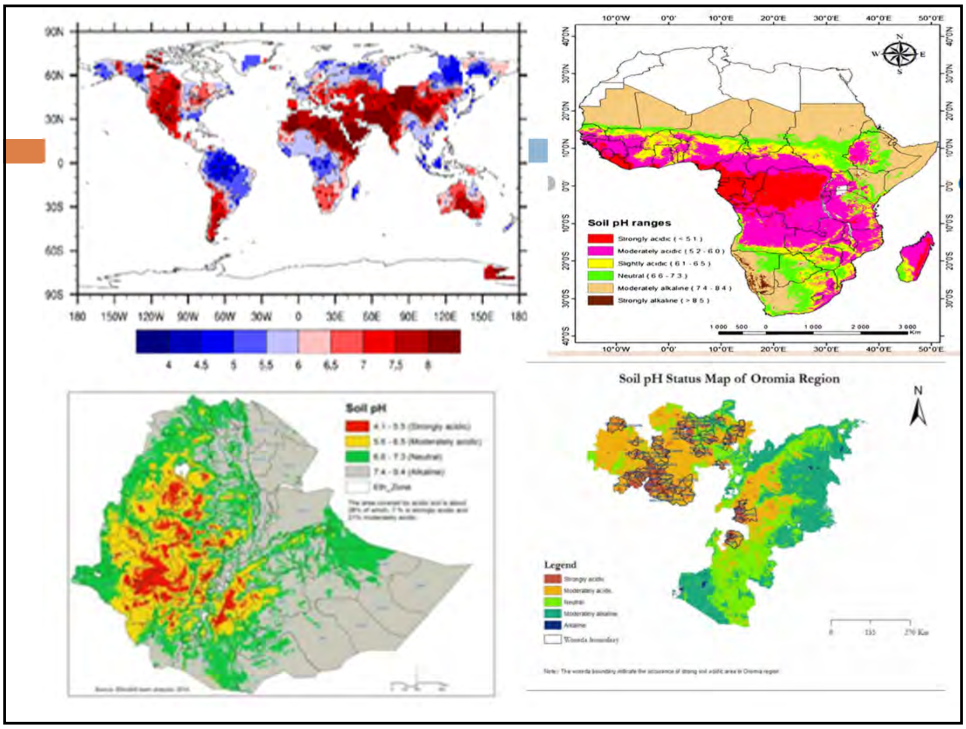
- ✓ Crop Rotation
- ✓ Cover Cropping
- ✓ Mulching
- ✓ Composting
- ✓ Reduced Tillage
- ✓ Avoiding Soil Compaction
- ✓ Balanced Fertilization
- ✓ Bio char Application
- ✓ Conservation Practices

Soil acidity status and Management

ETH-SOIL

Soil acidity is a pressing issue in Ethiopia, more than 43% of Ethiopian farmland is affected by soil acidity problem where major staple food crops are grown, and it leads to significant crop yields reduction and in severe cases, may resulted in complete crop production loss and thereby contributed to food insecurity.

- 50% of the world's agricultural land
- 22% to the African Continent
- As a country of 43%
- Oromia Region 28% or 1.79 mill hectares of agricultural land is affected by the soil acidity.



Management of Soil Acidity

ETH-SOIL

Liming

Lime (oxide and hydroxide of Ca and Mg) application has been recognized and used as the main practice for ameliorating strong acidity which curtails the availability of nutrients required at high amounts in soils for maximum yield.

Organic fertilizers

Organic fertilizer which can supplies multiple nutrient elements to the crop and at the same time, maintains soil organic matter content.

...Management of Soil Acidity

ETH-SOIL

Selecting or Using Acid Tolerant Crop Varieties

Selecting and/or using acid tolerant crop varieties on acidic area can reduce the impact of soil acidity.

Integrated soil Fertility Managements

An integrated organic, inorganic, and improved germplasm amendment with different material of plant and animal origin which is more or less decomposed and can be added to the soil to improve soil physical, chemical, and biological properties as well as reinforce the diversity and function of soil micro organisms.

Guder Lime Factory

ETH-SOIL


Lime application
ETH-SOIL


Lime Production and transportation
ETH-SOIL
IVECO

Lime transportation from Gudar

ETH-SOIL

Experience Sharing and Mega Field day (2023)

Gudar lime Factory

Demonstration

ETH-SOIL

Vermi compost production

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Vermi compost production by female farmer
ETH-SOIL


Compost preparation


Different Demonstration on green manuring
ETH-SOIL


Green Manuring
ETH-SOIL
M/Kegni Woreda
Sokoru Woreda

Improved seed Multiplication of lupine

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G/Bila Woreda

Beddelle Woreda

Conservation Agriculture Practice

ETH-SOIL

Conservation Agriculture Practice

ETH-SOIL

Gachi Woreda

Vermi culture distribution as a Region

ETH-SOIL

Verm culture and composting technology; from one farmer reach out to;

- **21 Zones**
- **275 woreda's**
- **2854 kebeles**
- **1197 FTC**
- **371 nursery sites**
- **399,140 farmers as regional aspects .**
- **265 Big Vermi culture center constructed.**

8.1 Biochar-Based Fertilizer Application Experiences in Oromia Region, Kisi Begna, Oromia Bureau of Agriculture


Vermi culture center
Shashamane
ETH-SOIL
Shalla

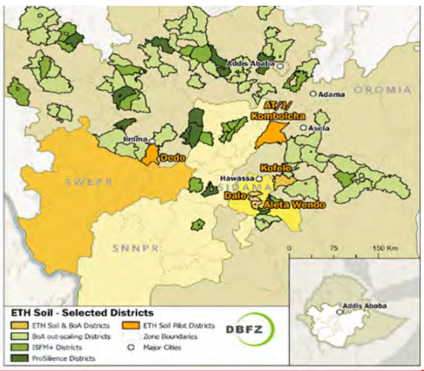

Buno Bedele, Gachi Woreda
ETH-SOIL

Eth-Soil project focuses and Plan of 2024/25

- **The German government has long since supported Ethiopian efforts to build technological capabilities, infrastructures and economic opportunities via the German Federal Ministry for Economic Cooperation and Development (BMZ).**
- **The German biomass research centre, DBFZ, has been entrusted to contribute its expertise : implementation of the ETH Soil project.**
- **The ETH-Soil project focuses on the use of residual biomass in pyrolysis, biogas and composting plants. Alongside energy production, the resulting charcoal, nutrient-rich fermentation products and compost shall be used in material form as bio fertilizers and applied to degraded fields.**

… ETH-Soil project focuses and Plan of 2024

Organise and provide farmers' trainings on bio char and BBF application in Dedo (82 farmers), A/T/J/Kombolcha (88 farmers) and Kofele (76 farmers) by 2024.



Activities Vs achievement of the plan

- **Translation of training materials.**

Translation was made from English to Oromiffa and 17 manuals were printed and deliverd to trainers.

… Activities Vs achievement of the plan

- **Elaboration of training materials for farmers.**
- **Organisation and implementation of a Kick-off event.**

The opening workshop of the project was held at Adama on May, 27/2024. 50 participants from Federal, Region, Zones , Woreda , OARC (IQQO) and ETH- SOIL staff were participated.

… Activities Vs achievement

ETH-SOIL

- **Briefing of Zonal and Woreda officials awareness raising for planned training activities.**
- **Organization and implementation of awareness raising and pre-training activities in the three pilot Woredas.**

… Activities Vs achievement

Selection process of beneficiaries

- **The beneficiaries were selected from suitable kebeles of smallholder farmers having degraded land and food insecurity and with a limited farm land size of not more than 0.5 ha. and willing to implement the technology.**
- **The selection was made in collaboration with JU and IQQO researchers who have prior experience on Biochar, BBF research.**
- **In Kofale and A/T, we got collaborative support from Batu and Assela researchers in selecting the farmers. The same collaboration was also provided by JU researchers in Dedo.**

… Activities Vs achievement

Distribution of bio char and BBF in three pilot Woredas

- ✓ **Biochar was prepared by the research institute of Batu, Asella and Jimma university and it was transported to villages by the same institutions.**
- ✓ **Accordingly, after reaching farmers' village, the farmers personally took over the operation.**
- ✓ **From Jimma University 16.8 ton of dry bio char and 50.4 ton BBF have been distributed to Dedo district total 67. 2 ton for 82 farmers.**

… Activities Vs achievement

… Activities Vs achievement

… Activities Vs achievement

- ✓ **In Kofale district 92 farmers got 212.4 ton of dry biochar to be used mixed with either traditional or vermi-compost in their farms**

… Activities Vs achievement

… Activities Vs achievement

From Batu Soil Research Centre 56.950 ton of dry bio char and 170.785 ton of BBF were distributed to A/T/J/K district.

… Activities Vs achievement

… Activities Vs achievement

ETH-SOIL

☞ **Training on bio char production and BBF formulation and application in all three pilot Woredas**

Dedo Woreda

1. **•Number of participant farmers were male 53 and Female 16 Total 69**
2. **•Number of DAs' male 14 and female 6 Total 20**
3. **•Number of Experts male 1 and female 2 Total 3**

… Activities Vs achievement

Kofale Woreda

- **Number of farmers male 67 and Female 9 Total 76**
- **DAs' Male 7 and Female 2Total 9**
- **Experts Male 5 and Female 2Total 7**

… Activities Vs achievement

ATJK

1. **• Number of participant farmers were male 61 and Female 27 Total 88**
2. **• Number of DAs' Male 9 and Female 2 Total 11**
3. **• Number of Experts Male 2 and Female 1 Total 3**

… Activities Vs achievement

ETH-SOIL

- **Organization / facilitation of awareness raising campaigns, "Farmers' Days" / exchange visits**

✓ **Farmers field day was conducted in two woreda's at Kofale and Dedo**

…cont'

Grain yield data Collected in Kofale District from four pilot Kebels.

Zone	Woreda	Kebele	Farmers no	Biochar received (kg)	Own compost used (kg)	BBF received (kg)	With BBF Grain Yield (kg)	Without BBF Grain Yield (kg)
West Arsi	kofale	Mamo	27	13050	39150	52200	6747.45	5288.075
		Wmanye Abosa	18	2925	8775	11700	1900.4	877
		Bitacha	13	1300	3900	5200	652.99	501
		Tulu Boke	18	3025	9075	12100	1732.5	880.018
			76	**20300**	**60900**	**81200**	**11033.34**	**7546.093**

Activities Vs achievement

ETH-SOIL

Organization and implementation of subsequent monthly meetings of a steering committee

- ✓ **The 1st and 2nd steering committee meeting was held at Finfine**
- ✓ **Participants from Zonal and Woreda officials, BoA project facilitators, OARI, DBFZ ETH-Soil project staff.**

… Activities Vs achievement

ETH-SOIL

- **Data recording of farming plots treated with BBF.**
- **Overall project coordination / management and reporting.**

DBFZ

ETH-SOIL

Thank you !
Galatoomaa !

Production of a high-quality biochar using Kon-tiki kilns

March, 2025

Adama, Ethiopia

1

Definition

- **Kon-tiki:** is a **deep-cone kiln** that produces biochar from local biomass
- **Kon-tiki:** low cost, simple; farm-scale; easy to operate; and high-quality biochar with no smoke
- Kon-tiki could be prepared from **metal-sheet** or Soil pit (Soil kon-tiki)

Soil pits

Metal kon-tiki

2

Soil Kon-tiki

- If the soil is rich in clay, the pit walls more stable and compact
- If the soil is sandy, the pit`s wall should be plastered with clay/Manure.
- The pit should be shallow enough that people can walk in (~1m)
- Thoroughly compact the soils with feet or shovels/
- Put a layer of stones around the pits rim – to stabilize the edge and serve as a little shield against wind

Disadvantage of Soil kon-tiki – often subjected to soil contamination

3

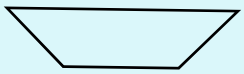
Metal kon-tiki

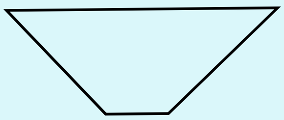
- It is built from thick (2mm) metal sheet
- There is no contamination with soil
- **Disadvantage:** relatively higher cost than soil kon-tiki; the metal could be damaged over time

Two types of kon-tiki shapes

1. Flat angle: the angle ranges between 40-45 °; easy to start the fire; it is good for shallow soils; lower volume of biochar production

2. Steep angle: the angle ranges between 60-63 ° good option for deep soil; high volume of production; difficult to start the fire

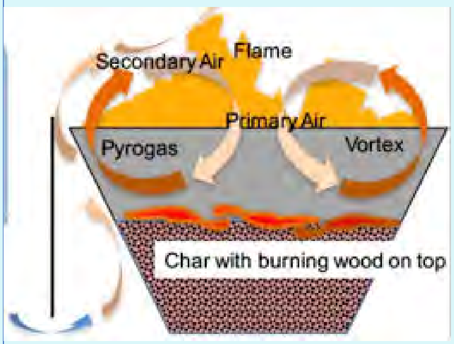




4

Kon-tiki principles

- It is not the biomass itself burns, but the flammable gases that evaporate from the biomass due to the reflecting heat of the fire
- Thus, the carbon (i.e., the backbone of the biomass) remains intact during the process
- The cone shape is required to bounce back the radiant heat generated by a fire



5

Feedstock selection

- Bulky biomass (less dense). Example: wood, twigs, corn-cob
- Dense materials (rice husk, saw dust, coffee husk) might be co-pyrolyzed with bulky materials in thin layer
- Feedstock should be dry, and the moisture content should be less than 20-25%

6

Operating the Kon-tiki

Step 1: Prepare a pile of chimney as a start-up (~ 2/3 of the Kon-tiki height)

Step 2: The chimney should be lighted from the top

7

Operating the Kon-tiki

Step 3: Add the first biomass on the top of the embers

Step 4: Once ash appears on the surface of the top layer, add the next layer of biomass

8

Operating the Kon-tiki

Step 5: **Quenching:** add a liquid (water/urine) at the edge of Kon-tiki to distinguish the fire (stop the process).

The quench water could be used as fertilizer or pest-repellent

For soil kon-tiki: a 10 cm soil layer could be compacted on top to stop the process

9

Controlling the quality of the process

- **No smoke:** The biomass is wet OR too much feedstock is added
- Observe an inward directed whirl at the kilns rim
- The temperature will be between 650 – 700 ^{o}C
- The end product is black
- If the product is grey, there is more burning (Ash)

10

Experience from Jimma University

Feedstock	Biochar Yield (%)	Time required (hrs)
Corn cob	25-30	4-5
Wood	20-23	5
Coffee husk	35-40	5
Bone char	80	4

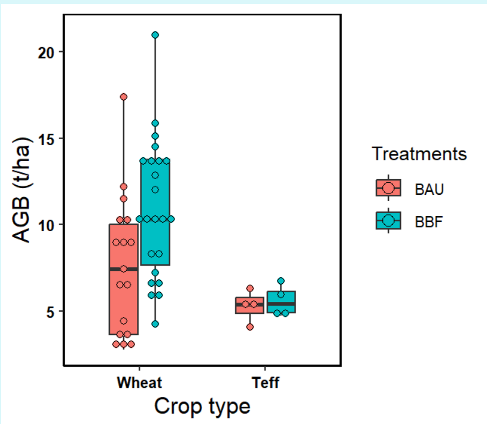
For 2024 growing season:

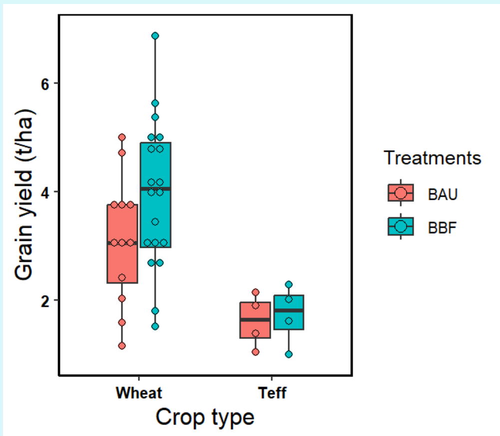
- ~33 t of biochar was produced from corn-cob
- ~ 54 t BBF (25% biochar + 75% manure/compost)
- BBF was applied at the rate of 1 kg m^{-2}
- Distributed to 80 farmers at Dedo

For 2025 growing season:

~25 t of biochar from wood is already produced

11





12

Oromia Agricultural Research Institute
Asella Agricultural Engineering Research Center

3rd Soil Symposium 2025

Biochar Production Techniques Applicable to Smallholder Farmers Level

BY:- Getachew Hailu

March 6-7, 2025
Adama, Ethiopia

Presentation outlines;

- Introduction
- Selection of potential biomass for biochar production
- Kon-tiki fabrication
- Biochar production
- Post processing Techniques of Biochar production

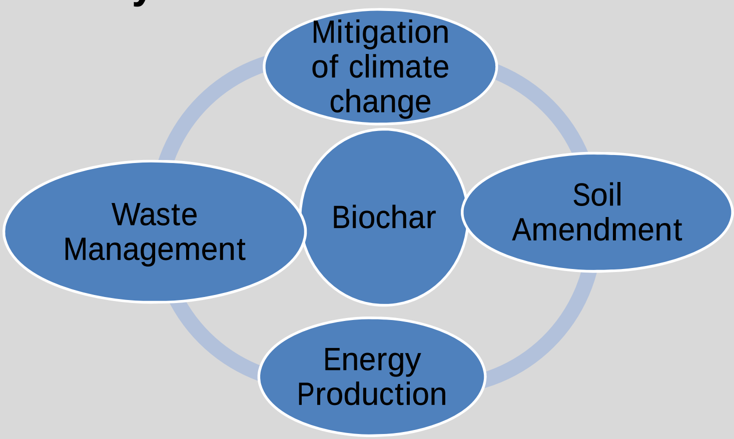
Introduction

- Biomass: living or once-living material, which is the feedstock (starting material) for making biochar
- Biochar: the carbon-rich product obtained when biomass, such as wood, manure or leaves, is heated in a closed container with little or no available air
- In more technical terms, biochar is produced by so-called thermal decomposition of organic material under limited supply of oxygen (O2),and at relatively low temperatures (<700°C)

Properties of Bio char

- High soil organic matter
- Enhanced cation exchange capacity (nutrient holding capacity)
- Improved water retention
- Beneficial soil microbial activity
- Enhanced fertility
- Stable ("aromatic") carbon structure

Why do we need bio char?



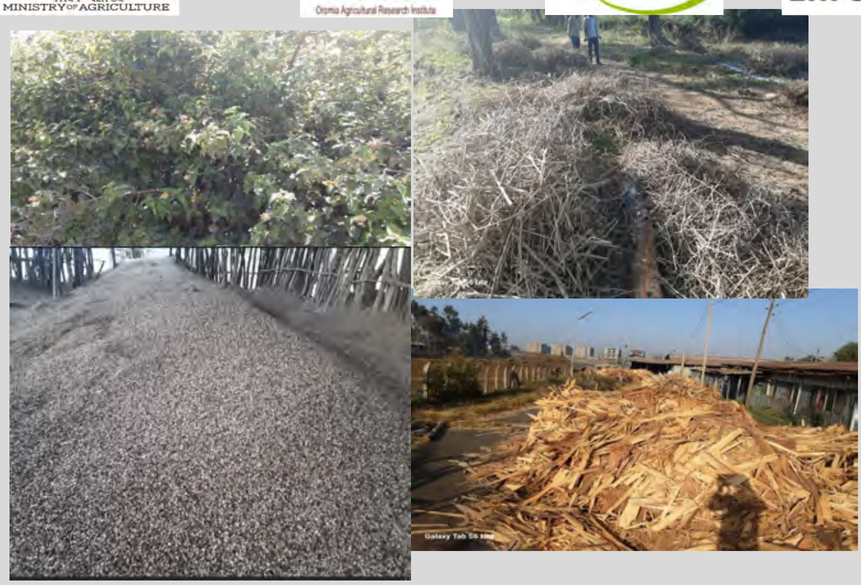
Selection of Potential Biomass

- The feasibility and pre-treatment method is vital in the categorization of feedstock raw material to prepare biochar (Fasih et al.,2021,Brown Amarasinghe et al., 2016)
- The kind of biomasses select and use for biochar production are may be :-
  - Agricultural biomass
  - Urban waste
  - Paper waste
  - Forest/woody biomass
  - Aquatic biomass

After selection of biomasses, the following activity are done:-

- Cutting
- Drying
- Collecting
- Transporting
- Sorting

→ Biomass

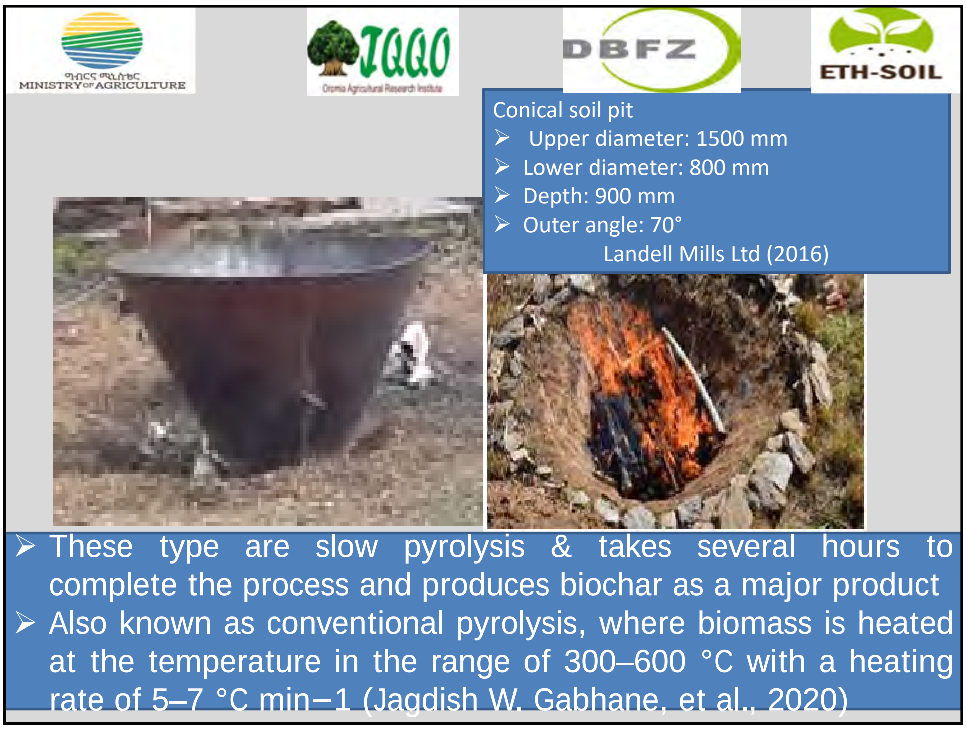


Type of Kon-tiki Produce

- The size and shape of kiln must be determined to be fabricate
- The size & gross capacity of the kiln depends on:-
  - Weekly or monthly volume of raw material to be pyrolysis
  - Shape & size of raw material

Biochar Production Systems

- Various cutting-edge technologies are used to manufacture biochar, including pyrolysis (Mishra and Mohanty 2021), gasification (Ibitoye et al. 2021), hydrothermal carbonization (HTC) (Ibitoye et al., 2022)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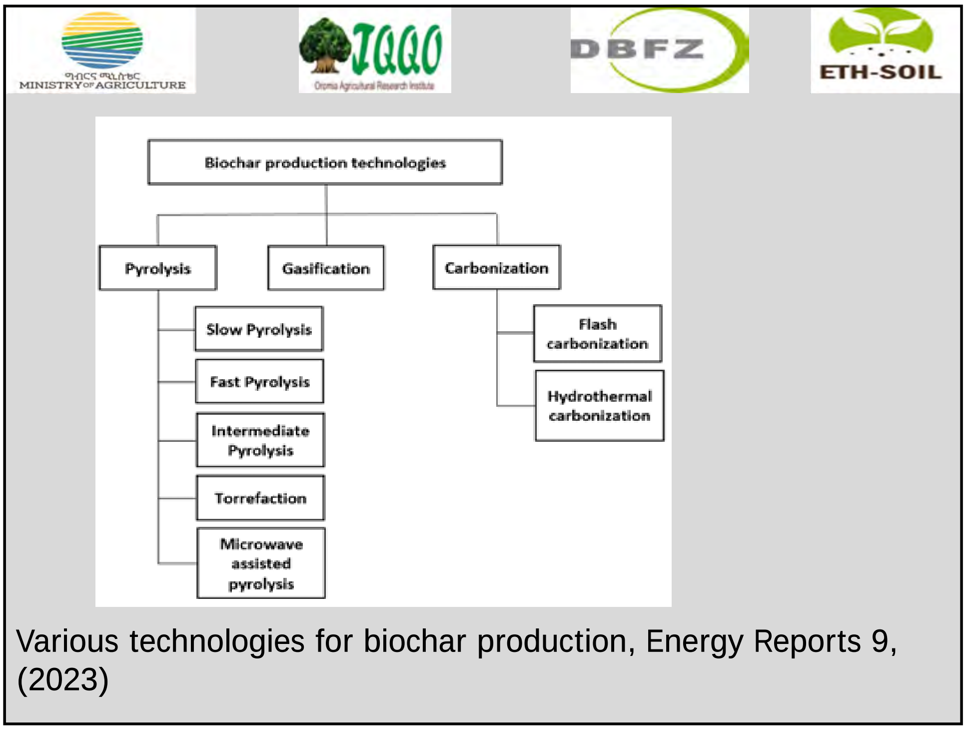
Conical soil pit
➢ Upper diameter: 1500 mm
➢ Lower diameter: 800 mm
➢ Depth: 900 mm
➢ Outer angle: 70°
Landell Mills Ltd (2016)
➢ These type are slow pyrolysis & takes several hours to complete the process and produces biochar as a major product
➢ Also known as conventional pyrolysis, where biomass is heated at the temperature in the range of 300–600 °C with a heating rate of 5–7 °C min−1 (Jagdish W. Gabhane, et al., 2020)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Biochar production technologies
Pyrolysis
Gasification
Carbonization
Slow Pyrolysis
Fast Pyrolysis
Intermediate Pyrolysis
Torrefaction
Microwave assisted pyrolysis
Flash carbonization
Hydrothermal carbonization
Various technologies for biochar production, Energy Reports 9, (2023)

- Slow pyrolysis have retention times ranging from a few minutes to several hours and generate 25%-35% biochar (Fasih et al.,2021,Brown et al., 2009)

- Slow pyrolysis is the most common method of manufacturing biochar (Fasih et al.,Yuan et al., 2019)

Kon-tiki Fabrication

Truncated square pyramid type kon-tiki		Cone type Kon-tik
Large kon-tiki	**small kon-tiki**	**Large kon-tiki**
Height =35cm	Height =39cm	Height =120cm
Top width = 200cm	Top width = 100cm	Top width = 200cm
Bottom width = 100cm	Bottom width = 50cm	Bottom width = 85cm

- In average 1208 and 362.8 kg of biomass were fed to large and small Kon-tiki in one batch of production
- Metal spade was used to unload the biochar produced in the large kon-tiki, while the small type kon-tiki were self-unloaded(flexible)

Bio char Production

- We produce bio char twice a day
- We use ten (10) kon-tiki's to produce biochar
- Thirteen human power(9 male and 4 female) were participated per day
- It took 2:30hr in average for one batch of biochar production

Biomass sample preparation and determine amount of biochar produced

The experimental data collected during production for both kon-tiki	
Large Kon-Tiki	**Small Kon-Tiki**
Biomass =1292.6kg	Biomass =356.25kg
Biochar=323.15kg	Biochar=97.97kg
25%	27.5%


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Biomass and bio char moisture content measuring


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Heaps of biochar produced

Post processing Techniques of Biochar production

- Post processing of biochar can include a number of processes that may take place after pyrolysis including
- Quench systems are applied that may include processes to further activate
- Functionalize, the biochar, or physical modifications such as drying, size reduction or pelletizing for ease of handling, blending, or application

Biochar drying mechanism


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Produced Biochar milling, Weighing, Packing, and storing


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IQQO
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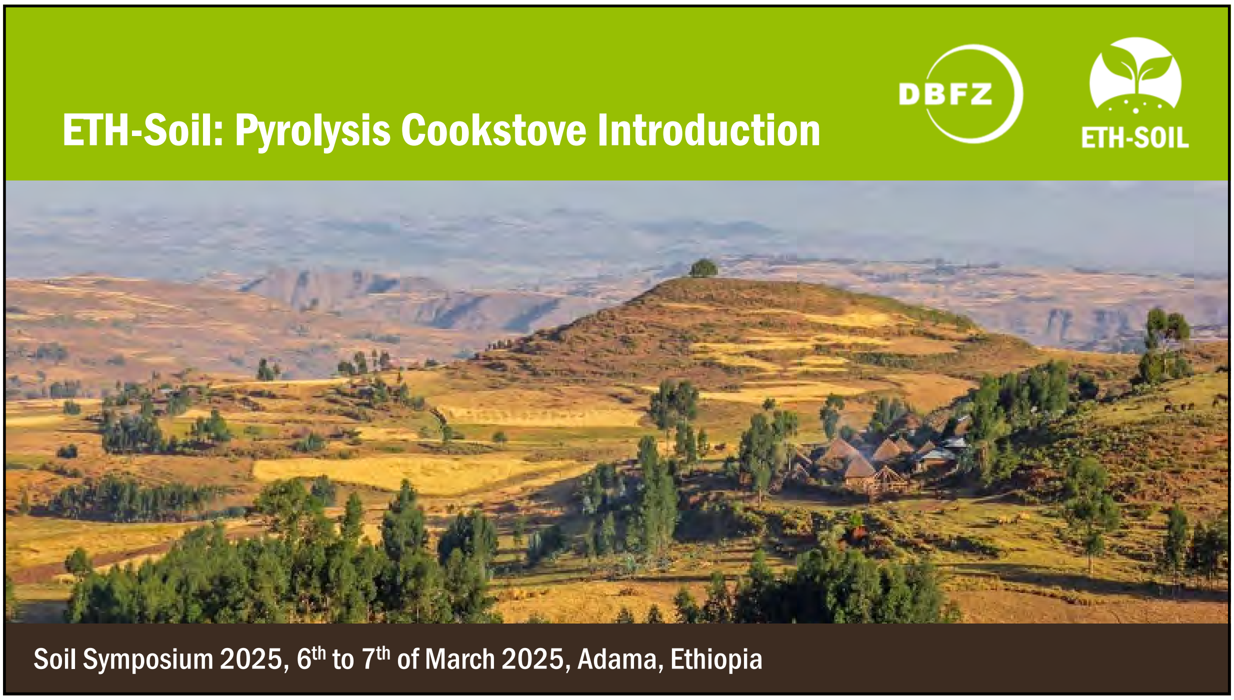
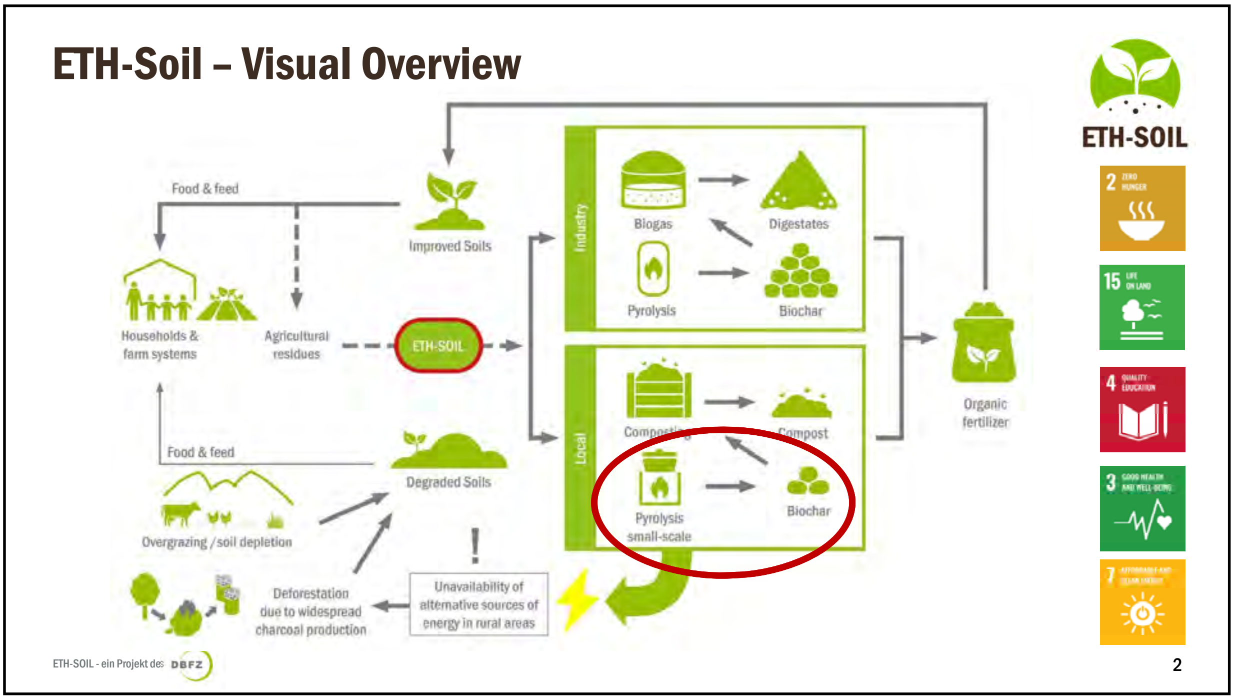
ETH-SOIL
Thank You VERY MUCH!


ETH-Soil: Pyrolysis Cookstove Introduction
DBFZ
ETH-SOIL
Soil Symposium 2025, 6th to 7th of March 2025, Adama, Ethiopia


ETH-Soil – Visual Overview
ETH-SOIL
Food & feed
Improved Soils
Households & farm systems
Agricultural residues
ETH-SOIL
Industry
Biogas
Digestates
Pyrolysis
Biochar
Local
Composting
Compost
Pyrolysis small-scale
Biochar
Organic fertilizer
Food & feed
Degraded Soils
Overgrazing / soil depletion
Deforestation due to widespread charcoal production
Unavailability of alternative sources of energy in rural areas
ETH-SOIL - ein Projekt des DBFZ
2

Biochar out of cookstoves

ETH-SOIL

- One module of ETH-Soil project

Local available biomasses at best residues	Low-emission and effective biomass cookstoves adapted to local boundary conditions	Biochar for further applications e.g. soil improvement

ETH-SOIL - ein Projekt des DBFZ

3

Cookstove development & introduction

german cooperation DEUTSCHE ZUSAMMENARBEIT

ETH-SOIL

Project steps	Study on cooking and households' fuel procurement	Cookstove prototype development	Transfer of cookstove production	Acceptability study & licensing	Scale-up of cookstove production and promotion	Monitoring of cookstove production and use
Cooperation partners	Abamela Consulting		IQQO - Agricultural Eng. and Mech. Research Centre (Asella+Jimma) Rural craft businesses (metal and clay) Woman cooperation*	ECCA MoWE	IQQO - Agricultural Eng. and Mech. Research Centre (Asella+Jimma) Rural craft businesses Woman cooperation* Contracted PR company BoA? (promotion)	IQQO - Agricultural Eng. and Mech. Research Centre (Asella+Jimma) ECCA
Supporting partners				*GIZ-Endev*		

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4

Previous and Current Cookstove Projects in the Target Regions

ETH-SOIL

- Major problems: cookstove maintenance, budget constraints, resource supply after projects
- Need of building up capacity for support and manufacturing/ maintenance
- Tailored solutions for the specific needs of different woredas

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Clay-Based Top-Lid-Updraft Pyrolysis Cookstoves

Design Principles, Efficiency, and Applications

ETH-SOIL

- A Top-Lit Updraft (TLUD) cookstove is a clean-burning and fuel-efficient stove
- TLUD uses biomass fuel and generates biochar as a by-product
- Clay-based stoves are cost-effective, insulating using locally available resources

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ETH-SOIL

Design Principles

- TLUD combustion – ignition starts from the top, batch operation.
- Air supply with natural draft– primary air for pyrolysis manually adjustable; secondary air for complete combustion.
- Biochar production– leaves behind a carbon-rich biochar after cooking.
- Modular portable design

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7

Impressions of design

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8

Characterisation at test bench

ETH-SOIL

- Experiments according to internationally harmonized test protocol for cookstoves ISO 19867-1
- Experiments with wooden fuels and avocado kernels

Table 4. Tier values for ISO voluntary performance targets; values for $PM_{2.5}$ and CO emissions are default values

Performance	Tier	Thermal efficiency (%)	Emissions (default) CO (g/MJ_d)	Emissions (default) $PM_{2.5}$ (mg/MJ_d)	Safety (score)	Durability (score)
Better performance ↑	5	≥ 50	≤ 3.0	≤5	≥ 95	≤ 10
	4	≥ 40	≤ 4.4	≤ 62	≥ 86	≤ 15
	3	≥ 30	≤ 7.2	≤ 218	≥ 77	≤ 20
	2	≥ 20	≤ 11.5	≤ 481	≥ 68	≤ 25
	1	≥ 10	≤ 18.3	≤ 1030	≥ 60	≤ 35
	0	< 10	> 18.3	> 1030	< 60	> 35

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Efficiency

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Energy use (%)	Efficiency value
Heat for cooking	16-21
Biochar (residual energy)	6-7
Overall efficiency	23-27

15-18 % of fuel–to-biochar conversion

Efficiency Tier 2

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Emissions

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Blindtext	Wood pellets	Avocado kernels
CO (g/MJ)	0.66 (Tier 5)	0.94 (Tier 5)
PM (mg/MJ)	212 (Tier 3)	125 (Tier 3)

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11

Conclusion

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- Clay-based TLUD cookstoves offer a sustainable, cost-effective, and efficient cooking solution
- They reduce fuel consumption, emissions, and produce useful biochar
- Ideal for households

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12

Kontakt

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www.eth-soil.com

10.1 Vermi-Compost Technology Disseminations and Experience in Ethiopia, Dr. Teferi Tadesse, Haramaya University

Vermicomposting Development in Ethiopia: Transforming Organic Wastes and Biomasses into Wealth through Training, Research, and Community Outreach

Haramaya University
March 6-7, 2025
Adama, Naflet Hotel

1

Contents

2

1. Introduction

- As it stands now, our agriculture is largely dependent on external inputs (chemical fertilizers, pesticides, processed feed and antibiotics, technology in the form of hybrid, etc.). As a result:-
  - ✓ the longer conventional practices are used on farmland, the more the system becomes dependent on external inputs
  - ✓ agriculture cannot be sustained as long as this dependence on external inputs remains
- On the other hand, the organic matter contents of our soils are declining from time to time
- Can you imagine the amount of biomasses going out of every farmland?
- What will happen if the inflow and outflow of plant nutrients from the soils are not balanced?

3

1. Introduction …

- The continuous transportation of biomasses (organic matter) from farmlands without replenishment has been adversely affecting soil health and fertility
- The beneficial roles of OM in the sustenance of soil health and productivity are well documented. Some of these are:
  - ✓ it is a natural resource of plant nutrients and microbial energy
  - ✓ it serves as cation exchange site and chelating agent
  - ✓ it improves the physical conditions of soils.
- It is, therefore, necessary to utilize effectively all the organic sources available on and off farms.

4

1. Introduction …

- The continuous transportation of biomasses (organic matter) from farmlands without replenishment has been adversely affecting soil health and fertility
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5

1. Introduction …

❖ However, future agriculture must be both sustainable and highly productive if it is to feed the growing human population. This twin challenges mean that we cannot simply abandon conventional practices wholesale and return to traditional or indigenous practices. Now, let us see the puzzles in relation to soils as follows:

- Is it possible to unlock the productive potential of soils naturally and sustainably to obtain sufficient, nutritious, and safe food (FAO, 2022)?
- Or do we rely exclusively on external inputs to replace mined soil nutrients and at what environmental and socioeconomic cost (FAO, 2022)?

6

1. Introduction …

- Therefore, the objectives of this presentation are:
  - To explore training/capacity building undertaken by Haramaya University
  - To highlight some of the progress in vermitechnology research
  - To highlight community outreach efforts and success stories

7

2. Training and/or Capacity Building

- Training for undergraduate students who are pursuing their BSc at Haramaya University (e.g. Mr. Tadesse Garomsa who has played a great role in disseminating vermitechnology in West Shoa Zone)

8

2. Training and/or Capacity …

- Short orientation for graduate students who are pursuing their MSc and PhD at HU (e.g. Mechara Agricultural Research Centre)
- Short-term training for Agricultural Development agents, experts, and researchers and provision of earthworms (Esenia Fetida) and/or establishment of vermitechnology sites
  - ✓ for Ministry of Agriculture
  - ✓Tigray Agricultural Research Institute
  - ✓ Adami Tulu Agri. Research Centre
  - ✓ Wonji Sugar factory
  - ✓ Many others
- Short term-trainings for farmers

9

2. Training and/or Capacity …

➢ In 2005 E.C., HU undertook the first short-term training for development agents, farmers, and experts:
  - General discussion was led by the then HU Vice President for Research Affairs Currently Director of EIAR Professor Nigussie Dechasa, and
  - The then HU Research Director, currently Vice President for Academic Affairs Professor Mengistu Urge
  - Closing remark by the then HU President, currently Ministry of Agriculture His Excellency Dr Girma Amante

10

2. Training and/or Capacity …

- Manual Preparation
  - ✓ active participation in the preparation of vermitechnology first draft manual organized by the MoA in around 2007 EC (unpublished)
  - ✓ Edition and improvement of vermitechnology manual (published in 2024 GC)

11

3. Research in Vermitechnology

- Dissemination of vermitechnology is running faster than its development
- In this presentation I have assessed about 27 research undertakings in different corners of Ethiopia
- The results of the research can be categorized as follows:
  - ✓ Integrated use improves soil quality, nutrient quality
  - ✓ enhanced yield and economic return
  - ✓ Its role in creating job opportunity
  - ✓ Positive environmental impact by stabilizing wastes

12

3. Research in Vermitechnology …

- Its role in managing invasive weeds such as Lantana camara
- In solidifying and improving the quality of bioslurry

13

3. Research in Vermitechnology …

- Healthy and high-quality crops could be produced

14

4. Community Outreach

- Early adopters (farmers)

15

4. Community Outreach …

4. Community Outreach …

- Amazing progress in Sidama RS:

17

5. Future Directions

- As a country, where are we in climbing the ladder of the waste management triangle? (Circular Agriculture)?
- Do you know the possibility of deriving huge wealth from waste?
- Can you guess the opportunities and challenges of waste management?
- What are the major factors affecting waste management?
- List the adverse effects of poor waste management.
- What will be your roles in realizing effective waste management system in Ethiopia?
- How do you link rural with urban in terms of waste management?
- Think of advancing from small-scale to large-scale organic fertilizer production from organic wastes and biomasses (designing, production, quality assurance, and marketing)

Thank You for Your Attention!!!

19

Promotion of alternative source of phosphorous fertilizer from bone char: Evidences from Ethiopia

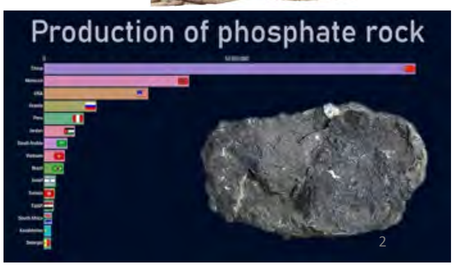
Milkiyas Ahmed[1], Abebe Nigussie[1], Geberemedihin Ambawu[1], Amsalu nebiyu[1], Kefelegn Getahun[1], Dawit Solomon[2], Johannes Lehmann[2]

[1]Jimma University, Jimma Ethiopia; [2]Cornell University, Ithaca, USA

March 5-6, 2025
Adama, Ethiopia

Introduction

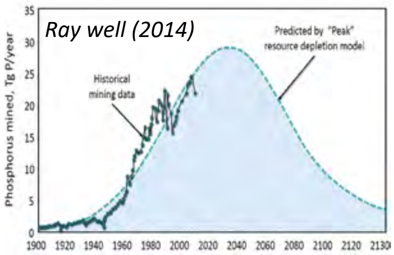
- Phosphorus is one of the most important fertilizer nutrients for crop production.
- However, availability is the main challenge for many farmers.
- P is a nonrenewable resource with a finite supply.
- It is mined in only a few regions globally.
- Most (73–76%) are mined in China, Morocco, or the United States.



2

Introduction …

- Life span of remaining rock phosphate is **between** 5**0 to 125 years** (Mogollon et al. 2018).



- P demand - estimated to increase 51–86% by 2050

- The price is therefore expected to increase further in the near future

- **It is therefore crucial to develop an alternative and renewable solution**

3

Options to Mitigate Phosphorus Scarcity

An alternative and renewable solution to reduce the dependency on RP

~100 million animals from 2008 - 2011 in Ethiopia (Simons et al. 2014)

Animal bone - huge potential to secure the demand especially in developing countries.

Table 1 | Total phosphorus in annual bone residues from slaughtered animals in Ethiopia.

	Total no. of animals[a]	Bone mass[a] (kg per animal)	% of animals slaughtered (per year)	Bone residues (tonnes per year)	Total phosphorus (tonnes per year)
Cattle	50,283,000	20-30	16-17	160,908-256,447	-
Sheep	23,642,000	4-5	19-34	17,968-40,192	-
Goats	22,070,000	4-5	15-30	13,242-33,106	-
TOTAL	95,995,000	-	-	192,118-329,744	17,279-36,272

Averages of total phosphorus from 2008-2011; average phosphorus concentration in bones of 9-11% (taken from ref. 8).

28-56 % of annual P_4

Quantifying potential of bone waste in major cities of Ethiopia for fertilizer production

- *~ 4 major cities in Ethiopia (Addis Ababa, Hawassa, Adama, Jimma)*

☺ From the four major cities: **35, 000 t – 100, 000 t bone year $^{-1}$**

☺ The national production is estimated to be – 300, 000 Mt year $^{-1}$

☺ From the four major cities: **4, 000 t – 10, 000 t P year $^{-1}$**

☺ The national P production from bone is estimated to be – 30, 000 P Mt year $^{-1}$

☺ From the four major cities: **30 – 102 million $**

☺ The national production is estimated to be – 300 million $

5

Animal bone waste

- Recycling P from animal bone waste, that would **otherwise generate environmental and health concerns.**
- With increasing urbanization, animal bone wastes are being concentrated in urban centers.
- Un-utilized, these wastes **pollute land and water**
- Represent a significant **solid-waste disposal problem** and **incur management costs**.
- Therefore, plays an important role in **closing the P loop**, **reduce the dependency on the hard currency imported fertilizer** and **environmental concern**.

6

Bone char production

- We recover bone phosphorus in kilns using pyrolysis, the charring of bones at high temperatures in the absence of oxygen.

Two models of locally constructed pyrolysis chambers

(a) Modified 55-gallon drum in brick housing

(b) Chamber built from sheet metal

(a) Removing charred bone from chamber

(b) Grinding pyrolyzed bones into fine dust

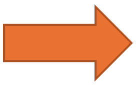
- Needs huge amount of fuel for charring
- Long cooling time necessary before they can be opened

7

Bone char production …

➢Production is possible with simple, inexpensive technology

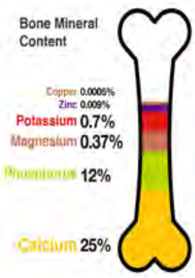
➢Charring removes any animal-borne diseases from the bones (e.g., mad-cow) and concentrates the P content.

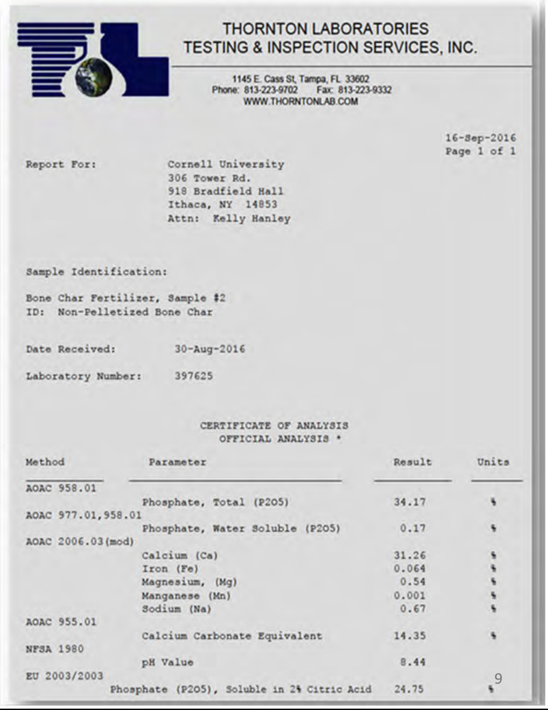


Palletization

8

10.2 Promotion of Alternative Sources of Phosphors Fertilizer from Bone-char: Evidence from Ethiopia, Dr. Milkiyas Ahmed, Jimma University





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WWW.THORNTONLAB.COM

16-Sep-2016
Page 1 of 1

Report For: Cornell University
306 Tower Rd.
918 Bradfield Hall
Ithaca, NY 14853
Attn: Kelly Hanley

Sample Identification:

Bone Char Fertilizer, Sample #2
ID: Non-Pelletized Bone Char

Date Received: 30-Aug-2016

Laboratory Number: 397625

CERTIFICATE OF ANALYSIS
OFFICIAL ANALYSIS *

Method	Parameter	Result	Units
AOAC 958.01	Phosphate, Total (P2O5)	34.17	%
AOAC 977.01,958.01	Phosphate, Water Soluble (P2O5)	0.17	%
AOAC 2006.03(mod)	Calcium (Ca)	31.26	%
	Iron (Fe)	0.064	%
	Magnesium, (Mg)	0.54	%
	Manganese (Mn)	0.001	%
	Sodium (Na)	0.67	%
AOAC 955.01	Calcium Carbonate Equivalent	14.35	%
NFSA 1980	pH Value	8.44	
EU 2003/2003	Phosphate (P2O5), Soluble in 2% Citric Acid	24.75	%

9

Aggregating animal bone waste

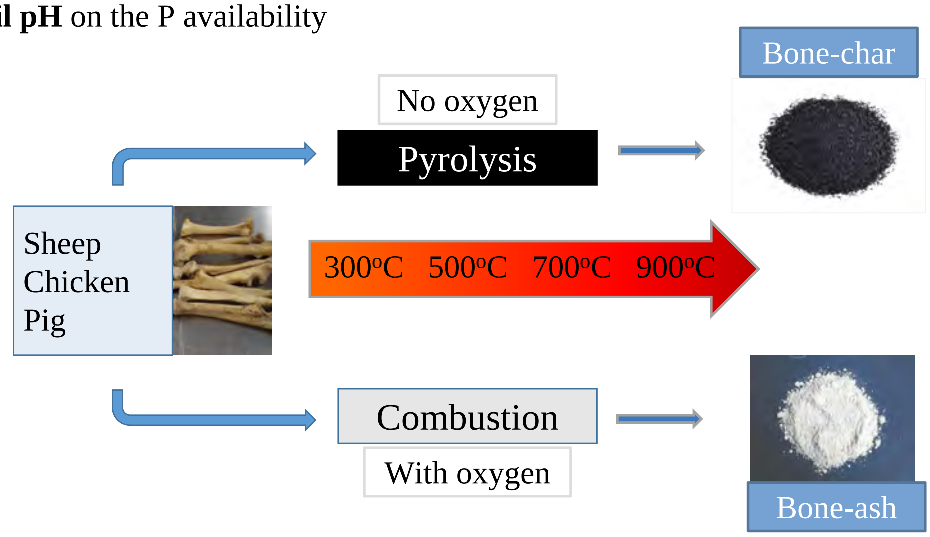
- Animal bone is found scattered
- We began a small experiment with about 100 Unemployed youths

- First week - we received an average of **2,687 kg** of bone every day for **2.0 ETB**
- Second week, we reduced the price to **1.25 ETB** per kg and received an average of **2,095** kg per day
- Terminated the experiment after two weeks of collection due to storage space and budgetary constraints that arose because of the large quantity of bones gathered.

10

Research Developments

- To determine the effect of **bone type, processing method, production temperatures, soil pH** on the P availability

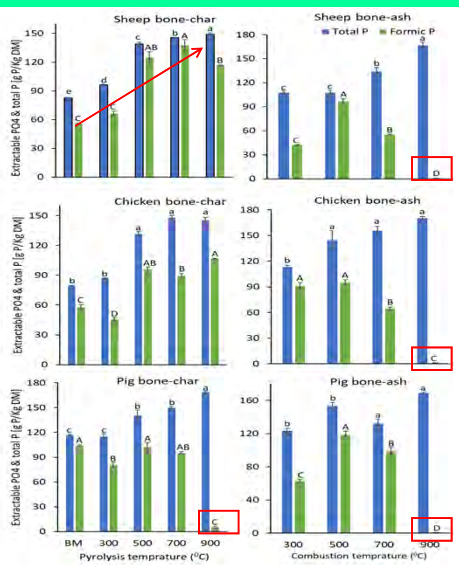


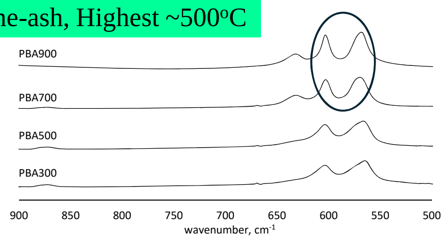
11

Research Developments ….

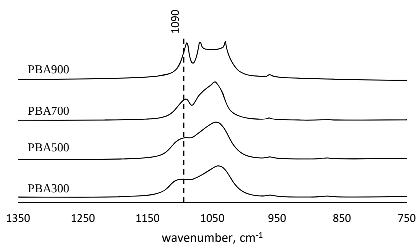
Total P - Increased with temperature, Higher in bone-ash than bone-char

2% Formic P - Extracted over 70% in bone-char than bone-ash, Highest ~500°C





FTIR spectra (500 – 900 cm^{-1})

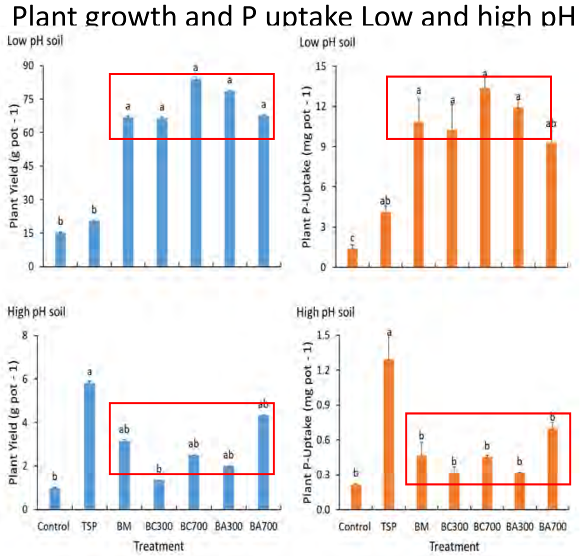


XRD spectra (750 – 1350 cm^{-1})

12

Research Developments ….

Plant growth and P uptake Low and high pH



- Significantly higher yield and P uptake at low pH

- Very low plant yield and P uptake at high pH

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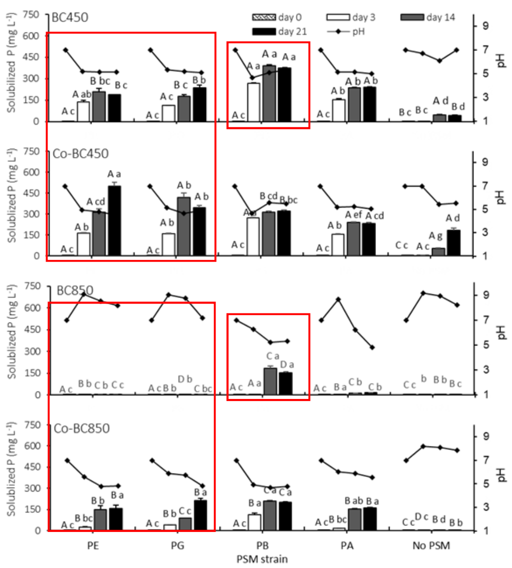
Research Developments ….

Enhancing solubility by PSM inoculation

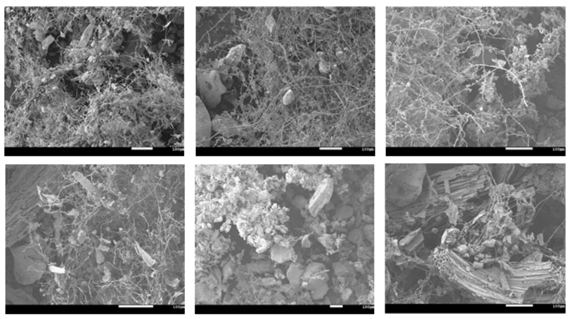


Higher solubility from lower temperature bone chars

- PE -188 and 500 mg P L^{-1}
  - 3.53 and 157 mg P L^{-1}

Co-pyrolysis enhanced P solubilization

✓PE and PG - 167% and 133% more P from Co-BC450 than BC450
✓PE, PG and PA:- 10- to 45-fold more from Co-BC850 than BC850



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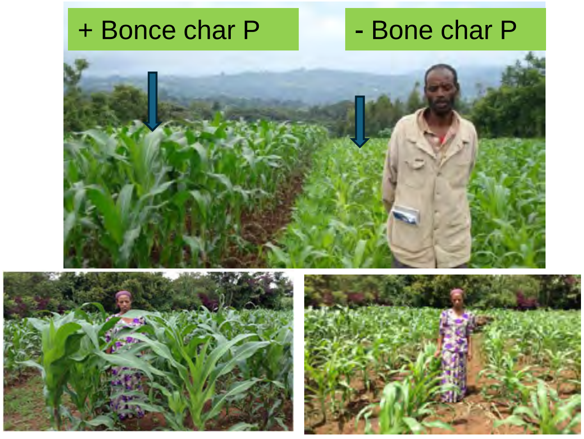
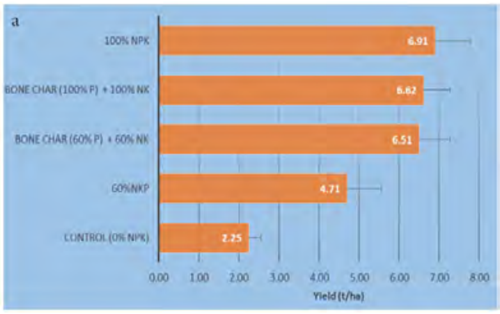
Research Developments

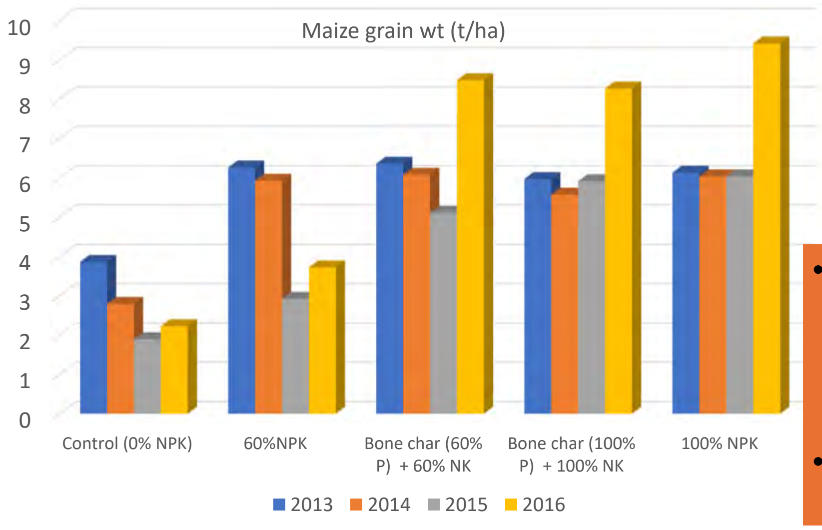




- Bone char can substitute Mineral P
- Can result in 40%-100% saving for farmers by reducing the cost of commercial fertilizer

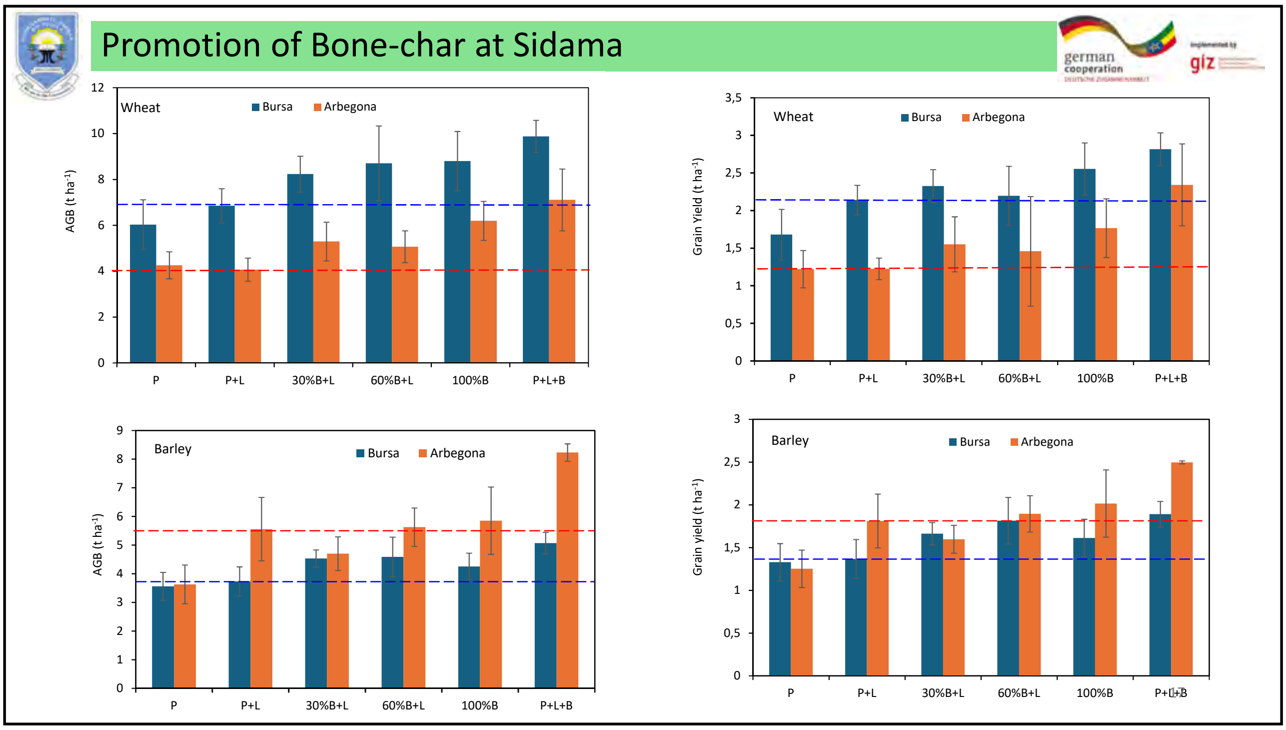
Research Developments ….

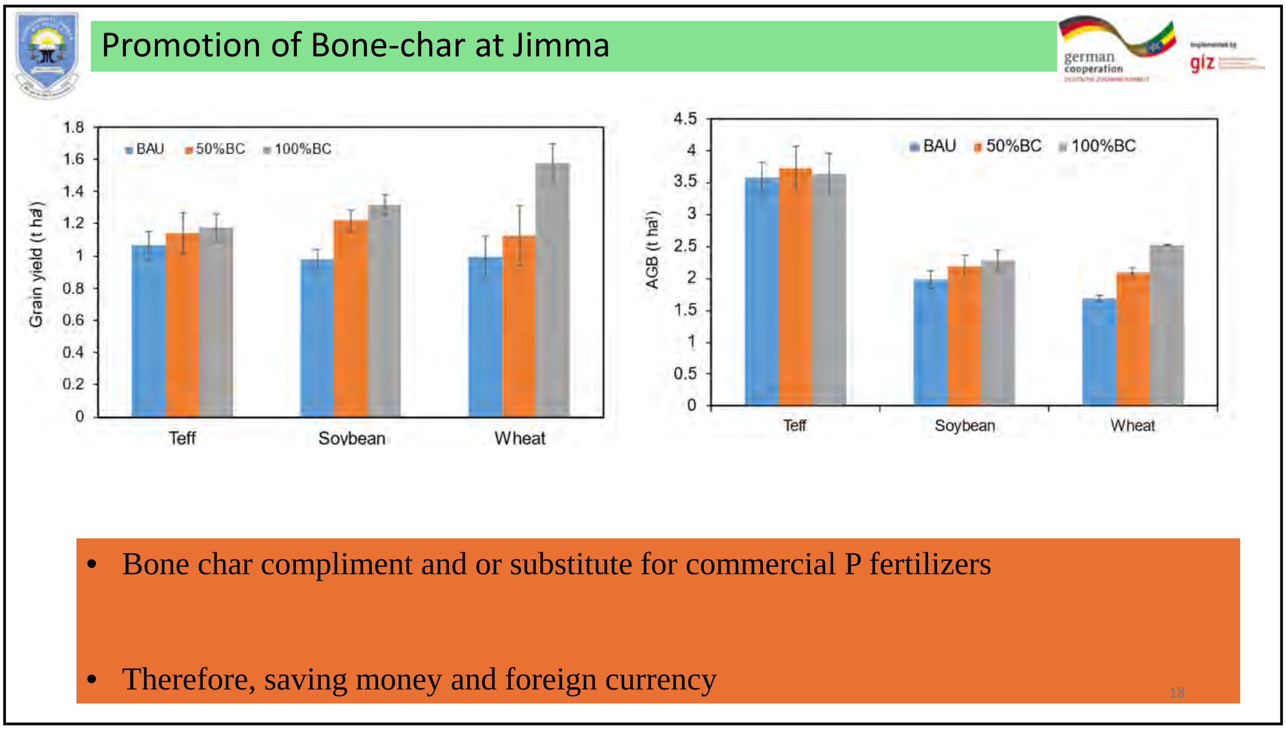
Four years yield data – Jimma (maize and soyabeans)



- Bone char compliment and or substitute for commercial P fertilizers
- Therefore, saving money and foreign currency

16


Promotion of Bone-char at Sidama
Wheat
Bursa
Arbegona
AGB (t ha⁻¹)
Grain Yield (t ha⁻¹)
Barley
Grain yield (t ha⁻¹)
P
P+L
30%B+L
60%B+L
100%B
P+L+B


Promotion of Bone-char at Jimma
BAU
50%BC
100%BC
Grain yield (t ha⁻¹)
AGB (t ha⁻¹)
Teff
Soybean
Wheat
• Bone char compliment and or substitute for commercial P fertilizers
• Therefore, saving money and foreign currency

Research Developments

Cost comparison

	Scenario 1 (Low Cost)	Scenario 2 (high cost)	Scenario 3 (intermediate)
Securing Supply of Bone Residues.			
1 Collection Site Rental Costs	1000	1000	1000
2 Collection Site Monthly Labor	7200	7200	7200
3 Bone Residue (Payout/month)	124080	119789	121935
Bones Residues (payout/kg)	1.00	1.67	1.34
Bones Collected (Kg/month)	124080	71730	97905
Total Cost of Bone Residue Collection	140280	135989	138135
Pyrolysis (converting bone meal to bone char)			
5 Processing Site Rental Costs	2500	2500	2500
6 Labor at Pyrolysis site	9000	9000	9000
7 Wood Costs per month	97770	102606	100188
Wood Cost (per m^3)	350	350	350
Wood per Kg Bone Char Produced (m^3)	0.0023	0.0041	0.0032
Total Bone Char Fertilizer Produced (kg)	89338	51646	70492
Pyrolysis Percent Yield (Y_{pz})	72.00%	72.00%	72.00%
Bone Residue Input	124080	71730	97905

	Scenario 1 (Low Cost)	Scenario 2 (high cost)	Scenario 3 (intermediate)
Total Cost of Pyrolysis	109270	114106	111688
Post-Production And Distribution			
8 Monthly Granulating Cost	18883	16638	17761
Granulating Cost Per kg	0.12	0.17	0.14
Binder (cost per kg finished pellet)	0.06	0.08	0.07
Drying (cost per kg finished pellet)	0.05	0.07	0.06
Binder (cost per kg finished pellet)	0.02	0.02	0.02
Technicians	8000	8000	8000
Percent Loss during Processing	0.00%	0.00%	0.00%
9 Cost Bagging, Transport, Distribution per Month	64323	37185	50754
Cost Bagging, Transport, Distribution per kg	0.72	0.72	0.72
Total Cost Post-Production and Distribution	83206	53823	68515
Fixed Costs	35700	35700	35700
Variable Costs per kg TSP Equivalent with P_b	4.75	7.58	5.79
Variable Costs per kg TSP Equivalent. $C_{proc.}$	2.70	3.98	3.17
Variable Costs per DAP equivalent, with P_b	8.38	11.11	9.38
Variable Costs per DAP equivalent, $C_{proc.}$	6.35	7.72	6.85
Total Cost of Bone Char Production	332756	303918	318337
Total Output (Bone Char kg/month)	89338	51646	70492

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Cost comparison

Cost comparison bone char fertilizer versus imported alternatives.

	Low Est.	High Est.
Farmgate Price per 100 kg of bone char fertilizer	USD 27.05	USD 37.10
Farmgate Price per 100 kg of triple super phosphate (TSP) equiv.[a]	USD 39.49	USD 54.16
Farmgate Price per 100 kg of imported TSP[b]	USD 64.49	USD 64.49
Farmgate Price per 100 kg of diammonium phosphate (DAP) equiv.[c]	USD 56.80	USD 71.48
Farmgate Price per 100 kg of imported DAP[d]	USD 75.00	USD 75.00

a, TSP-equivalent is146 kg of bone char fertilizer and has the same P content as 100 kg of imported TSP
b, TSP is not sold commercially in Ethiopia,
c, The DAP equivalent is146kg of bone-char fertilizer, and 39 kg of urea and has the same P and N content as100 kg of imported DAP.
d, The price of DAP sold at input shops in Jimma town and local farmers cooperatives in **2015**

Highest cost line items in production process of bone char fertilizer

	Low Estimate	% of Total	High Estimate	% of Total
Payments to Bone Collectors (USD)	2,618.75	32.10%	5,374.00	37.44%
Wood Fuel Costs (USD)	1,650.86	20.23%	3,842.41	26.77%
Bagging, Transport, Distribution (USD)	1,086.05	13.31%	1,392.94	9.70%

With the new production technique, we could reduce the production cost by 20%

20

Willingness to Pay

- We examined farmers' willingness to pay for a new-to-the-market phosphorus-only fertilizer
- Found that farmers have a **positive willingness to pay that does not differ between locally sourced and imported phosphorus.**

=

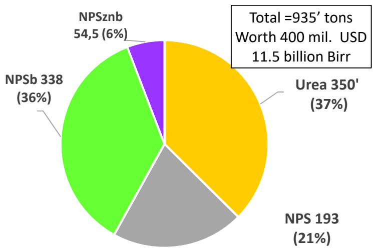
- This suggests a market exists for bone-derived phosphorus fertilizers

21

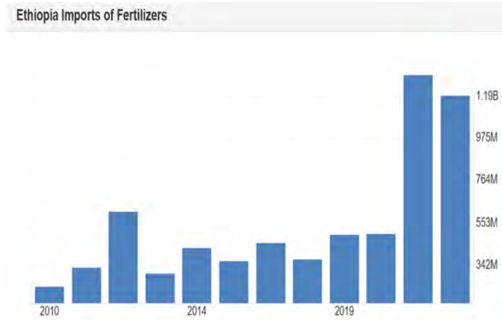
german cooperation
DEUTSCHE ZUSAMMENARBEIT
Implemented by giz

22

Biofertilizer (*Rhizobium Inoculant*) Production, Supply and availability Potential in Ethiopia



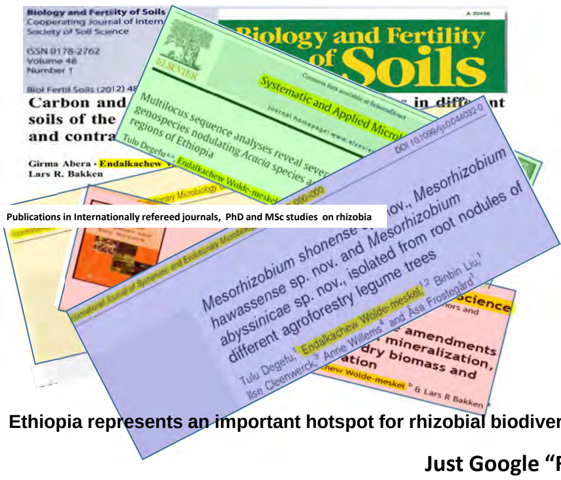
Fertilizers imported in 2016 ('000 tons)



1

Biofertilizer (*Rhizobium Inoculant*) Production, Supply and availability Potential in Ethiopia

- **ዕምቅ ሀብት (*resources*) & *Potentials* ፡**



Ethiopia represents an important hotspot for rhizobial biodiversity in the region (East Africa), which is not yet fully utilized

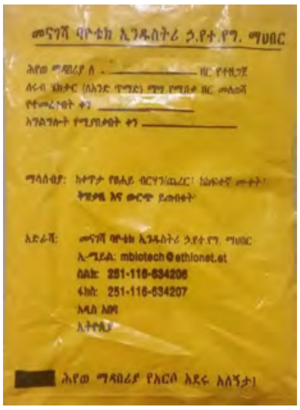
Just Google "Rhizobia & Ethiopia"

2

:….. Improved legume production technologies, **INOCULANTS**

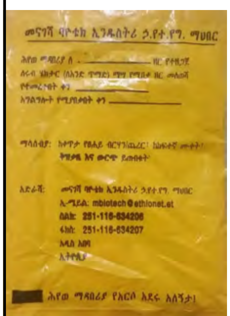
Rhizobial Inoculants:
- taking rhizobia from laboratory Research to Field
- “essential” input , among others, for demonstration,
- new to smallholders

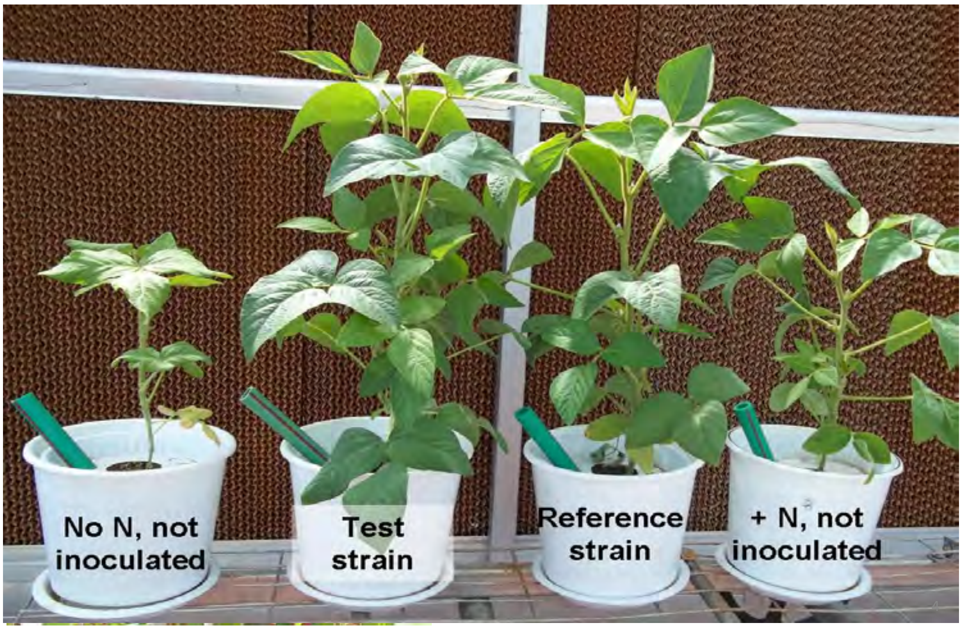
The technology is simple:



3

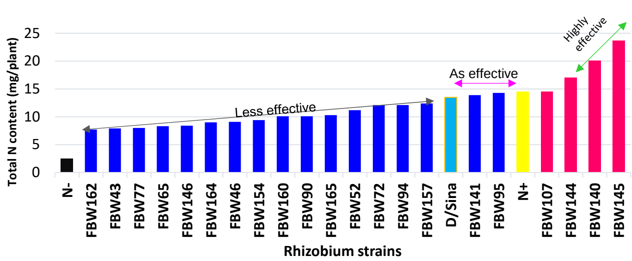
Growth of soybean plants inoculated with compatible rhizobial stain

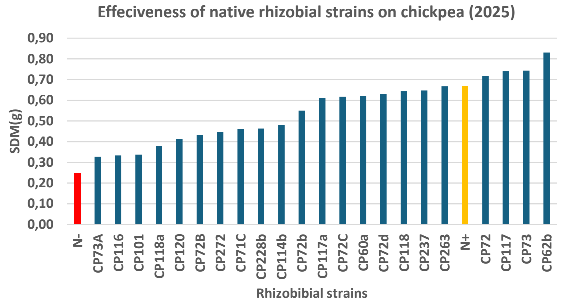


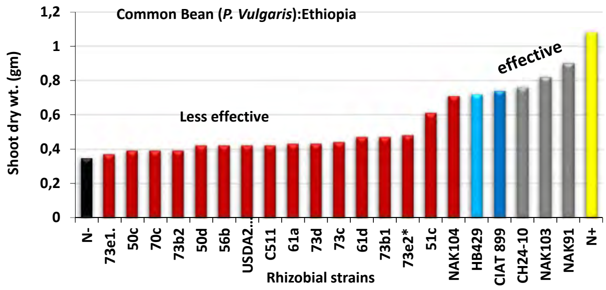


Symbiotic efficiency of rhizobial strains – screening

Faba bean: Screening of Rhizobium strains and field inoculation







5

- Results from previous efforts

The Graphic effect of inoculating common bean with rhizobium strain HB429. The inoculant is produced by Menagesha PLC and supply is available for all users.

+R +P Common bean var. Nasir

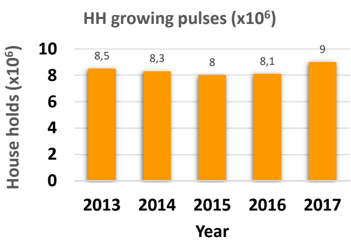
Maize growth as affected by previous inoculation treatment on soyabean (soy – maize rotation, Bako Oromia)

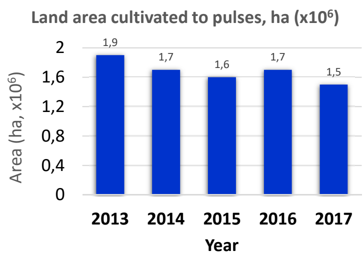
Comparative growth of maize on soya –maize crop rotation plots (i.e. the soya plots with inoculated and non inoculated treatments in the preceding year)

7

...... Potentials

Pulses cultivation in Ethiopia



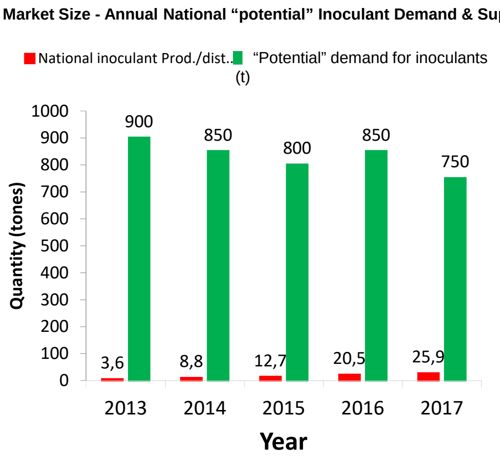


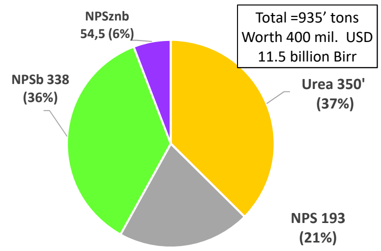
Assuming: - 1.6 million ha of land is cultivated to legumes per year, and
- N fixation of 25kg/ha by inoculating legumes with compatible strain

- There would be 40,000 tons/yr of N input from the atmosphere via BNF,
- This is equivaled to 28 million USD/yr

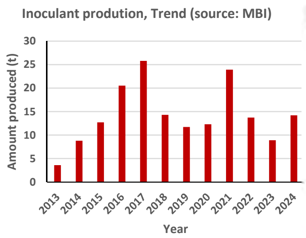
8

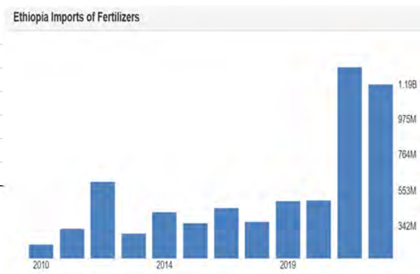
…… Potentials





Fertilizers imported in 2016 ('000 tons)

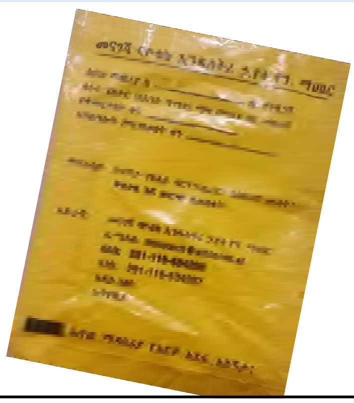




9

What should we do In order to fully realize the full potential of bio inoculation of legumes? ACTION !

- ***Enhance Inoculant production*** *(in addition to domestic market, there is also export market opportunities e.g. export of beans inoculant to east African countries – potentially bringing the much need foreign currency !)*
  - Support the private producer (Gov't should support NOT COMPETE)
  - Quality control (should be the gov't role, **crucial !!!!)**
  - Only one national production factory/facility recommended (no need to replicate factories in regions-inoculant production require specialized handling/treatment)



10

- …… *ACTION !*

Bundle Inoculant technology with other supports

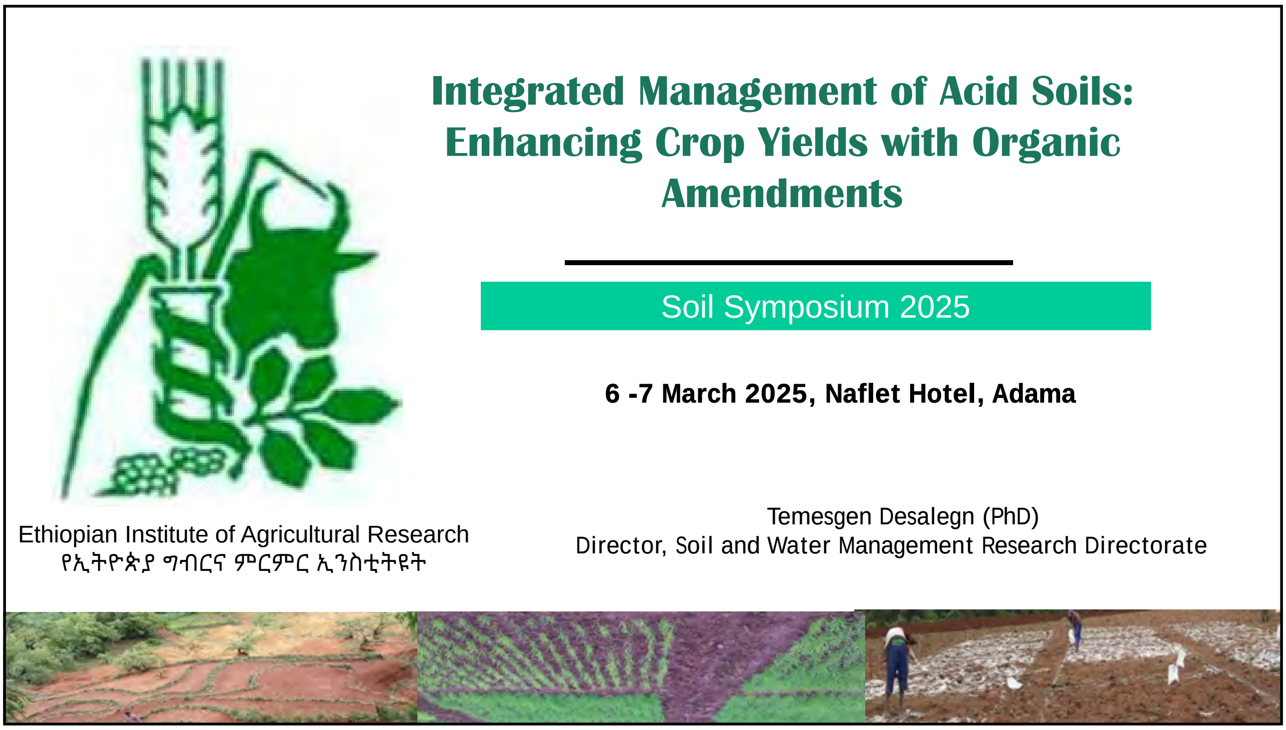
- Input supply/delivery
  (+ improved seeds, agrochemicals – small P fertilizer)
- Mechanization (planters, thresher :-
  Pulses in wheat/barley/maize belts)
- Weed/disease control – herbicides/fungicides

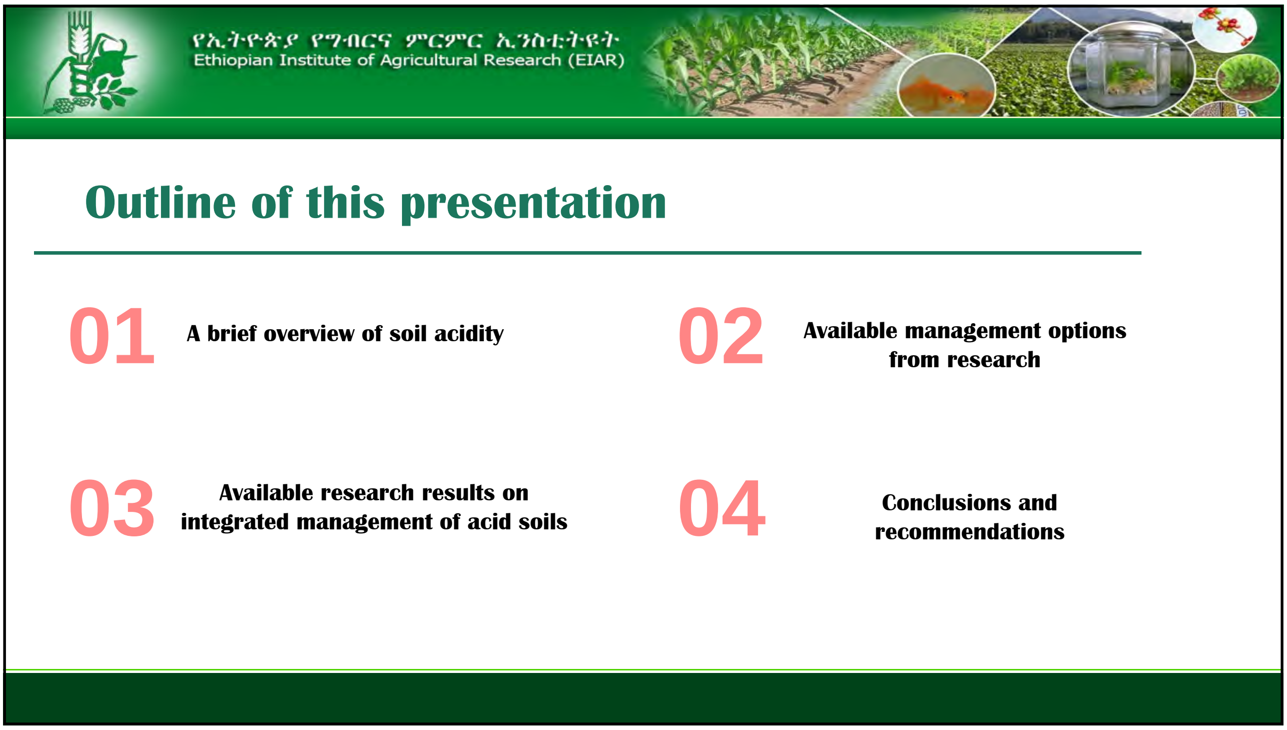
- Extension support(agronomy/Training to farmers)
- Facilitate Contract Farming/cluster farming – (oil/feed factories VS grain supply)
- Output market access (support PPPs and Value Chains)

11

Thank You

12


Integrated Management of Acid Soils: Enhancing Crop Yields with Organic Amendments
Soil Symposium 2025
6 -7 March 2025, Naflet Hotel, Adama
Ethiopian Institute of Agricultural Research
የኢትዮጵያ ግብርና ምርምር ኢንስቲትዩት
Temesgen Desalegn (PhD)
Director, Soil and Water Management Research Directorate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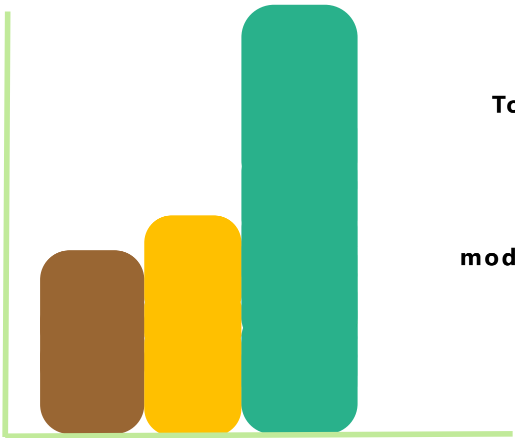
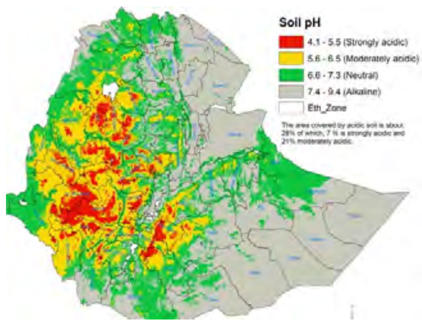
Ethiopian Institute of Agricultural Research (EIAR)
Outline of this presentation
01 A brief overview of soil acidity
02 Available management options from research
03 Available research results on integrated management of acid soils
04 Conclusions and recommendations

Doc ID

Area under soil acidity in Ethiopia





44%

Total arable Land

30%

moderately acidic - strongly acidic

14%

Very strongly acidic

3

Doc ID

Impact

- **Yield losses could be up to 100% in some places**

- **Field crops have become homestead crops**

- For example: Wheat in western Oromia
- Migration to other places in search of livelihoods

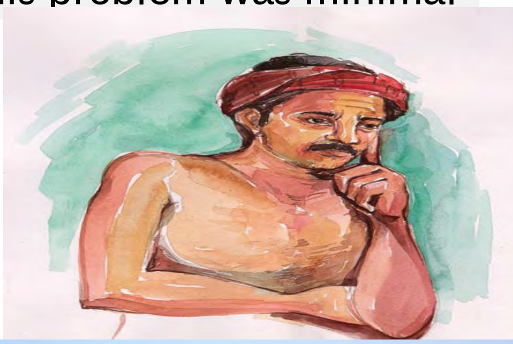
4

Doc ID

Research and development attention

❖ In the past, the attention given to this problem was minimal

- Technological
- Institutional
- socioeconomic related constraints



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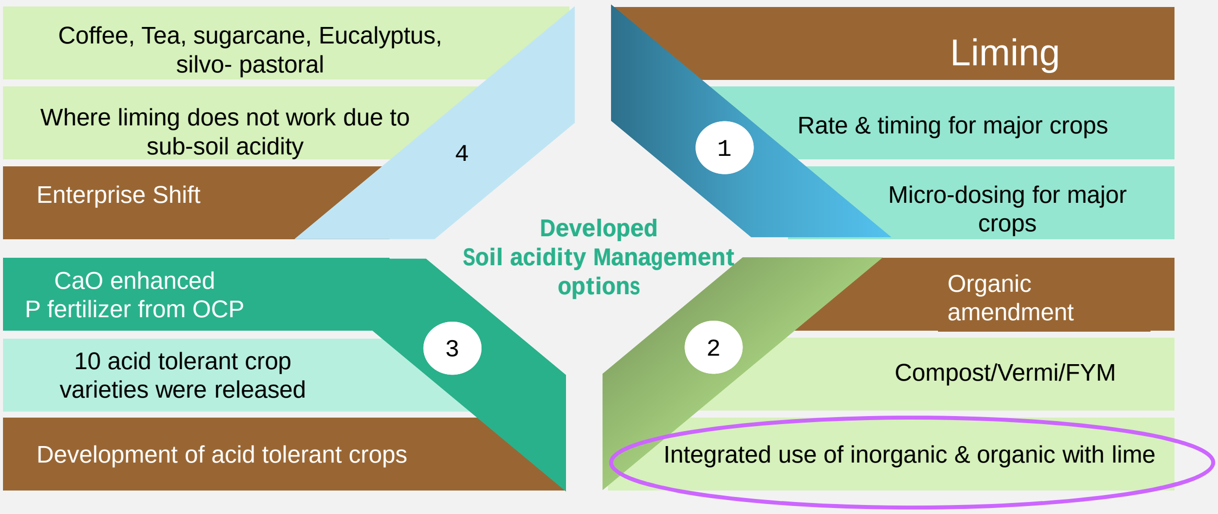
Doc ID

Land use change - Eucalyptus plantations

6

Available Research results

Doc ID



7

Experience Sharing in Soil Acidity Management in Brazil

06 -15 July 2024

Participants

1. Federal MoA
2. EIAR
3. OARI
4. ARARI
5. SEARI
6. SWEARI
7. CEARI
8. SARI

- **We are not very farm from them – technology generation**
- **Difference the magnitude of investment varies**
- **Investment in agriculture rewards!**

8

Liming acid soils

- Liming is often referred to as the foundation or "workhorse" to sustain crop production and productivity in acid soils conditions
- Its success stories have been documented in many countries
- 90-130% increase in yields has been reported when lime applied with fertilizers

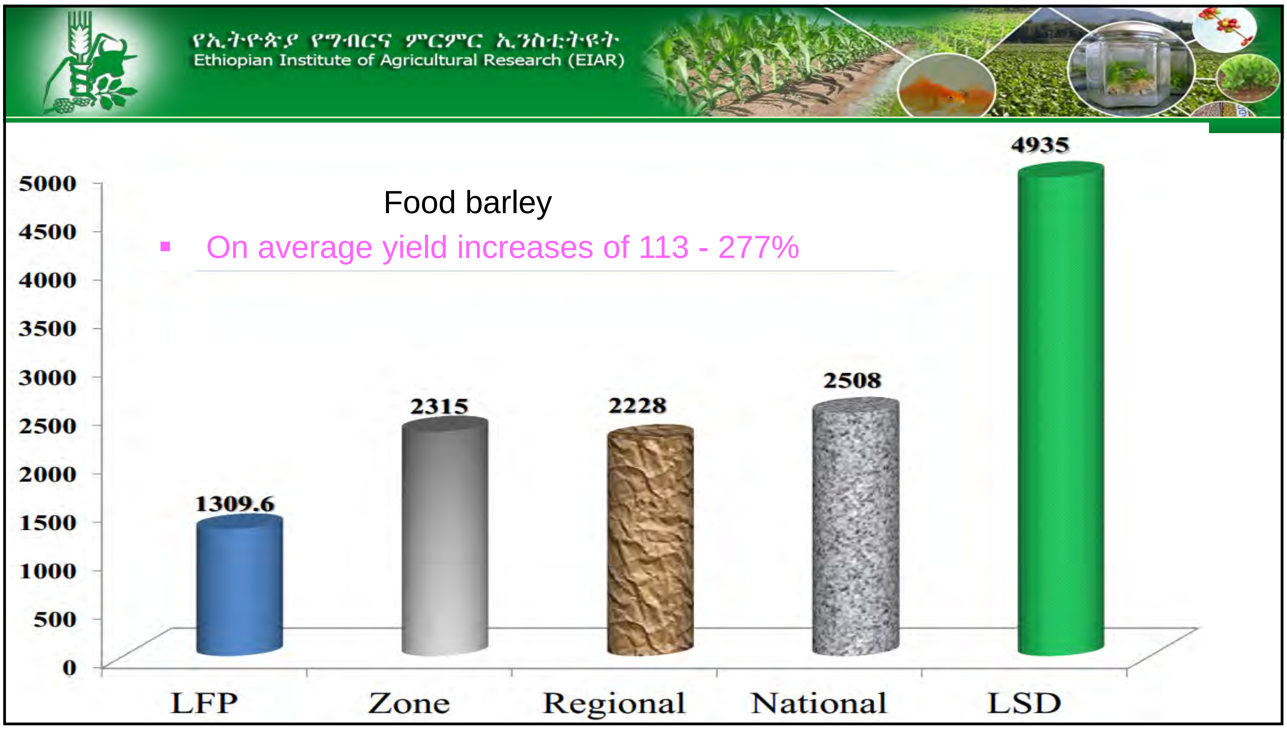
9

With lime | Without lime

Photo by Temesgen D.

10


Courtesy, GIZ ISFM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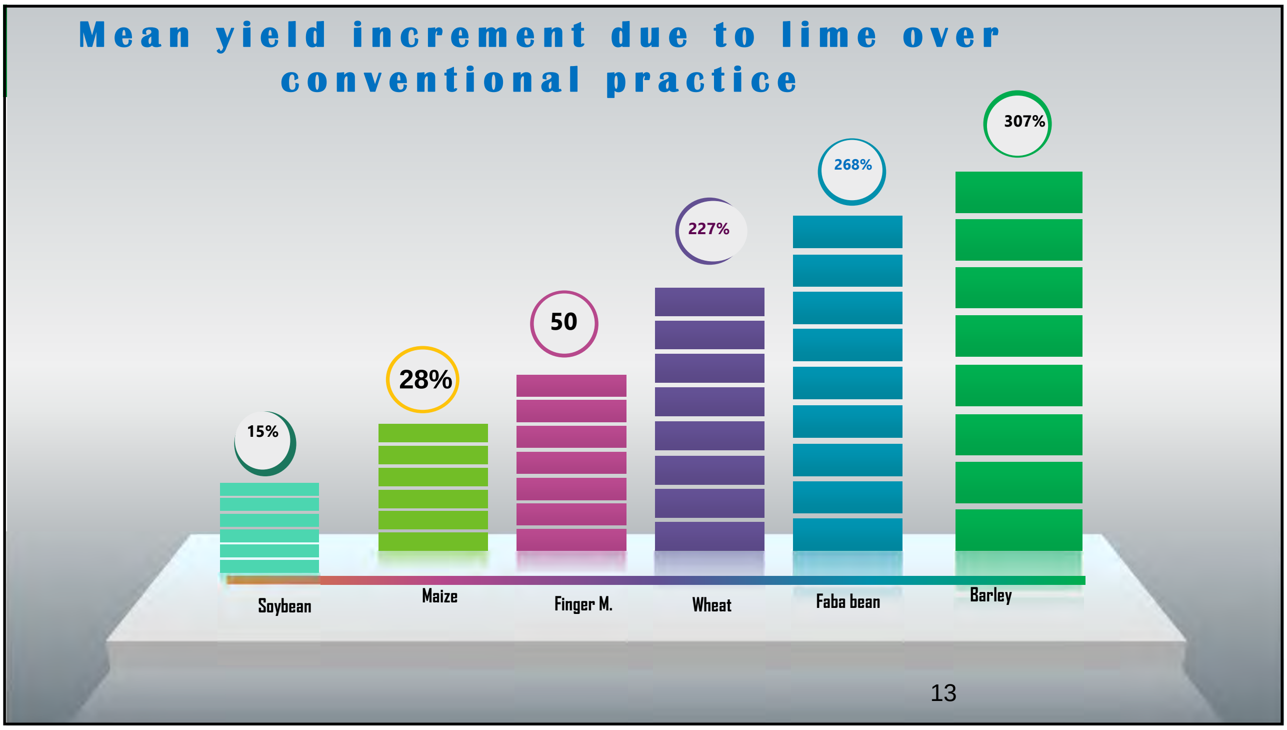
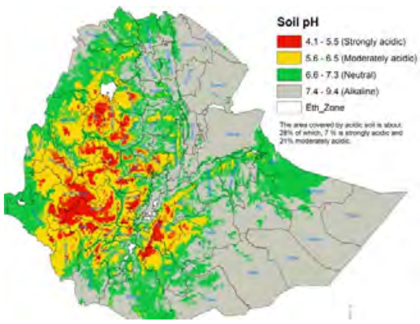
Ethiopian Institute of Agricultural Research (EIAR)
Food barley
On average yield increases of 113 - 277%
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1309.6
2315
2228
2508
4935
LFP
Zone
Regional
National
LSD

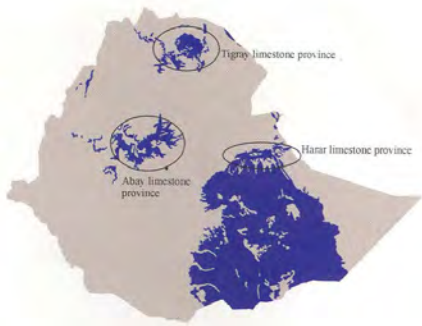


Problem and solution mismatch

- **Generally, there is mismatch between the locations of lime resources and where the problem of soil acidity exists in Ethiopia**



Soil acidity locations in Ethiopia



Locations of lime deposits in Ethiopia

- This Incurs high transportation cost on smallholder farmers residing very far from the lime deposits
- Success story recorded in Brazil was due to proximity of lime to the problem areas (in 100 km raduis)

14

Paradigm shift in using technology

- We should not copy and paste technology
- What worked some where else may not work well in Ethiopia
  - ✓ Difference in socio-economic & Environmental conditions
  - ✓ Cultural settings
- Hence, we need to adapt it our conditions
- For example:

1. Soil acidity is located in the highlands where per capita land holding is >1 ha

- So, why we need tractor amounted lime spreaders? Why not hand push or animal drawn implements?

2. If lime resources are very far, why one fits all thinking?
3. Why should we burn biomass so long we can use it for compost,vermicompost or incorporate into soil

We need to develop our own brand of soil acidity management in Ethiopia

15

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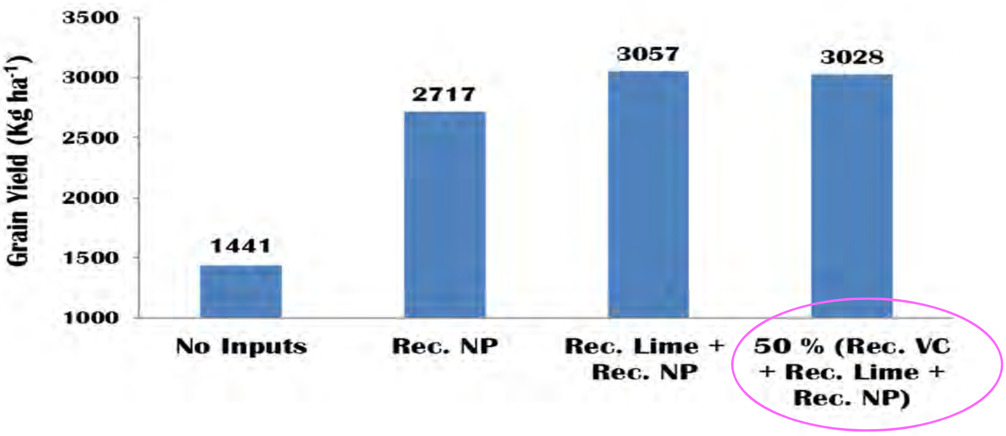
Ethiopian Institute of Agricultural Research (EIAR)

Integrated options in the management of soil acidity

1. Effect of Integrated use of lime and organic fertilizer on major crops (Wheat GY kg/ha)

At Ambo



17

2. Effect of Integrated use of lime and organic fertilizer on major crops (Barley)

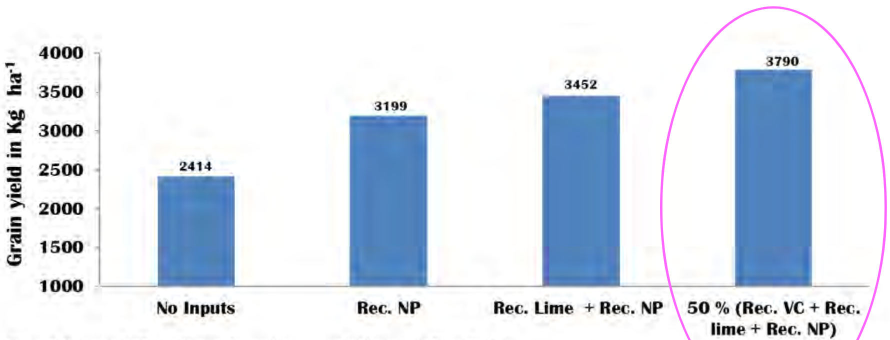


Figure 1. Integrated effect of lime and vermicompost on barley crop in Ejere district

Source: Fikadu et al., 2015

18

Doc ID

3. Effect of Integrated use of lime and organic fertilizer on major crops (Barley)

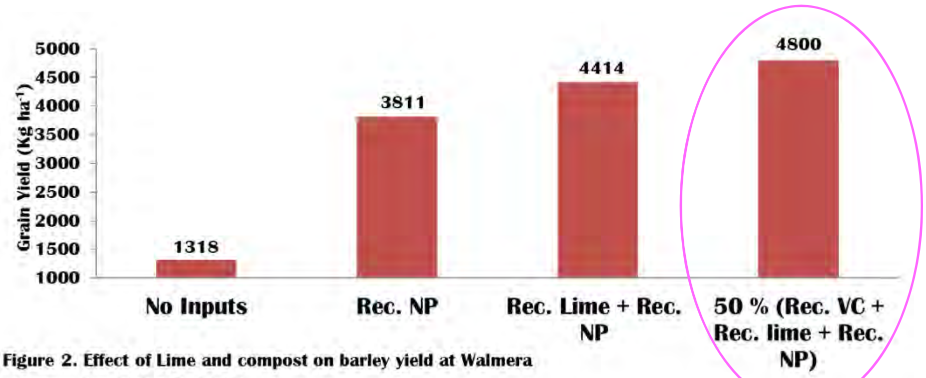


Figure 2. Effect of Lime and compost on barley yield at Walmera

Source: Woubishet D. 2017

19

Doc ID

4. Effect of Integrated use of lime and organic fertilizer on major crops (Maize GY Kg/ha)

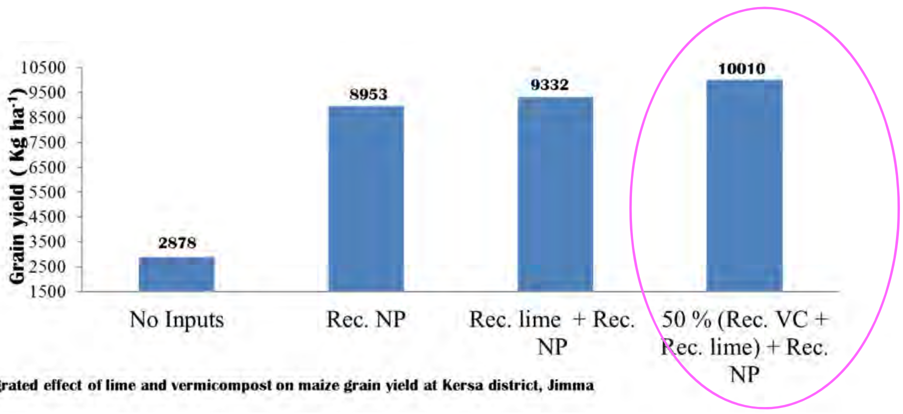


Figure 3. Integrated effect of lime and vermicompost on maize grain yield at Kersa district, Jimma

20

5. Effect of Integrated use of lime and organic fertilizer on major crops (Maize GY Kg/ha)

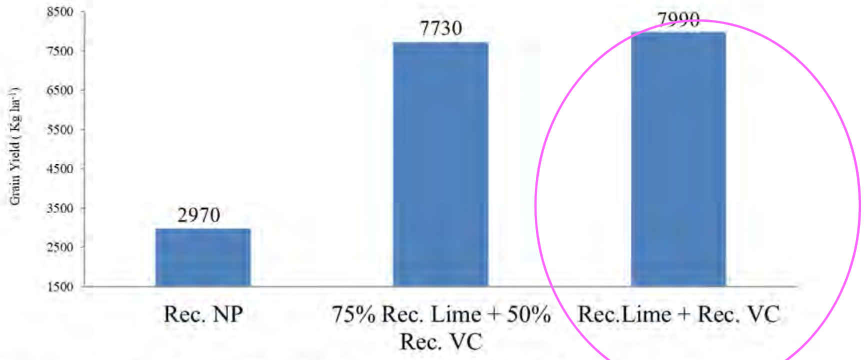


Figure 4. Lime and Vermi compost application on maize yield in Lalo Asabi district, West Wollega zone. SourceL Wegene and Lemma, 2023

21

6. Effect of Integrated use of lime and organic fertilizer on major crops (Faba bean SY Kg/ha)

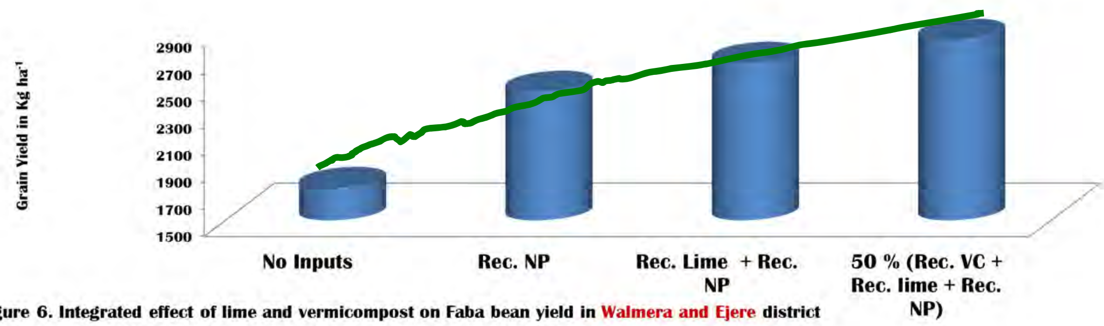


Figure 6. Integrated effect of lime and vermicompost on Faba bean yield in Walmera and Ejere district

22

7. Effect of Integrated use of lime and organic fertilizer on major crops (Soybean SY Kg/ha)

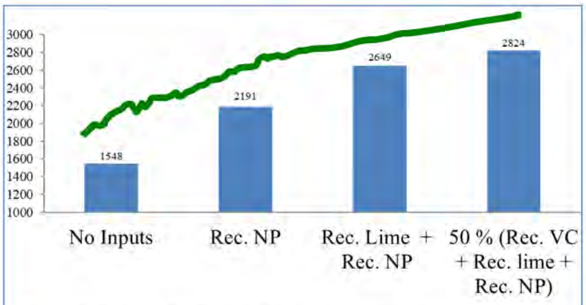


Figure 7. Integrated effect of lime and vermicompost on seed yied of soybean at Assosa

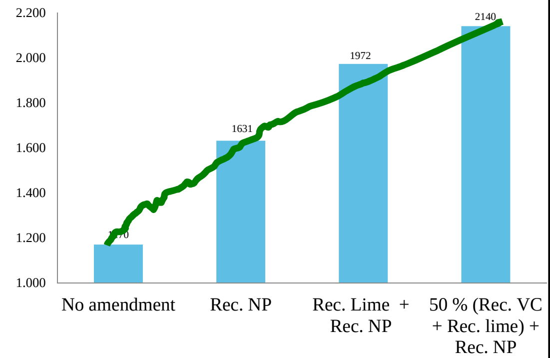
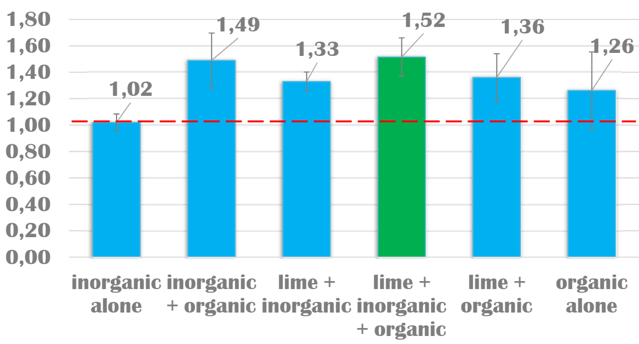


Figure 8. Integrated effect of lime and vermicompost on Soybean Yield in southwestern Ethiopia

23

Data collation on acid soil management options

- A total of 10,474 data points
- Published & unpublished raw data
- Derived from 228 experiments
- Conducted since 2007 (17 yrs)
- Across 7 regions: Oromia, Amhara, B-Gumuz, Sidama, South Eth, SW Eth, Central Eth;
- 53 districts with significant soil acidity coverage
  - ✓ Harmonized, cleaned, Analyzed and interpreted
  - ✓ 5 manuscripts on different acid soil management options developed



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Conclusions and recommendations

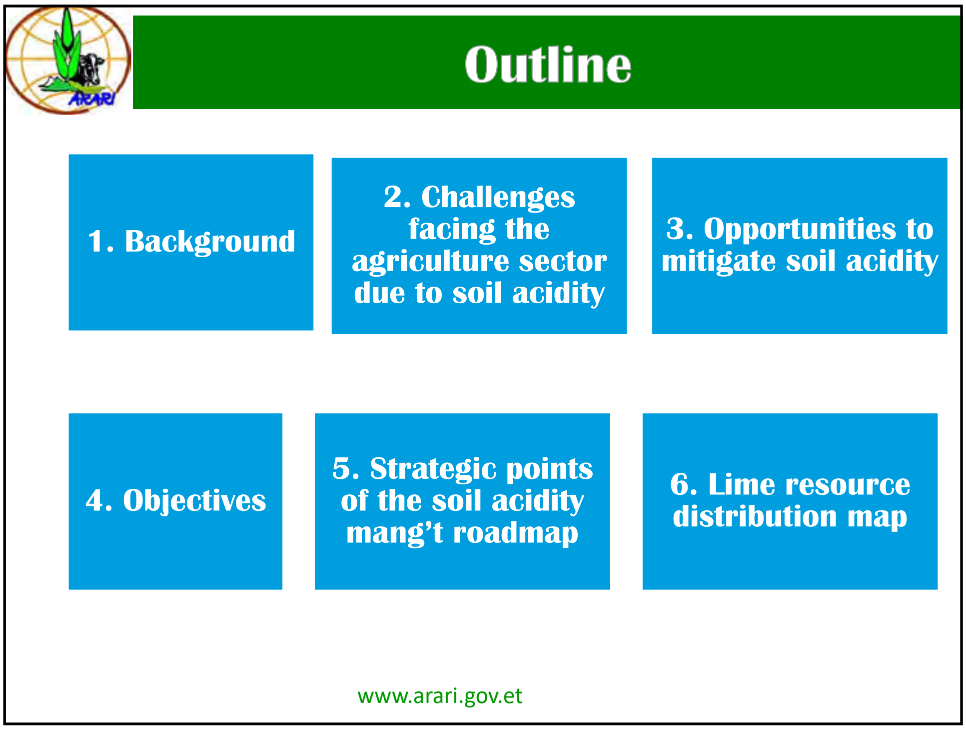
- The combined application of 50 % (inorganic and organic fertilizer with lime) gives highest grain yield of crops as compared to 100% chemical fertilizer under acidic conditions
- The practice is affordable by small holders farmers, and improves soil health
- Based on the comprehensive results, it is advisable to promote the integrated use of inorganic and organic fertilizer with lime in acid prone areas of Ethiopia
- The approach not only offers a viable alternative to produce crops in areas where lime is inaccessible or unaffordable due to high costs associated with transportation, but also sustainable.
- Hence, our own brand of soil acidity management in Ethiopia should be the integrated approach

Thank for your attention!

EIAR
Ethiopian Institute of Agricultural Research

If you need more information: **Please you can reach me at: Temesgen2015@gmail.com**


ARARI
Acid Soil Management Roadmap in Amhara Region
Team members
Tesfaye Feyisa (PhD), Birhanu Agumas (PhD), Prof. Yihenew G.Silassie (PhD), Menale Wondie (PhD), Asresu Yitayew (PhD), Demeke Nigussie (MSc), Asmamaw Yayeh (MSc) and Ateka Aychew (MSc)
Dec. 23, 2024, Kombolcha
www.arari.gov.et


Outline
1. Background
2. Challenges facing the agriculture sector due to soil acidity
3. Opportunities to mitigate soil acidity
4. Objectives
5. Strategic points of the soil acidity mang't roadmap
6. Lime resource distribution map
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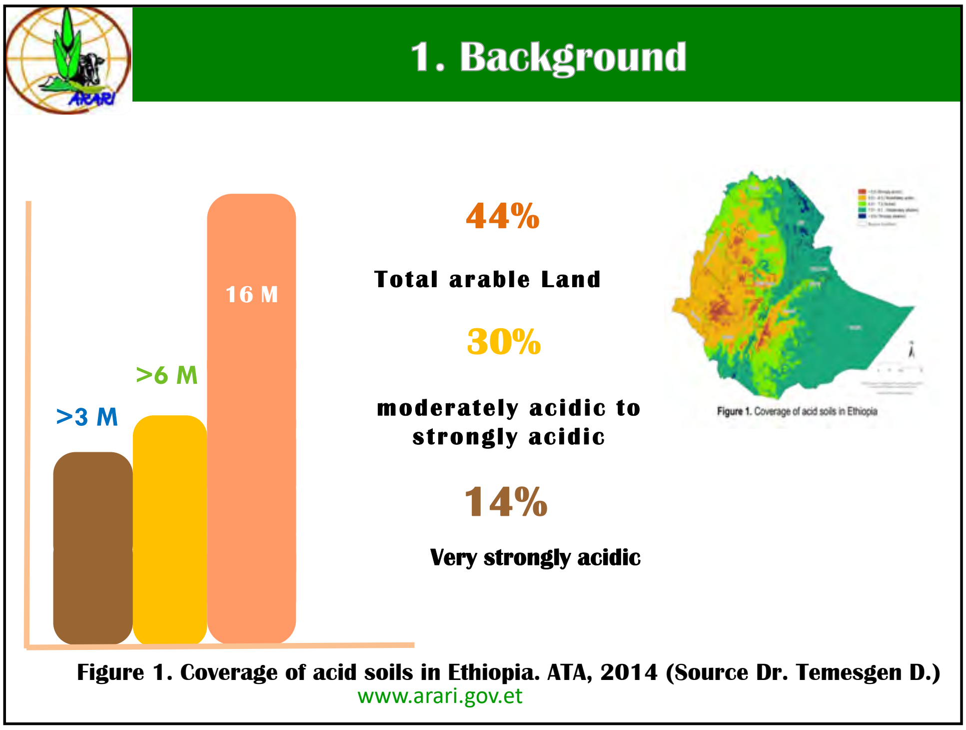

Figure 1. Coverage of acid soils in Ethiopia. ATA, 2014 (Source Dr. Temesgen D.)

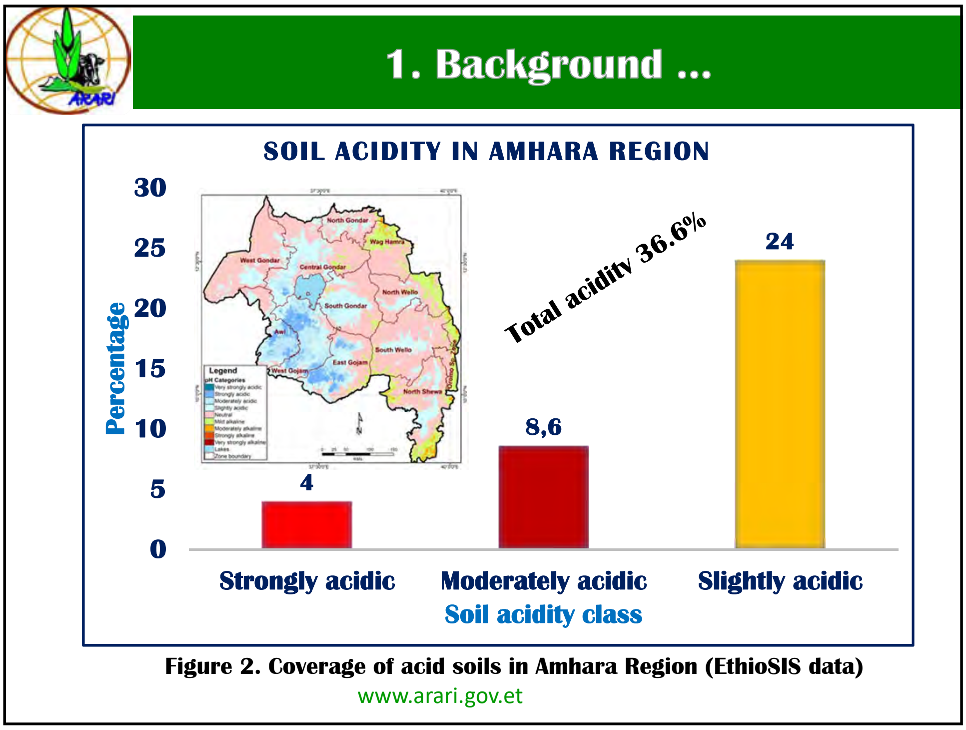

Figure 2. Coverage of acid soils in Amhara Region (EthioSIS data)

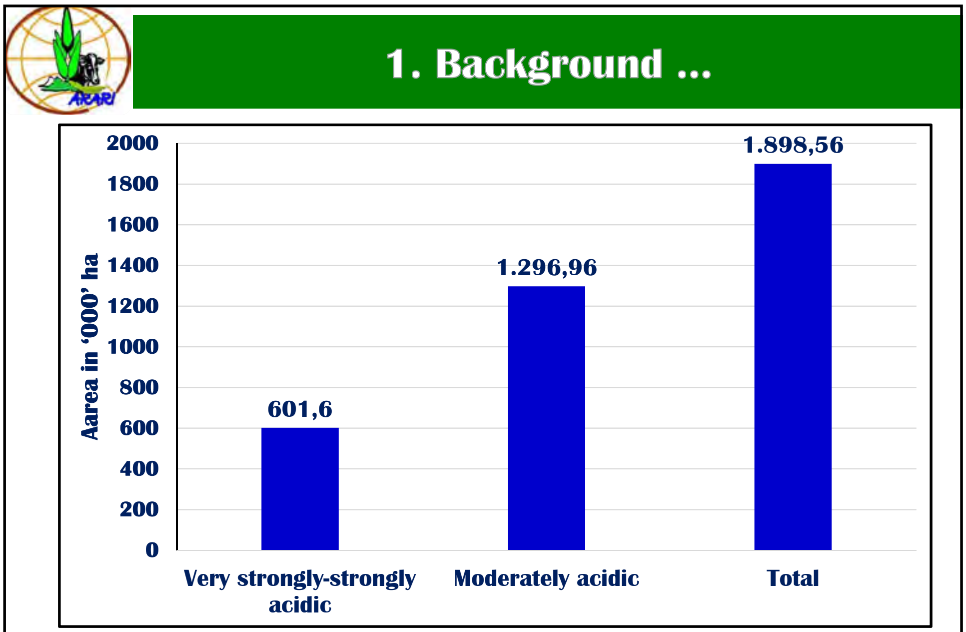

Figure 3. Strong and medium soil acidity in Amhara Region (EthioSIS data)
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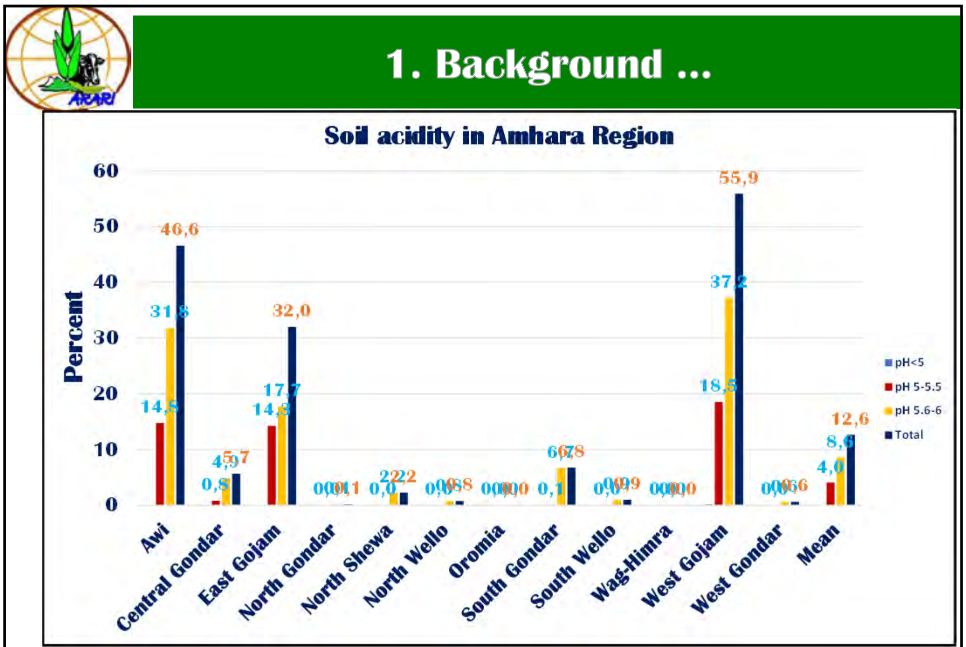

Figure 4. Zone level acid soil coverage in Amhara Region
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2. Challenges facing the agriculture sector due to soil acidity

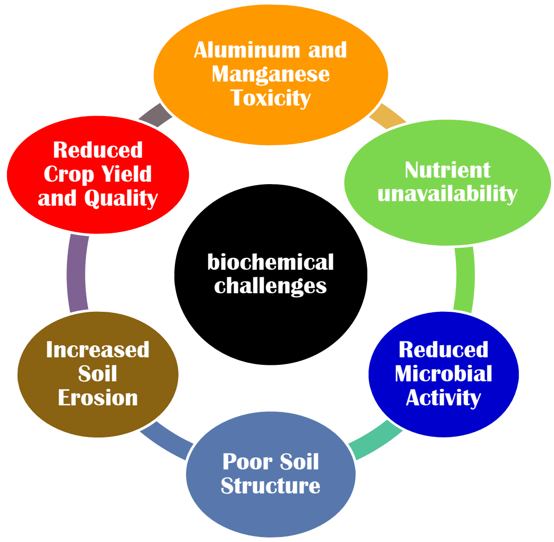

Figure 5. Low agricultural productivity linked to biochemical challenges

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2. Challenges facing the agricultural sector due to soil acidity…..

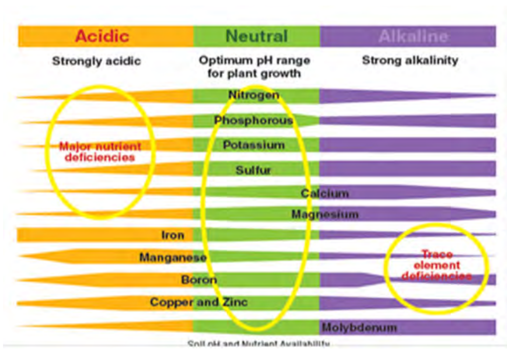

Figure 6. Effect of soil pH on availability of nutrients

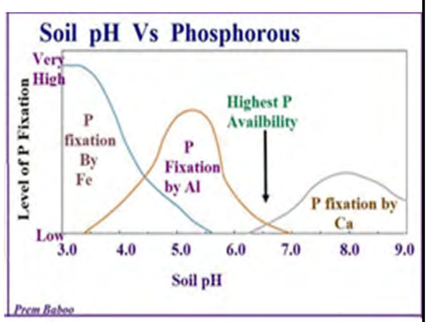

Figure 7. Effect of soil pH on P availability

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2. Challenges facing the agricultural sector due to soil acidity.....

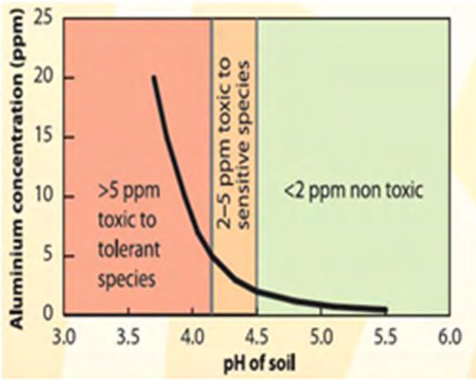

Figure 8. Al toxicity to plants

Figure 9. Mn toxicity to plants (0, 90, 180 ppm Mn)

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2. Challenges Facing the Agricultural Sector Due to Soil Acidity.....

Figure 10. Performance of faba bean growing on un-limed (a) and limed fields (b)

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2. Challenges Facing the Agricultural Sector Due to Soil Acidity...

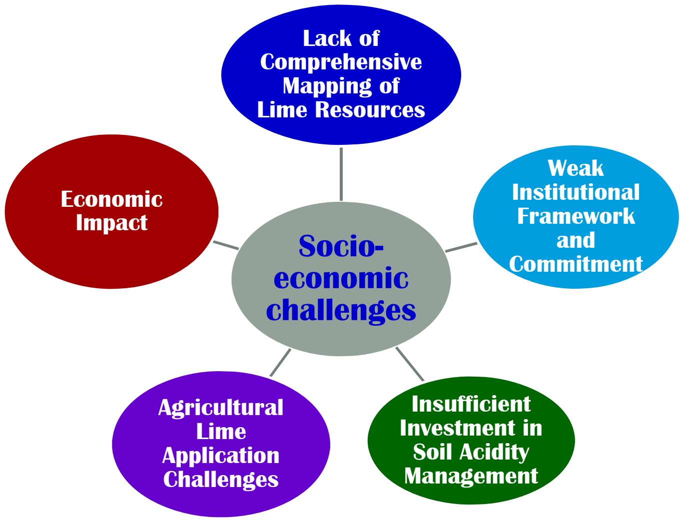

Figure 11. Low yield due to socioeconomic challenges

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3. Opportunities to mitigate soil acidity

1. **Availability of huge lime resources in the region >212 billion tonnes**
2. **Availability of Huge Organic Resources**
3. **Availability of Acid Soil Management Technologies**

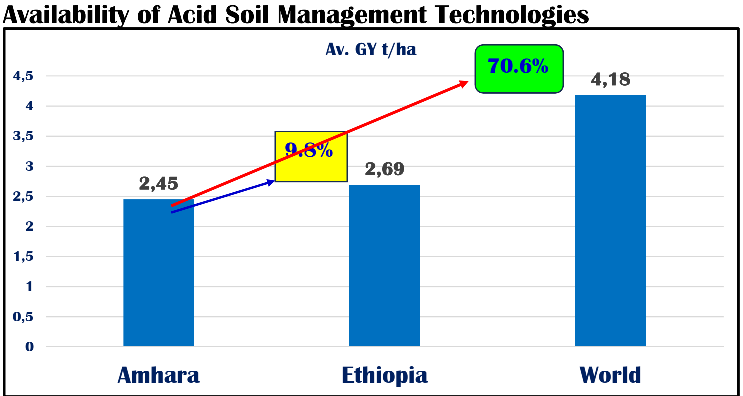

Figure 12. Crop yield per ha in Amhara, Ethiopia and the World 2022 (CSA, 2022)

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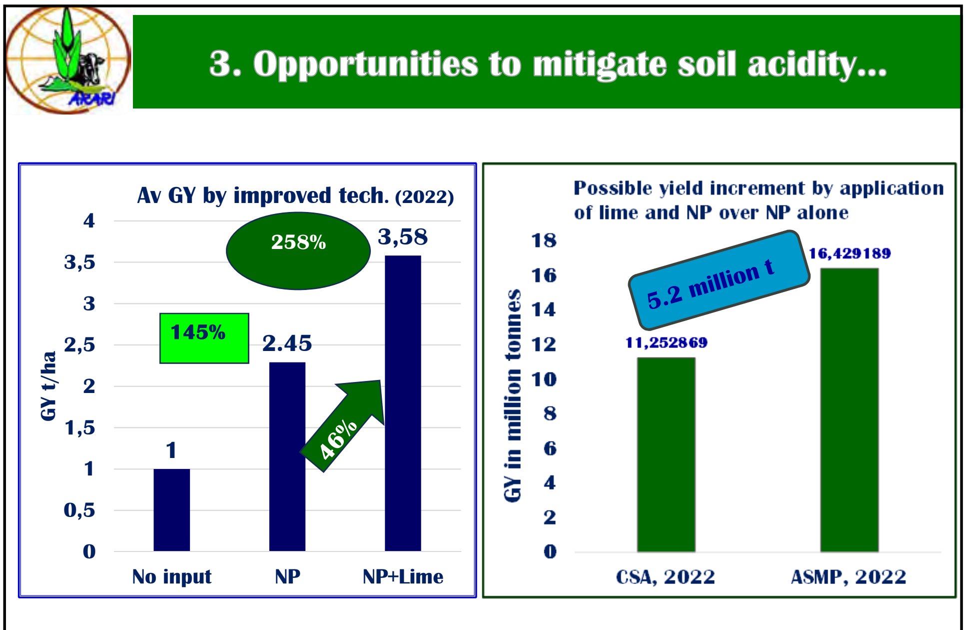

Figure 13. GY advantage in Amhara due to application of lime with RNP compared to NP alone

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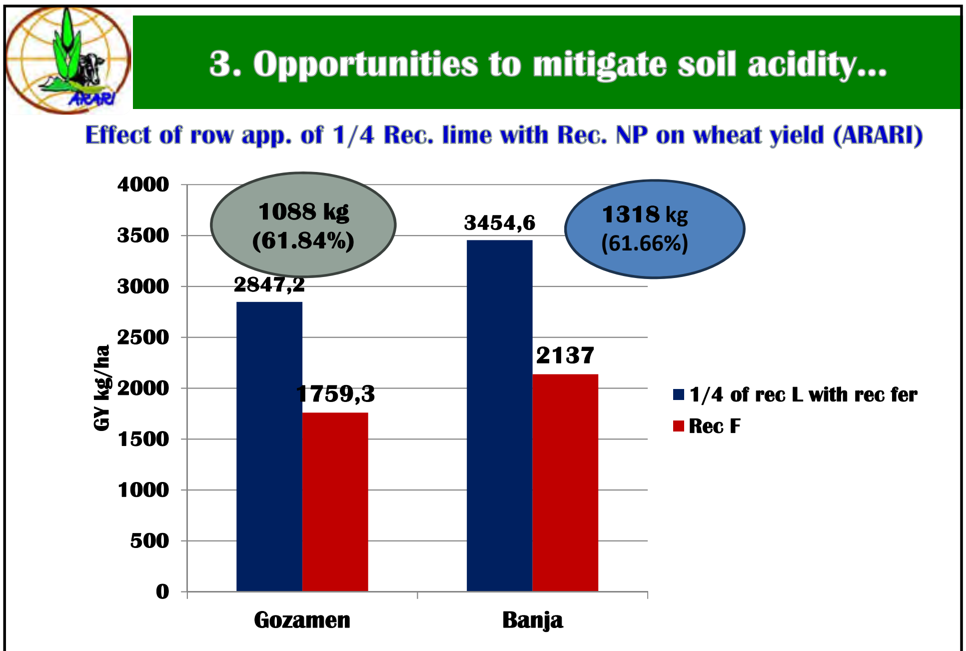

Figure 14. Effect of row application of ¼ of lime with RNP compared to RNP alone

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- **Vermicompost + lime + RNP increased faba bean GY by 100-315% contributing to food and nutrition security and to export**

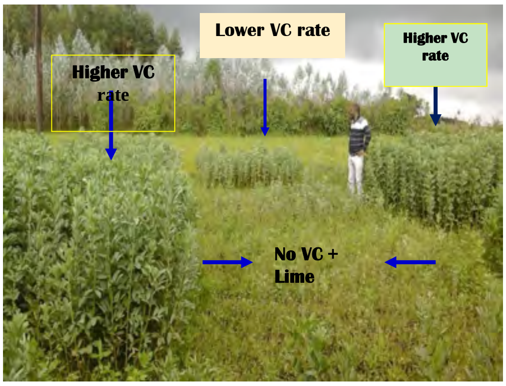

Figure 15. Effect of ISFM on faba bean yield

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3. Opportunities to mitigate soil acidity...

CaO enhanced phosphorus fertilizer

- ✓ **increased wheat yield by 10% over RNP+S**
- ✓ **increased teff yield by 19% - 29% over RNP+S**
- ✓ **increased food barley yield by 29% over RNP+S**

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3. Opportunities to mitigate soil acidity…

- **Overall, the proper implementation of ASMPs in the region will significantly contribute to food and nutrition security, reduce import dependence, and provide raw materials for agricultural processing industries and beyond**

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3. Opportunities to mitigate soil acidity…

4. Availability of Labor (60%) working force (13.8 million out of 23 million)

5. Availability of Government Initiatives (Governmental flagship)

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4. Objectives of the roadmap

General objective:

- ✓ **To improve agricultural productivity and environmental sustainability in the Amhara Region through effective management of acid soils**

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4. Objectives of the roadmap...

Specific Objectives:

- ✓ **To enhance access to soil amendments (lime, organic fertilizers, and alternatives) and improve market linkages.**
- ✓ **To strengthen regulatory frameworks and institutional support for lime quality control and subsidies.**

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4. Objectives of the roadmap....

Specific Objectives:

- ✓ To build capacity and foster collaboration among stakeholders for effective acid soil management.
- ✓ To develop monitoring, follow-up, and implementation mechanisms, addressing cross-cutting issues.

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5. Strategic points for soil acidity management roadmap

5.1: Improve application challenges and access to lime and organic fertilizer

- Ensure adequate production, supply, and affordability of lime and organic fertilizers.
- Promote alternatives like biochar and gypsum where lime is less accessible.
- Build efficient distribution and market systems for soil amendments

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5. Strategic points for soil acidity management roadmap…

5.1.1 Conduct comprehensive soil acidity mapping to prioritize interventions areas

5.1.2 Establish lime distribution hubs and incentivize local lime production.

5.1.3 Upgrade the capacity of Dejen lime crusher machine.

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5. Strategic points for soil acidity management roadmap…

5.1.4 Create market linkages using mobile platforms for real-time lime availability and pricing.

5.1.5 Implement demonstration plots and awareness campaigns to show the benefits of soil amendments.

5.1.6. Introducing Lime Pelleting Machines

Pelleted lime

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5. Strategic points for soil acidity management roadmap…

1.6. Introducing lime and organic fertilizer spreader machines

1.7. Enhancing Lime Packaging for Safety and Ease of Handling

1.8. Implementing Temporal Split Application of Lime

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5. Strategic points for soil acidity management roadmap …

5.2: Exploring alternatives to lime for enhancing crop yield

5.2.1. Select and test acid-tolerant crop varieties

5.2.2. Adopting Conservation Agriculture Practices

5.2.3. Adopting agroforestry practices

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5. Strategic points for soil acidity management roadmap…

5.3: Enhance Market Information Systems

5.3.1. Establish a regional market information system.

5.3.2. Collect and validate market data on lime and fertilizers.

5.3.3. Set up an expert network for market analysis.

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5. Strategic points for soil acidity management roadmap…

5.4: Strengthen Regulatory Systems for Quality Control

5.4.1 Develop and implement quality standards and certification systems for lime and fertilizers.

5.4.2 Establish mobile testing units to assess lime and fertilizer quality at production and distribution sites.

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5. Strategic points for soil acidity management roadmap…

5.4: Strengthen Regulatory Systems for Quality Control

5.4.3 Train stakeholders (producers, distributors, and extension agents) on quality control criteria.

5.4.4 Introduce a labeling system that indicates product quality and certification.

5.4.5 Enforce penalties for the production and distribution of substandard products.

5.4.6 Upgrade the existing quality control labs with modern diagnostic tools and infrastructure.

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5. Strategic points for soil acidity management roadmap…

5.5: Strengthening Capacity of Soil Laboratories, Agricultural Extension Services, and Research

5.5.1. Soil Laboratory Capacity Building

- ✓ Upgrade some of the existing soil laboratories with modern diagnostic tools and infrastructure.
- ✓ Empower research institutions to generate innovative acid soil management technologies.
- ✓ Promote interdisciplinary collaboration among researchers to explore new approaches and solutions for addressing soil acidity challenges.

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5. Strategic points for soil acidity management roadmap…

5.5: Strengthening Capacity of Soil Laboratories, Agricultural Extension Services, and Research

5.5.1. Soil Laboratory Capacity Building…

- ✓ **Train and hire skilled personnel for soil labs and agricultural extension services.**
- ✓ **Develop farmer-friendly soil testing kits for on-site use.**
- ✓ **Increase financial support for research institutions and capacity-building programs.**

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5. Strategic points for soil acidity management roadmap…

5.6: Promote Institutional Collaboration & Policy Support

5.6.1. Establish a steering committee to coordinate soil acidity management initiatives.

5.6.2. Advocate for government subsidies and tax incentives on lime and organic fertilizers.

5.6.3. Create a sustainable lime distribution system

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5. Strategic points for soil acidity management roadmap…

5.6: Promote Institutional Collaboration & Policy Support

5.6.4. Develop and enforce policies promoting sustainable land management practices.

5.6.5. Facilitate knowledge-sharing platforms for stakeholders.

5.6.6 Regularly review and update soil management policies based on emerging research findings

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5. Strategic points for soil acidity management roadmap …

5.7: Cross-Cutting Issues

5.7.1 Develop programs targeting female farmers to enhance their participation in soil management initiatives.

5.7.2 Introduce climate-smart agriculture practices like agroforestry and water conservation.

5.7.3 Ensure soil management strategies align with environmental protection policies.

5.7.4 Promote digital tools for precision agriculture and soil monitoring.

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5. Strategic points for soil acidity management roadmap …

5.7.5: Community Participation and Ownership

5.7.6: Public-Private Partnerships (PPP)

5.7.7: Resource mobilization and financing

5.7.8: Monitoring, evaluation, and learning (MEL)

5.7.9: Policy alignment and advocacy

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5. Strategic points for soil acidity management roadmap …

5.8. Follow-up Actions next to the road map approval

5.8.1. Develop an implementation plan.

5.8.2. Facilitate stakeholder engagement and resource mobilization and capacity building.

5.8.3. Establish a robust monitoring and evaluation framework and define key performance indicators (KPIs)

5.8.4. Develop communication strategy to raise awareness

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Conclusion

- **The strategic and action points will be executed in short term (1-2 years), mid term (3-5 years) and long term (6-10 years)Acid soil managment roadmap final edited1.doc**
- **Within this timeframe the strongly and moderately acid soils (1.8 million ha) will be treated, production and productivity will be increased and food and nutrition security in the region will be assured and then thinking about export**

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Conclusion...

- **All stakeholders will start playing their roles right after this workshop**
- **The regional government will lead the execution of the actions making it a top development agenda**

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Acknowledgements

The team is highly grateful to:

- **Dr Asmare Dejen, Ato Ajebe Sinishaw and Dr Likawent Yiheyis for leading the initiative.**
- **Bureau of Mines for providing lime data**
- **USAID for financing and co-facilitating the workshop**
- **ARARI and BoA management, ARARI researchers and directors in BoA for the valuable comments on the draft roadmap**
- **All participants for coming and contributing to this cause**

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5. Strategic points for soil acidity management roadmap...

Thank you very much

for your attention!

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MINISTRY OF AGRICULTURE
german cooperation
ETH-SOIL
South Ethiopia Agricultural Research Institute (SEARI)
Jinka Agricultural Research Center (JARC)
Presentation on Soil Symposium 2025
By; Genanaw Tesema
March, 2025
Adama, Ethiopia
1


ETH-SOIL
Title: Integrated Use of Compost, FYM, and Lime for Acidic Soil Amelioration and Barley Yield Improvement in Semen Ari District, South Ethiopia
2

INTRODUCTION

- **Soil acidity** is a major constraint to crop production worldwide.
- **Tropical soils** are heavily weathered, losing essential nutrients (K, Mg, Ca) and accumulating **H, Al, and Mn**, which negatively impact crops (Okalebo et al., 2009).
- **Highland soils** are particularly prone to acidity due to:
  - ✓ High rainfall leading to nutrient leaching and runoff.
  - ✓ Continuous cropping leads to depleting soil nutrients.

3

con't

- Soil acidity is a significant constraint to agricultural productivity in many regions of Ethiopia, particularly in South Ethiopia areas like Semen Ari District.
- Acidic soils in this region often have
  - ✓ low nutrient availability,
  - ✓ poor microbial activity, and
  - ✓ hindered root development, all of which contribute to reduced crop yields.

4

Con't

- Barley (Hordeum vulgare L.), a key staple crop, is particularly sensitive to soil pH imbalances, resulting in poor growth and decreased yields (Abera et al., 2018).
- In response to this issue, several soil amendments have been used to ameliorate soil acidity and improve fertility.
- Compost and farmyard manure (FYM) are organic amendments commonly used in the region :-
  - ✓ To increase nutrient content,
  - ✓ Enhance soil structure, and improve microbial activity (Tadesse et al., 2018).

5

con'd Introduction

- Lime is another common amendment applied to neutralize soil acidity, increase pH, and enhance nutrient availability for crops (Bekele et al., 2020).
- However, the individual use of these amendments has shown limited success in addressing the complex challenges of soil acidity,
- Many studies emphasizing that an integrated approach might be more effective for long-term soil health improvement (Tian et al., 2020).

6

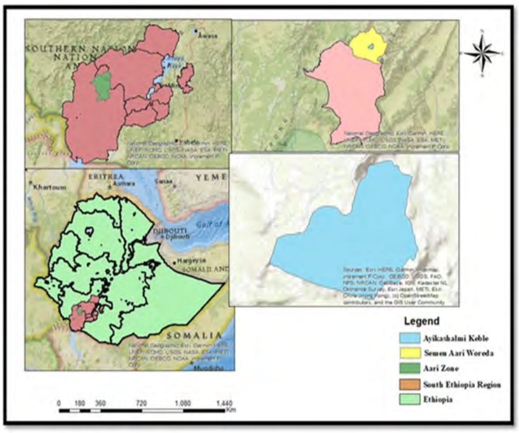
con’t

- Despite the recognized importance of barley in Semen Ari District, there is limited research that explores the combined effects of compost, FYM, and lime on soil amelioration and barley yield improvement.
- There fore, this research aimed to fill this gap by investigating **the *integrated use of compost, FYM, and lime to address soil acidity and enhance barley yields in Semen Ari District.***
- Not only this but also, the research could provide ***local farmers with a sustainable, low-cost solution to increase crop productivity and improve soil health***

7

MATERIALS AND METHODS

Figure;- Map of the Study Area



Located at <u>05°46’46.9’’ N</u> latitude and <u>036°33’17.9’’ E</u> longitude with an elevation of <u>2804</u> m above sea level.

8

Experimental Layout, Design, and Treatments

- The experiment was laid out in a randomized complete block design (RCBD) with three replication.

The treatments included;-

1) Control (no inputs),
2) Recommended NP (92N,69 P_2O_5)
3) 7.6t lime,
4) 10 t/ha FYM,
5) 10 t/ha compost,
6) 7.6t lime + 10 t/ha FYM and
7) 7.6t lime + 10 t/ha compost.

9

- Planting space was 30 cm between rows and sown by drilling seed rate of 150 kg·ha^{-1}.
- Barley variety (HB 1307) in the experimental site was used as a test crop.
- All the recommended rates of P Source fertilizer from TSP, were applied at sowing,
- However N was applied in split: half at sowing and the remaining half at about 35 days after sowing.

10

Lime applications and germination performance

11

Field performance of barley in the amended soil

12

RESULTS AND DISCUSSION

13

Table1. Soil physicochemical properties of the experimental soil before lime application

Soil properties	Values	Rating	References
Clay	31		
Silt	40		
Sand	29		
Textural class		Clay loam	USDA, 2017);FAO, 1998
pH(H_2O)	4.55	Very strongly acidic	Murphy (1968)
Bulk density(g/cm^3)	1.3		
Organic carbon (%)	1.34	Low	Debele (1980) as cited by Tekalign et al. (1991)
Total N (%)	0.083	low	Landon, 1991);Sikora et al., 2013
Exchangeable acidity(cmol/kg)	5.2		
Exchangeable aluminum Al (me/100g)	2.9		
Available P (ppm)	10.3	Low	Cottenie (1980);Bray and Kurtz (1945) and Birhane et al., 2014

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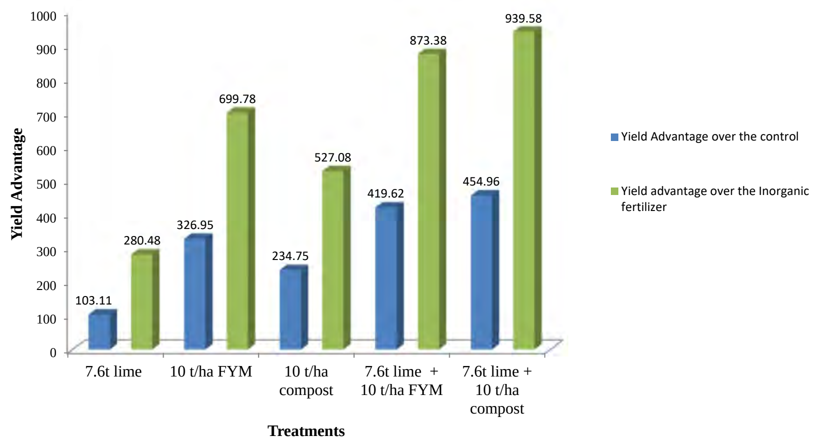
Table 2: Barley growth, yield and yield traits as influenced by combined application of lime, FYM and compost

Treatments	Biomass (kg ha^{-1})	Grain (kg ha^{-1})
Control (no inputs)	1279.3de	443.4e
Recommended NP	682.1e	236.7e
7.6t lime	2132.4d	900.6d
10 t/ha FYM	4501.0b	1893.1bc
10 t/ha compost	3515.4c	1484.3c
7.6t lime + 10 t/ha FYM	5503.5a	2304.0ab
7.6t lime + 10 t/ha compost	5620.1a	2460.7a
Mean	3319	1389
CV	22.5	27
LSD	884.7	444.5

15

Figure2; yield advantageous of Lime, compost and FYM over the control and inorganic fertilizer



16

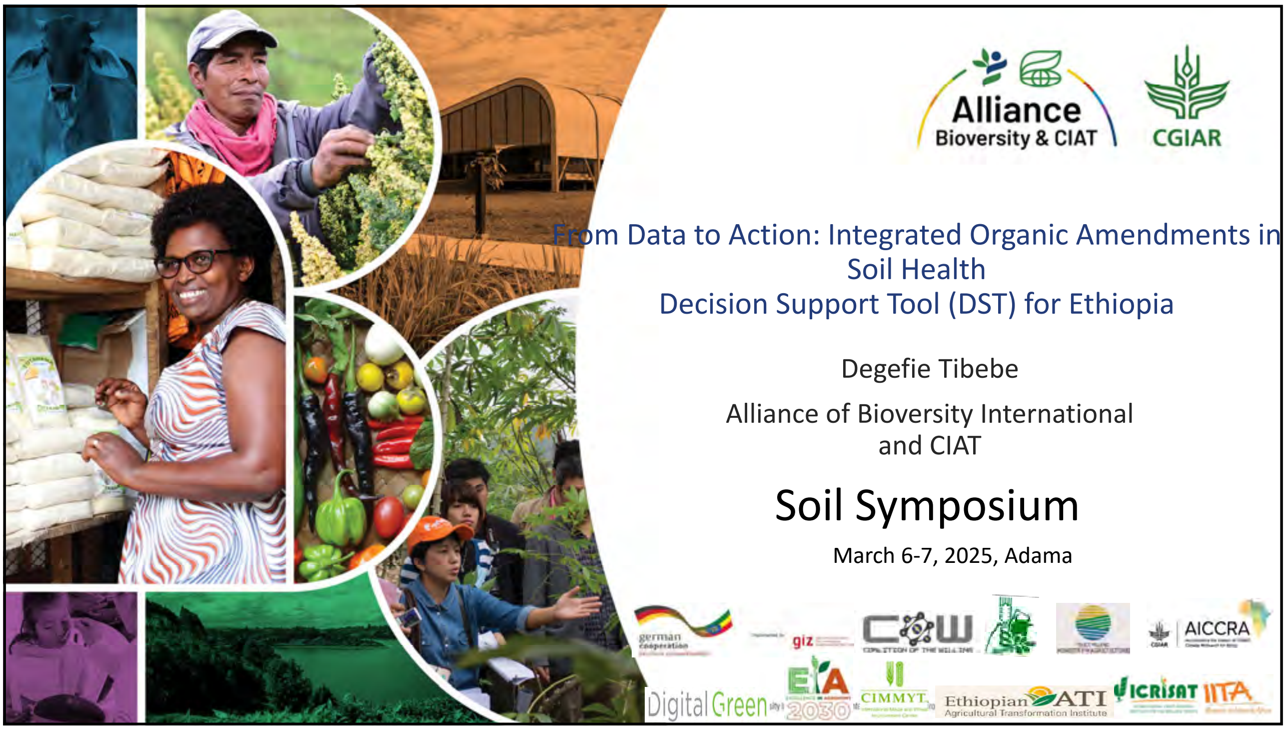
CONCLUSION AND RECOMMENDATION

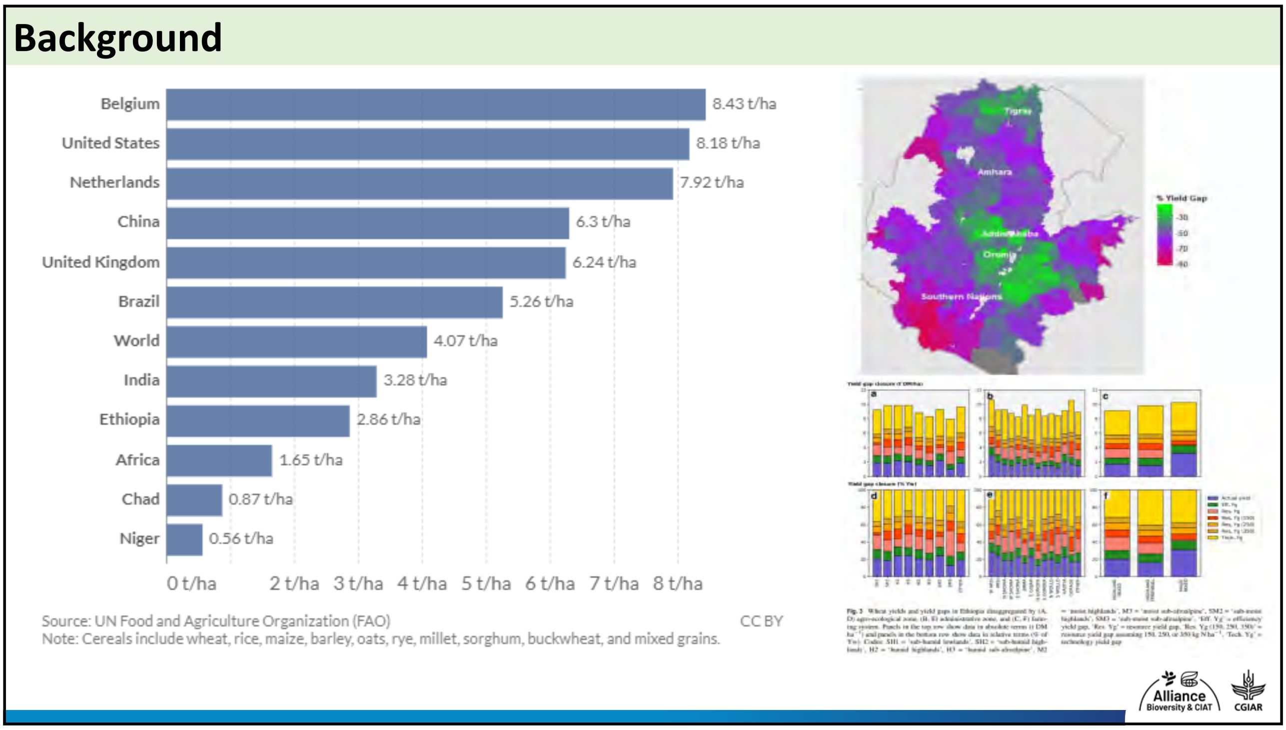
- The findings from this study indicated that the integrated application of lime with organic sources, such as farmyard manure (FYM) or compost, significantly;
  - ✓ Reduced soil acidity
  - ✓ Enhanced the grain yield of barley, and
  - ✓ Improved nutrient availability.
- How ever, **use of chemical fertilizer alone did not effectively** improve barley yields due to the high soil acidity,
- There fore, the study suggests that farmers in the area, and in similar regions with strongly acidic soils, could benefit from using 10 t ha^{-1} of FYM or compost combined with 7.6 t ha^{-1} of lime.

17

Thank You !

18


Alliance
Bioversity & CIAT
CGIAR
From Data to Action: Integrated Organic Amendments in Soil Health
Decision Support Tool (DST) for Ethiopia
Degefie Tibebe
Alliance of Bioversity International and CIAT
Soil Symposium
March 6-7, 2025, Adama
giz
AICCRA
Digital Green
CIMMYT
Ethiopian ATI
Agricultural Transformation Institute
ICRISAT
IITA


Background
Belgium 8.43 t/ha
United States 8.18 t/ha
Netherlands 7.92 t/ha
China 6.3 t/ha
United Kingdom 6.24 t/ha
Brazil 5.26 t/ha
World 4.07 t/ha
India 3.28 t/ha
Ethiopia 2.86 t/ha
Africa 1.65 t/ha
Chad 0.87 t/ha
Niger 0.56 t/ha
0 t/ha 2 t/ha 3 t/ha 4 t/ha 5 t/ha 6 t/ha 7 t/ha 8 t/ha
Source: UN Food and Agriculture Organization (FAO)
CC BY
Note: Cereals include wheat, rice, maize, barley, oats, rye, millet, sorghum, buckwheat, and mixed grains.
Tigray
Amhara
Oromia
Southern Nations
Alliance
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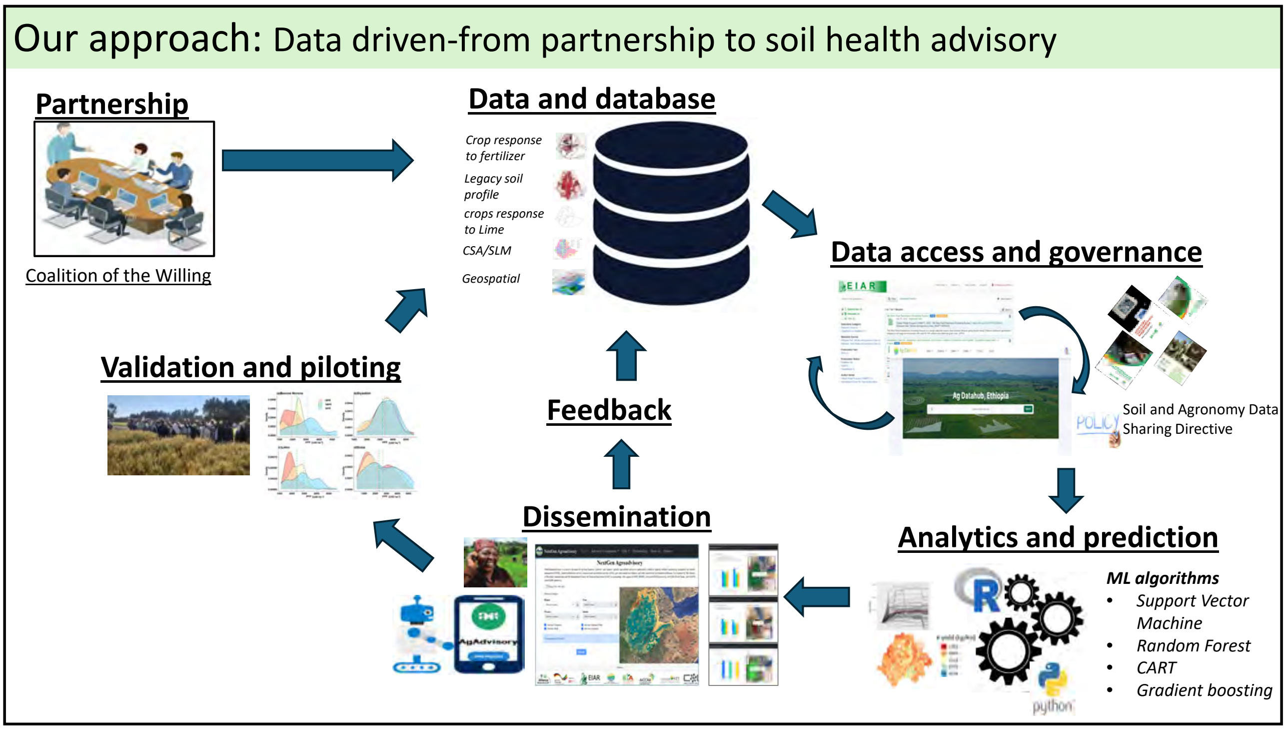
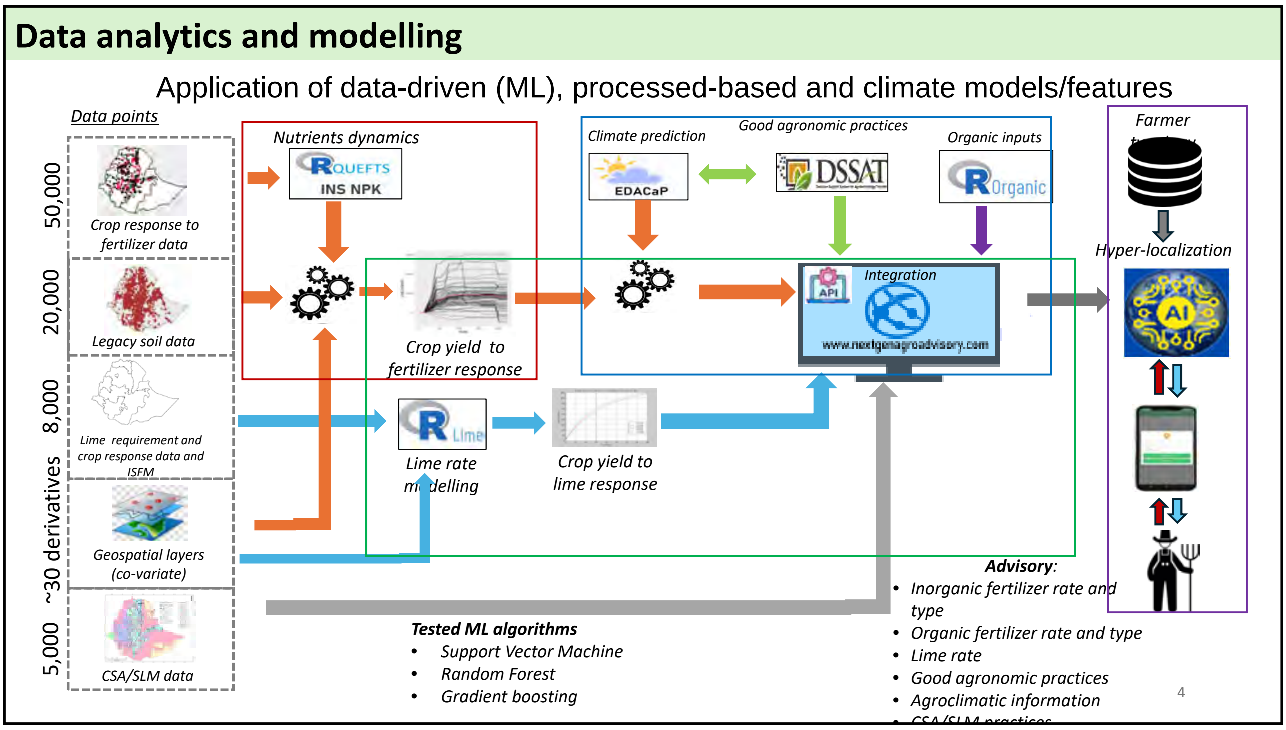
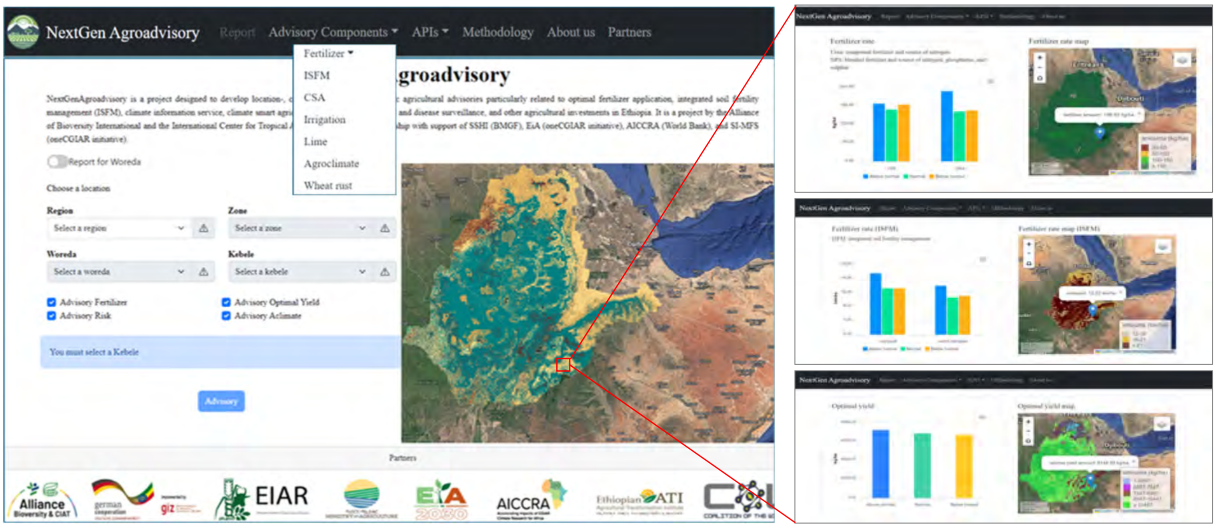
10.7 From Data to Action: Integrated Organic Amendments in Soil Health Decision Support Tool (DST) for Ethiopia, Dr. Degefie Tibebe, International Center for Tropical Agriculture





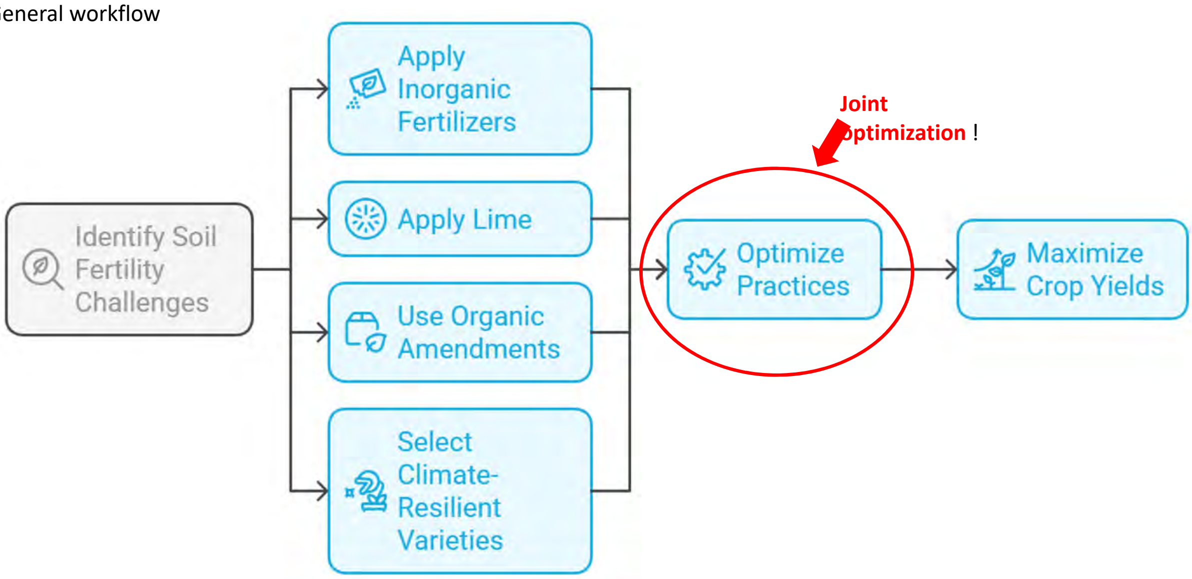
What we have now



[GitHub - EthiopiaCiatGit/SCSFR: The repo contains an R code ...]

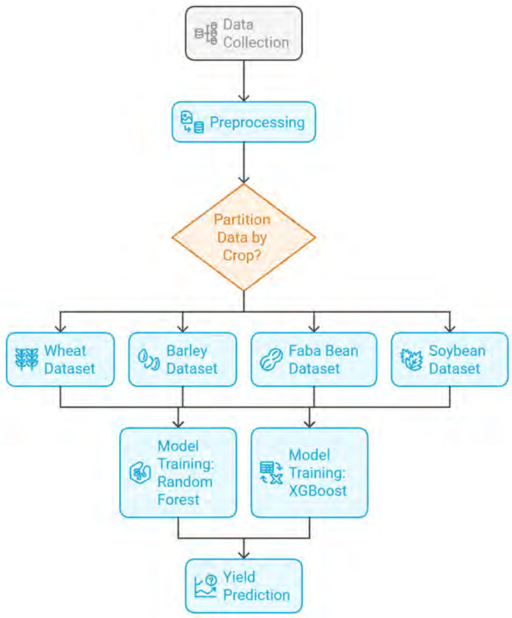
Towards developing integrated Organic amendment to soil health

General workflow



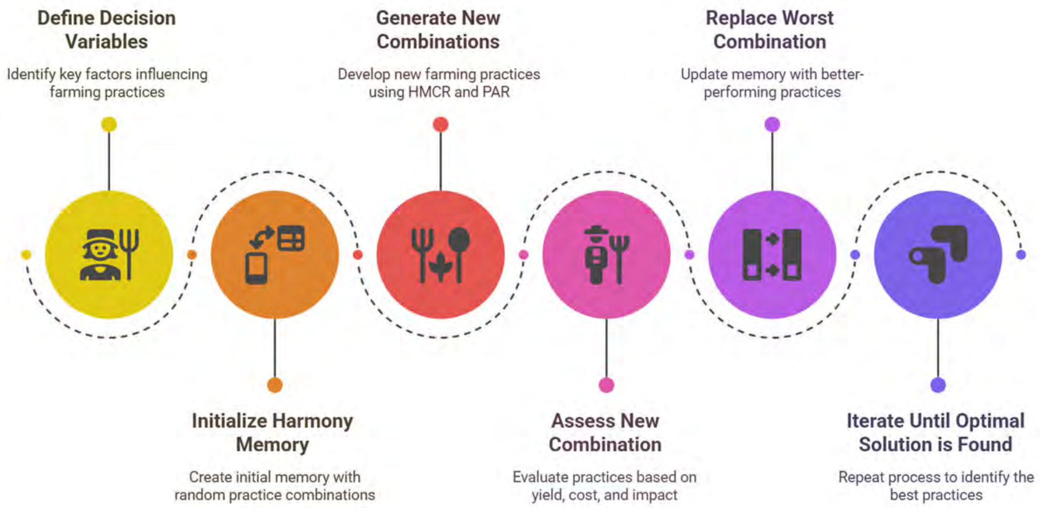
Towards developing integrated Organic amendment to soil health

Model development



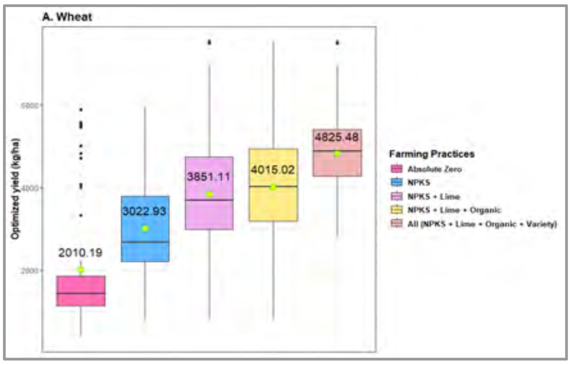
Towards developing integrated Organic amendment to soil health

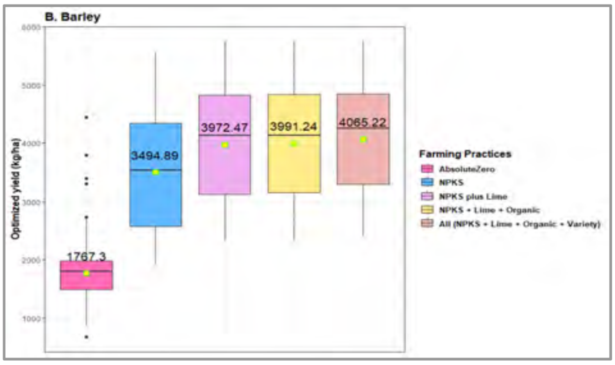
Harmony Search Workflow- Joint optimization



Towards developing integrated Organic amendment to soil health

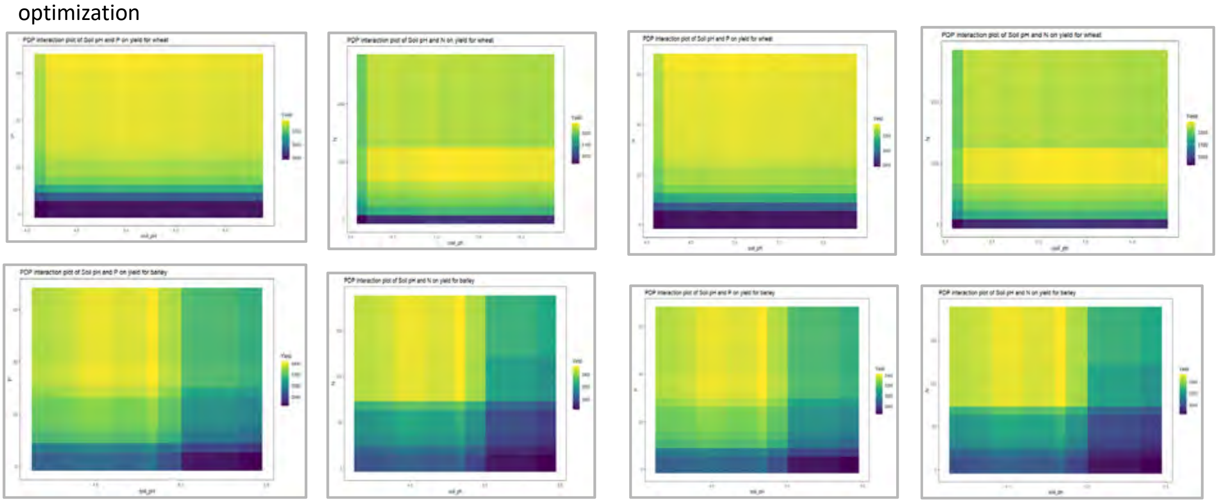
Simulations for four scenarios optimized for yield





Towards developing integrated Organic amendment to soil health

Some preliminary results from optimization



Further information, please use the following QR code

Alliance Bioversity & CIAT

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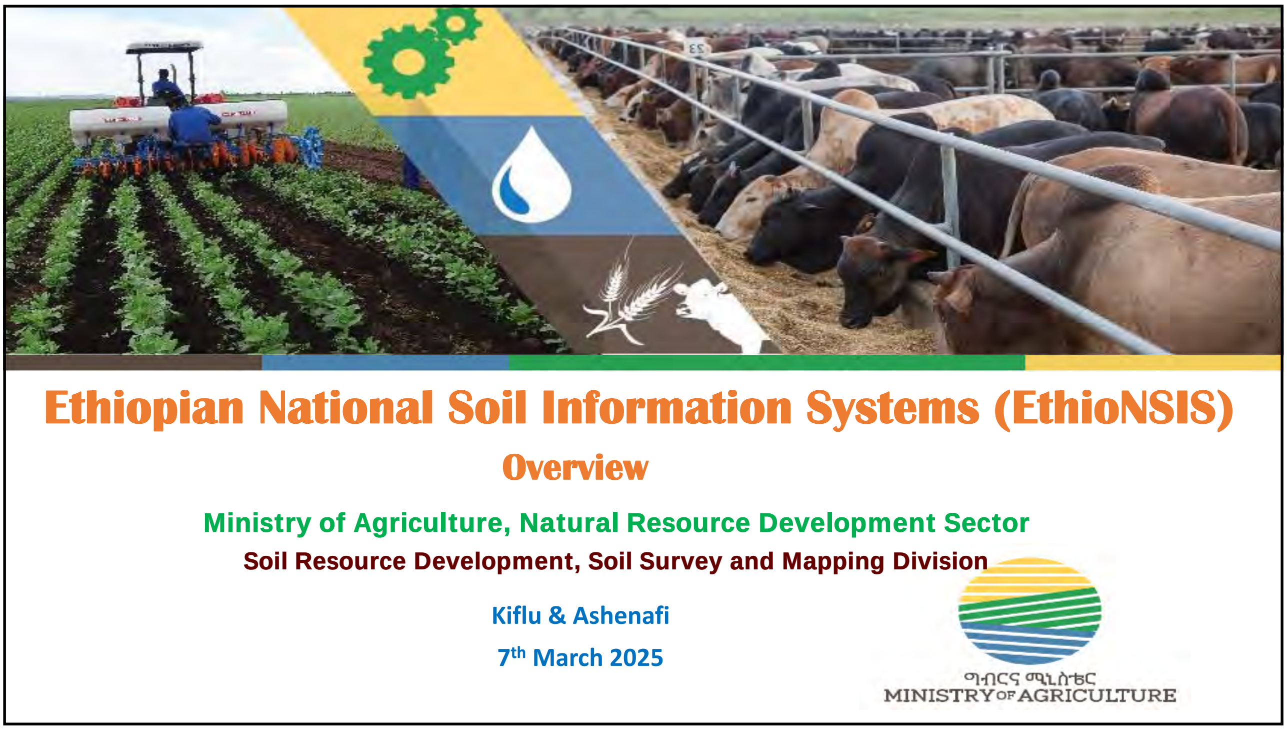
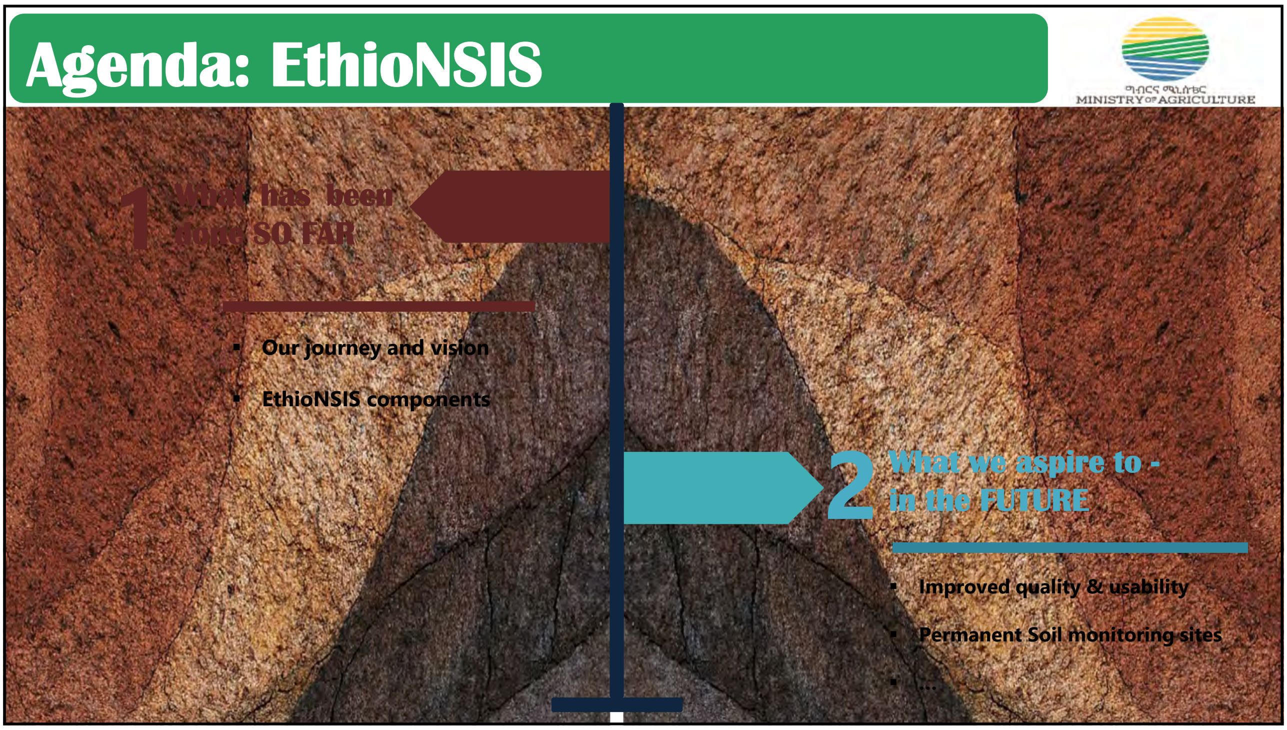
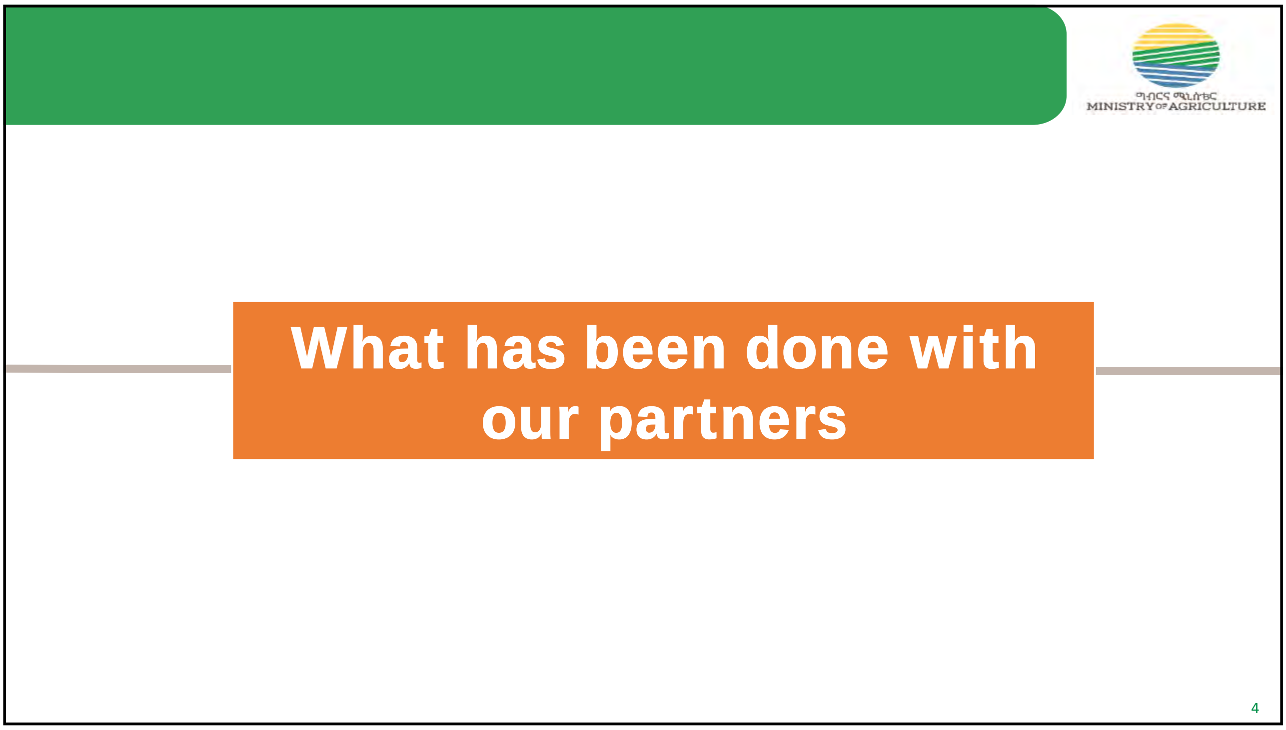
10.8 Introduction of NSIS Portal Execution, Kiflu Gudeta, SRD, Ministry of Agriculture of Ethiopia

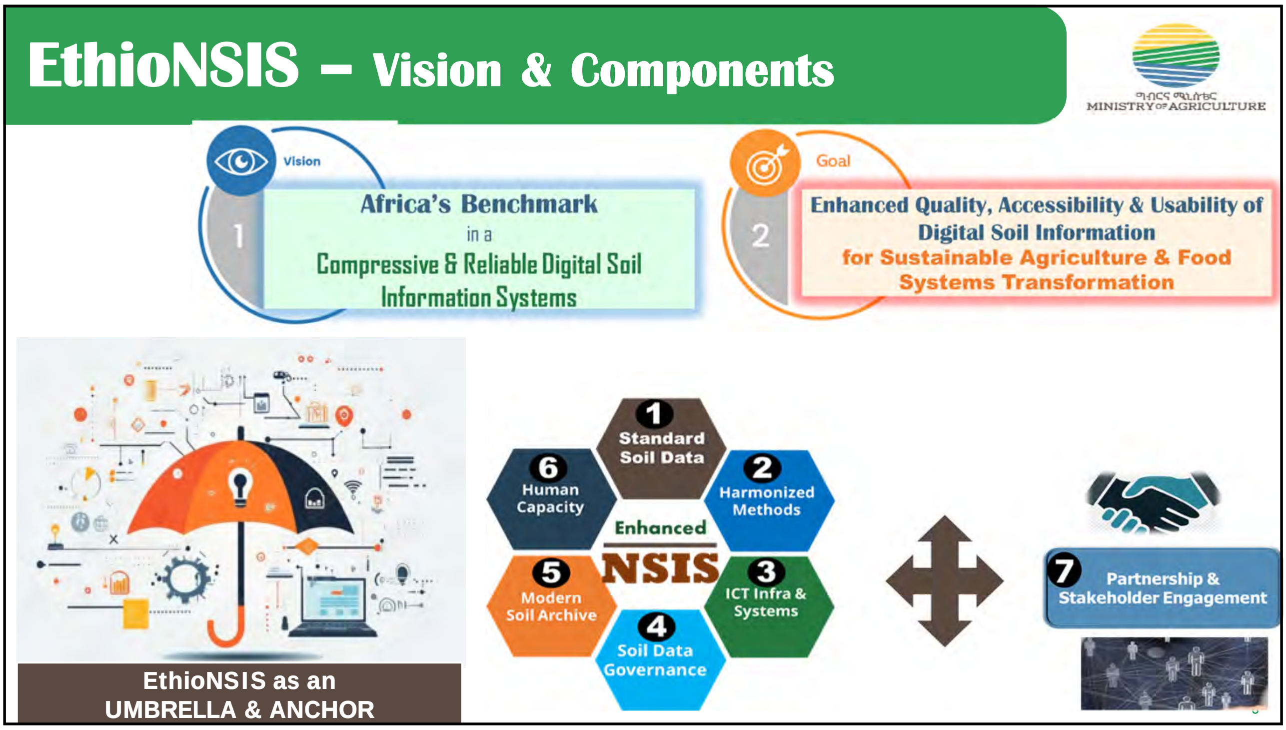


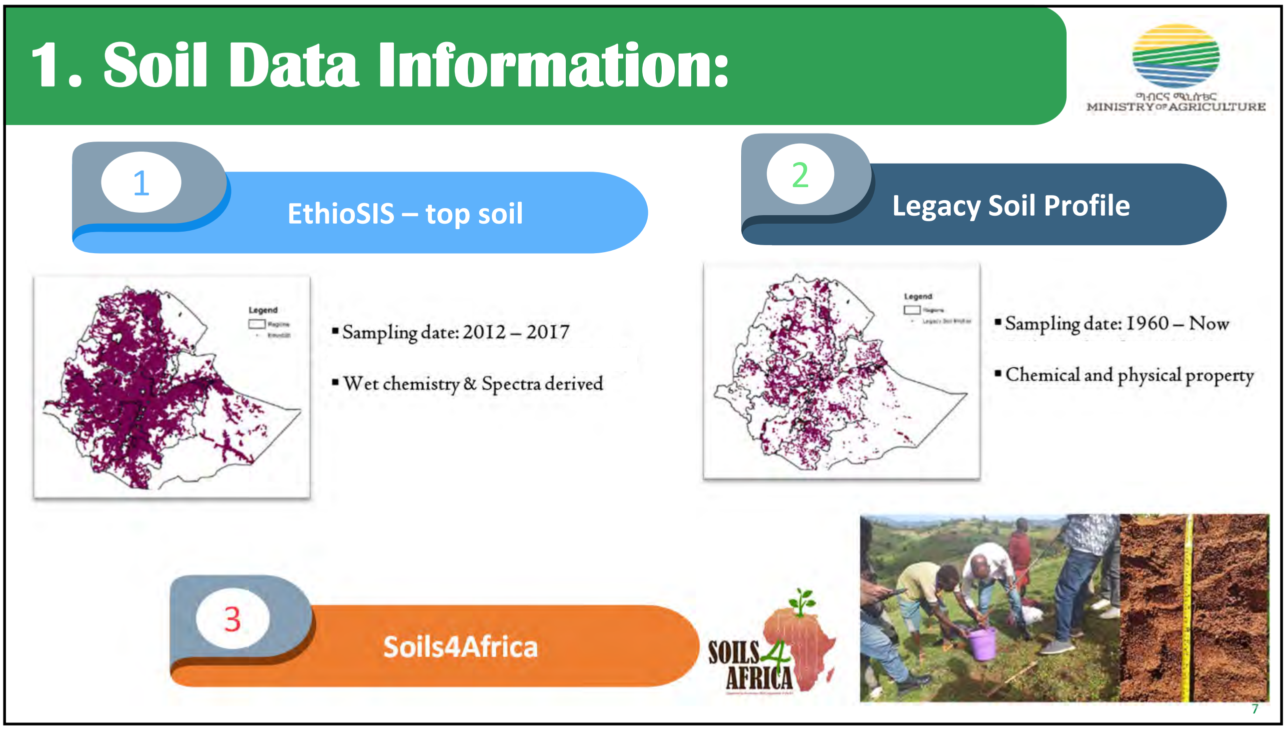


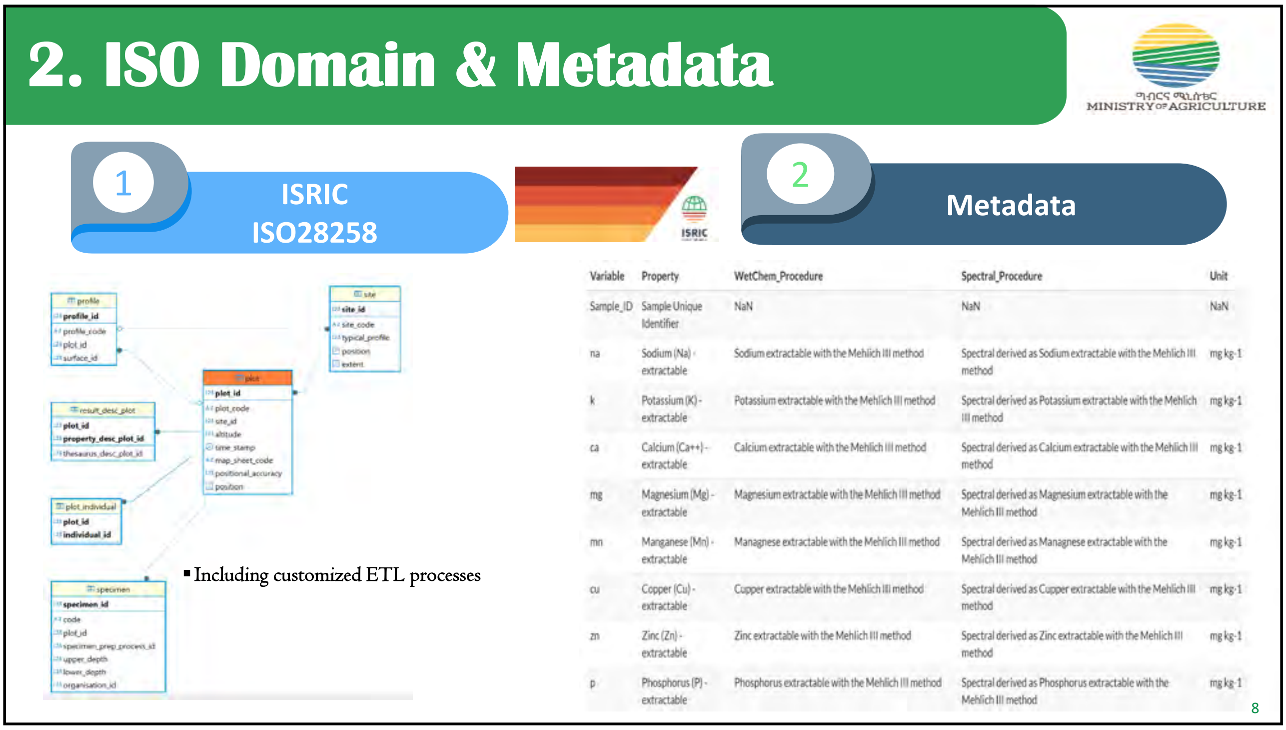

Do you STRONGLY Agree that …
MINISTRY OF AGRICULTURE
Reliable Soil Information For Soil Security
is crucial Just as
National Intelligence For National Security
For
❖ Detecting Potential Threats,
❖ Well-informed Decisions
and
❖ Targeted Actions
3


MINISTRY OF AGRICULTURE
What has been done with our partners
4

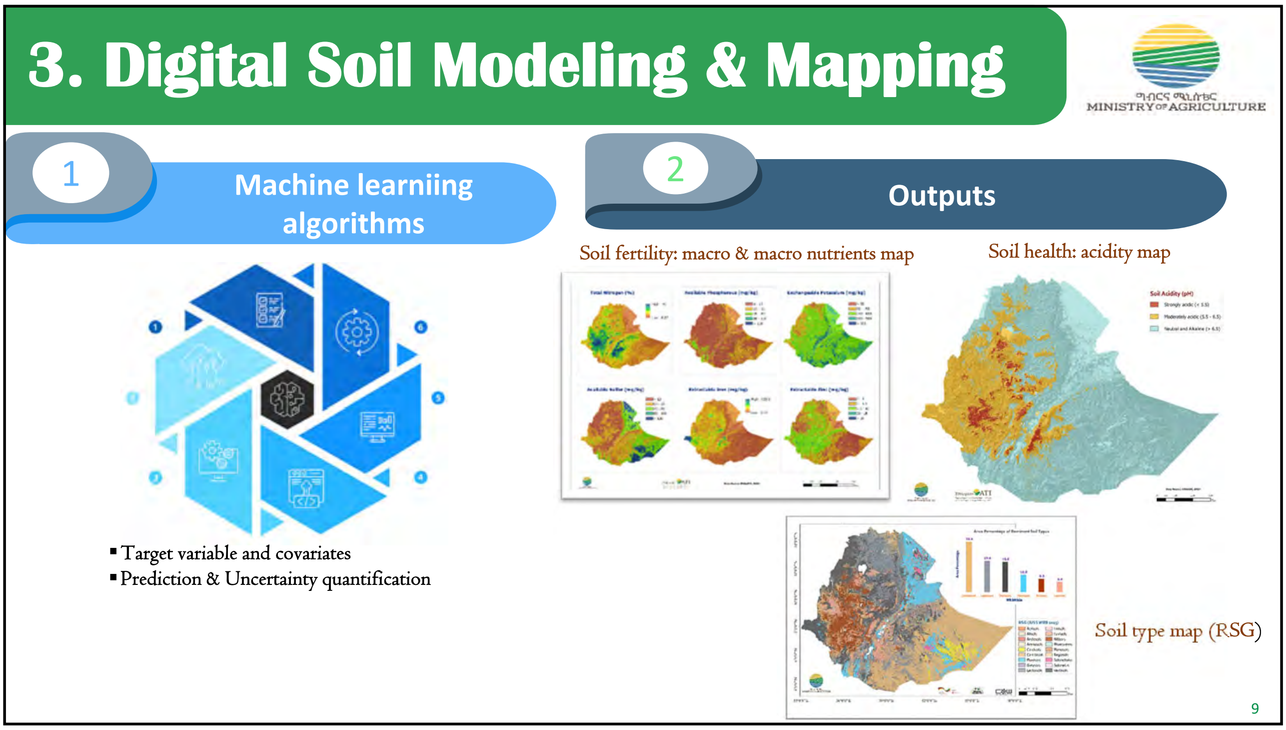

EthioNSIS – Key Milestones in Our Journey
MINISTRY OF AGRICULTURE
2021-23
▪ Digital soil type mapping
▪ Data sharing Directive approval
2024
▪ NSIS Enhancement
▪ ISO data model
▪ Soils4Africa
▪ Field Campaign
2012
▪ Launch of EthioSIS project
▪ Digital Soil fertility mapping
2017
▪ NSIS Geoportal Development
5

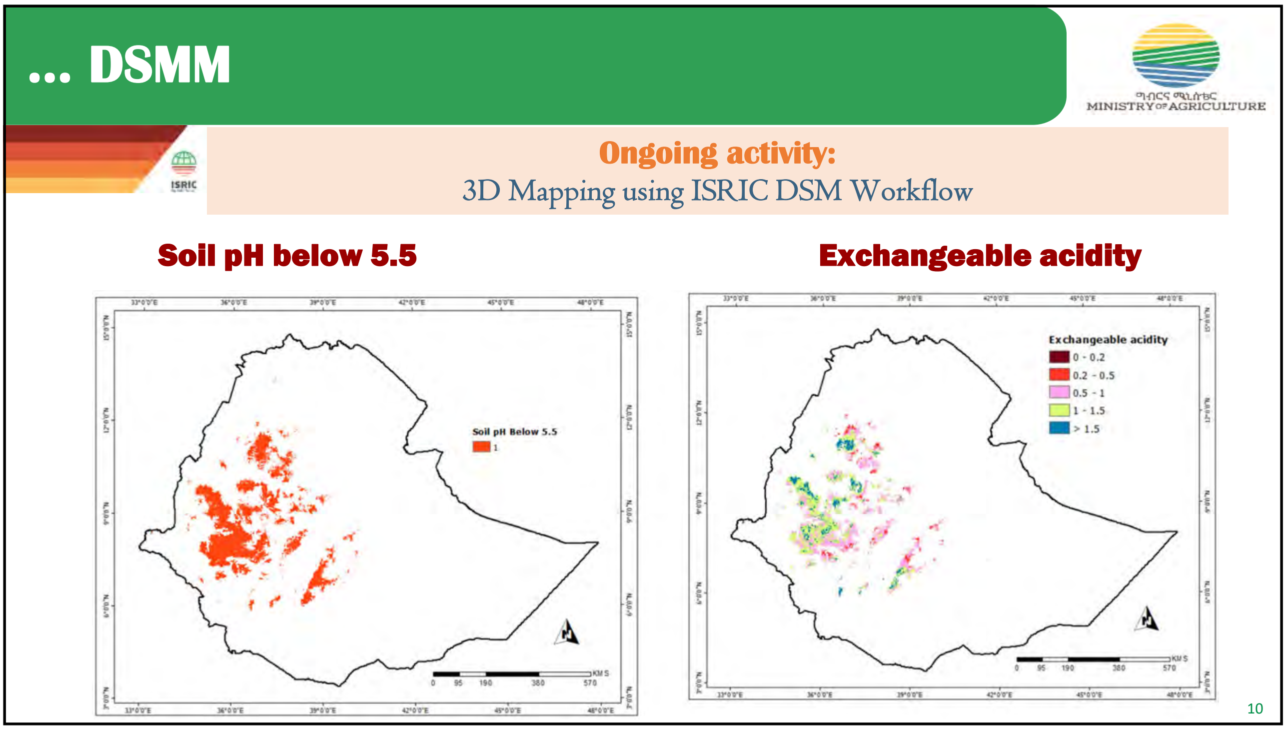

EthioNSIS – Vision & Components
MINISTRY OF AGRICULTURE
Vision
1
Africa's Benchmark
in a
Compressive & Reliable Digital Soil Information Systems
Goal
2
Enhanced Quality, Accessibility & Usability of Digital Soil Information
for Sustainable Agriculture & Food Systems Transformation
EthioNSIS as an
UMBRELLA & ANCHOR
1 Standard Soil Data
2 Harmonized Methods
3 ICT Infra & Systems
4 Soil Data Governance
5 Modern Soil Archive
6 Human Capacity
Enhanced
NSIS
7 Partnership & Stakeholder Engagement



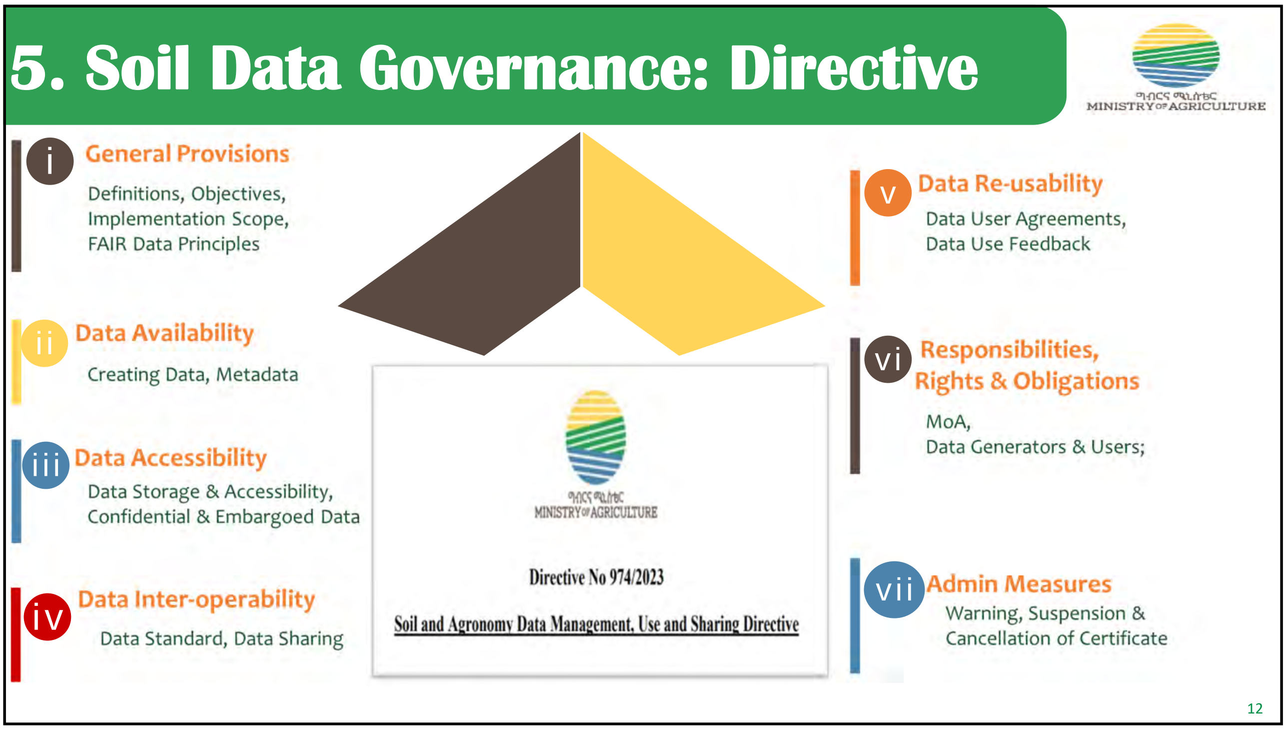


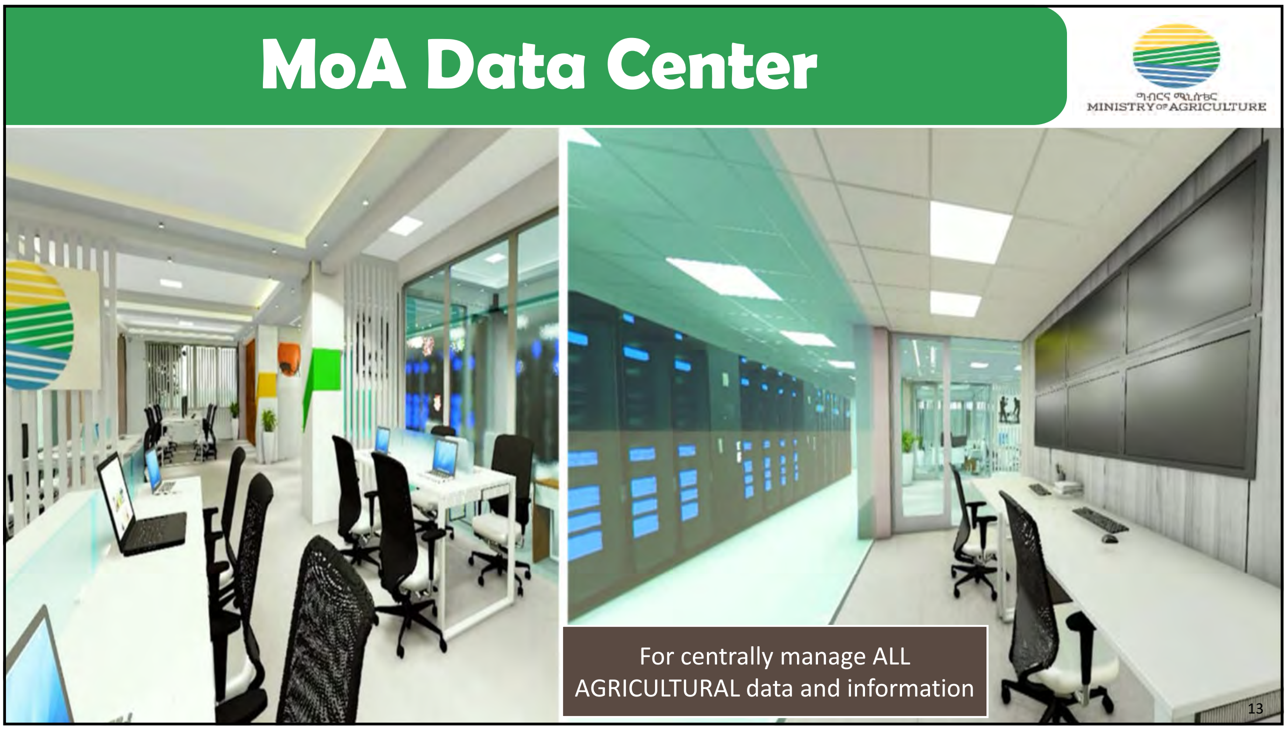
Variable	Property	WetChem_Procedure	Spectral_Procedure	Unit
Sample_ID	Sample Unique Identifier	NaN	NaN	NaN
na	Sodium (Na) - extractable	Sodium extractable with the Mehlich III method	Spectral derived as Sodium extractable with the Mehlich III method	mg kg-1
k	Potassium (K) - extractable	Potassium extractable with the Mehlich III method	Spectral derived as Potassium extractable with the Mehlich III method	mg kg-1
ca	Calcium (Ca++) - extractable	Calcium extractable with the Mehlich III method	Spectral derived as Calcium extractable with the Mehlich III method	mg kg-1
mg	Magnesium (Mg) - extractable	Magnesium extractable with the Mehlich III method	Spectral derived as Magnesium extractable with the Mehlich III method	mg kg-1
mn	Manganese (Mn) - extractable	Managnese extractable with the Mehlich III method	Spectral derived as Managnese extractable with the Mehlich III method	mg kg-1
cu	Copper (Cu) - extractable	Cupper extractable with the Mehlich III method	Spectral derived as Cupper extractable with the Mehlich III method	mg kg-1
zn	Zinc (Zn) - extractable	Zinc extractable with the Mehlich III method	Spectral derived as Zinc extractable with the Mehlich III method	mg kg-1
p	Phosphorus (P) - extractable	Phosphorus extractable with the Mehlich III method	Spectral derived as Phosphorus extractable with the Mehlich III method	mg kg-1


3. Digital Soil Modeling & Mapping
MINISTRY OF AGRICULTURE
1
Machine learniing algorithms
2
Outputs
Soil fertility: macro & macro nutrients map
Soil health: acidity map
▪ Target variable and covariates
▪ Prediction & Uncertainty quantification
Soil type map (RSG)
9


… DSMM
MINISTRY OF AGRICULTURE
ISRIC
Ongoing activity:
3D Mapping using ISRIC DSM Workflow
Soil pH below 5.5
Exchangeable acidity
Soil pH Below 5.5
1
Exchangeable acidity
0 - 0.2
0.2 - 0.5
0.5 - 1
1 - 1.5
> 1.5
10


4. Soil Geoportal
MINISTRY OF AGRICULTURE
NSIS
Data
Request
Maps
Categories
About Us
Search
admin
National Soil Information System
The National Soil Information System of Ethiopia is end-to-end automation intended to provide new capabilities for users of the system.
https://nsis.moa.gov.et/
Search
Advanced Search
Welcome to
NSIS – Geoportal
for
Soil & Geospatial Data
Access & Sharing
11


5. Soil Data Governance: Directive
MINISTRY OF AGRICULTURE
i
General Provisions
Definitions, Objectives, Implementation Scope, FAIR Data Principles
ii
Data Availability
Creating Data, Metadata
iii
Data Accessibility
Data Storage & Accessibility, Confidential & Embargoed Data
iv
Data Inter-operability
Data Standard, Data Sharing
MINISTRY OF AGRICULTURE
Directive No 974/2023
Soil and Agronomy Data Management, Use and Sharing Directive
v
Data Re-usability
Data User Agreements, Data Use Feedback
vi
Responsibilities, Rights & Obligations
MoA, Data Generators & Users;
vii
Admin Measures
Warning, Suspension & Cancellation of Certificate
12


MoA Data Center
MINISTRY OF AGRICULTURE
For centrally manage ALL AGRICULTURAL data and information
13


Concerted Efforts: Stakeholders & Partners
MINISTRY OF AGRICULTURE
Partners
Stakeholder engagement
Government institutions
Knowledge partners
Funding organization

Ethiopian ATI
ISRIC
IFDC
USAID
BILL & MELINDA GATES foundation
CABI
CIMMYT
Acatech TECHNOLOGY
BENEFIT REALISE
14

MINISTRY OF AGRICULTURE

What we aspire to...

15

AFSH-2024 Summit: Soil Info System

MINISTRY OF AGRICULTURE

1 Declaration

Enhance a digital information system to operationalize fertilizer, crop and climate decision support tools on soil management at national, regional and continental levels

2 SIA Framework

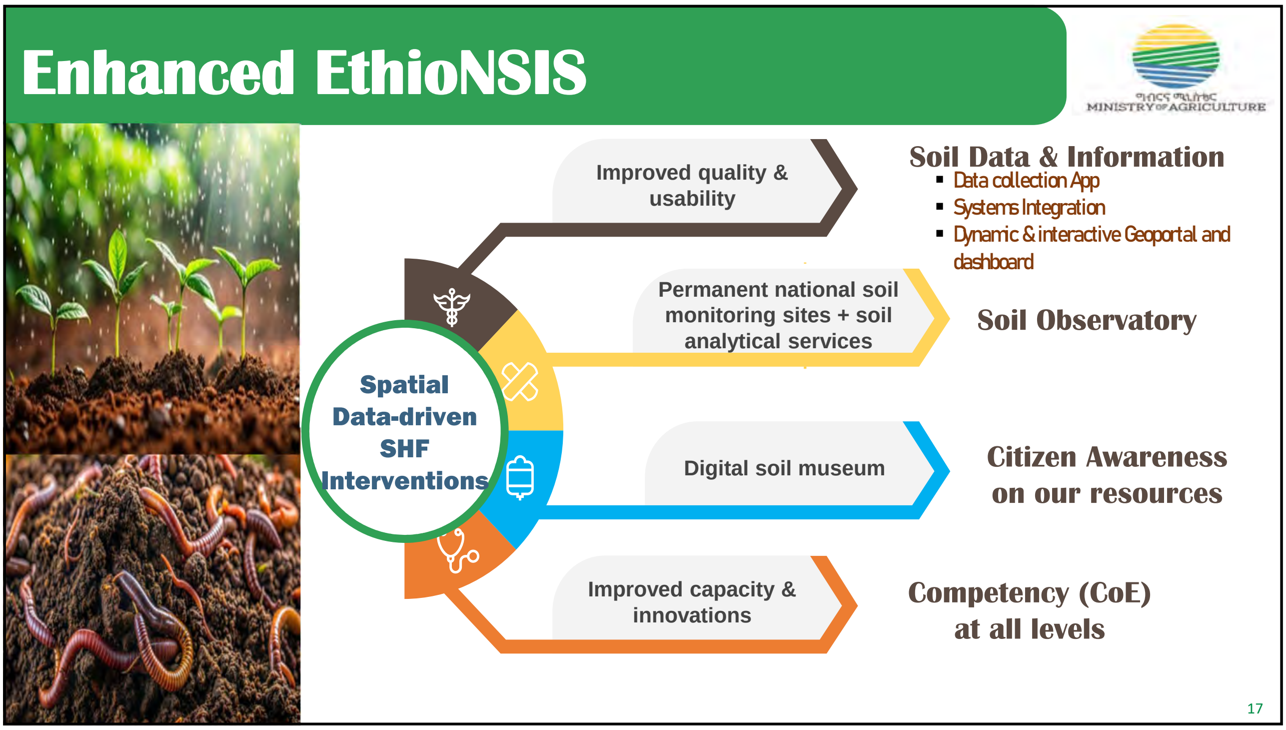
Priority Area 3: Optimize data and information for effective planning and monitoring

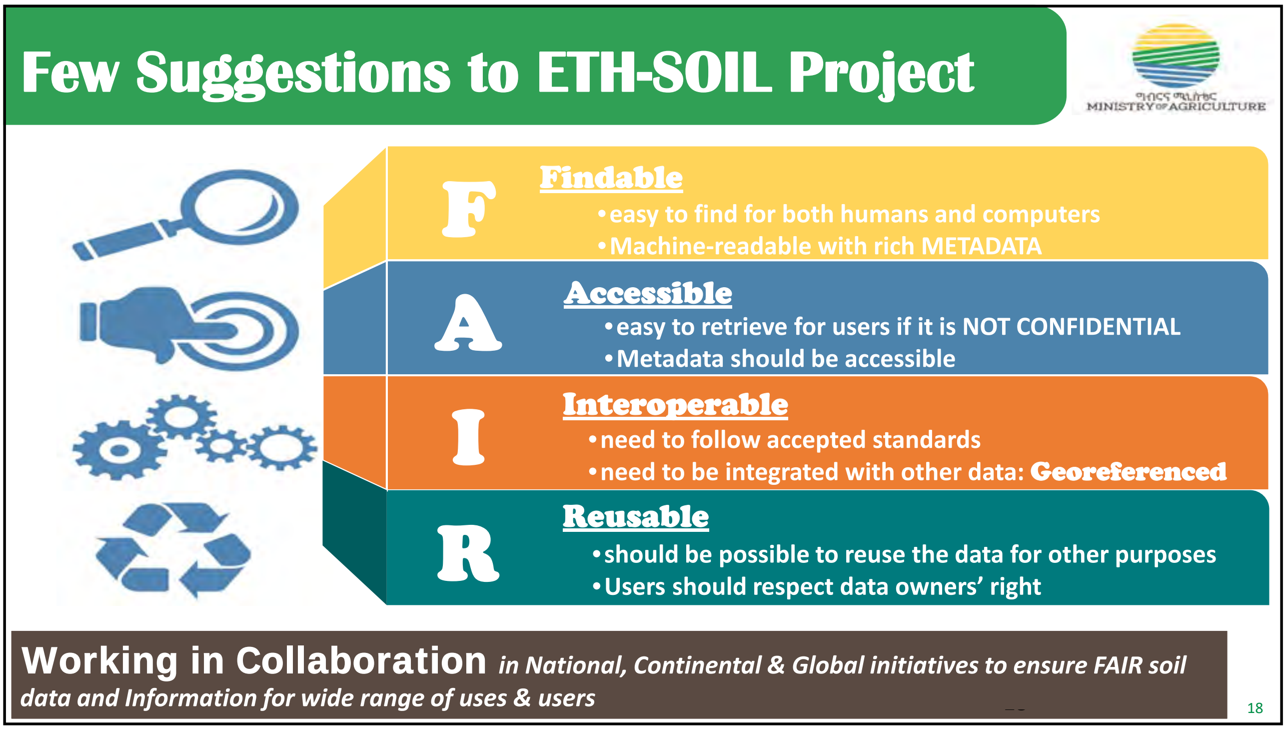
3 Action Plan

- Enhance **soil Information Systems** for evidence-based decision support
- enhance capacities of countries in soil and fertilizer analysis and soil mapping and monitoring

16

10.8 Introduction of NSIS Portal Execution, Kiflu Gudeta, SRD, Ministry of Agriculture of Ethiopia






አመሰግናለሁ
Thank You
ግብርና ሚኒስቴር
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ከማምረት በላይ | Beyond Production

ETH-SOIL

eth-soil.com

DBFZ
Deutsches Biomasseforschungszentrum
gemeinnützige GmbH

Kerstin Wilde
ETH-Soil Project Manager
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Phone: +49 (0)341 2434-112
E-Mail: info@dbfz.de
Internet: www.dbfz.de

Implemented by: DBFZ