IWMI International Water Management Institute

TECHNICAL BRIEF

Reducing soil degradation to increase resilience to climate change and strengthen livelihoods in Ethiopia

Background

Soil degradation is a major problem in Ethiopia. Depletion of soil organic matter is a cause of low agricultural productivity, as soils become less fertile and less resilient to extreme weather events, which are expected to increase with climate change. Further, this could increase the risk of crop failure and soil erosion, and soil carbon and nutrient losses. Low soil fertility is linked to poverty. Therefore, farmers need support to invest in soil conservation measures and to more effectively use organic resources, such as dung, to restore soils. If used effectively, such measures could be successful in addressing soil degradation.

Flash flooding in Halaba district, Southern Nations, Nationalities, and People's Region (SNNPR).

Research approach

Our research studies have focussed on a small number of *kebeles* in Halaba district, SNNPR. The research included collection of data at farm level on the fertility, organic matter, structure and water dynamics of soils. In addition, focus group discussions and household surveys were used to collect information on the attitudes of farmers and households. This included information on the factors influencing farmer investment in soil and water conservation measures, use of organic resources, and the relationship between soil fertility and poverty. Data collection spanned the El Ninõ event of 2015/2016, and explored the impact of the severe drought and subsequent floods which affected the area during this period. The data collected were used to drive a mathematical model which accounts for the impact of different uses of farm resources on soil organic matter, crop production, animal production, water use, fuel availability, on- and off-farm labor, and farm income and expenditure.

HAWASSA UNIVERSITY

SARI 2001

The James Hutton Institute

1495 UNIVERSITY OF ABERDEEN

Key findings

1. Productivity of soils in Ethiopia is below the potential for the region.

- Severe soil degradation is prevalent in many areas across Ethiopia, and soil productivity is far below potential for the region.
- Degraded soils are characterized by less organic matter and low carbon content, which leads to greater susceptibility to erosion, reduced fertility, and decreased capacity to capture and store water and carbon (Figure 1).

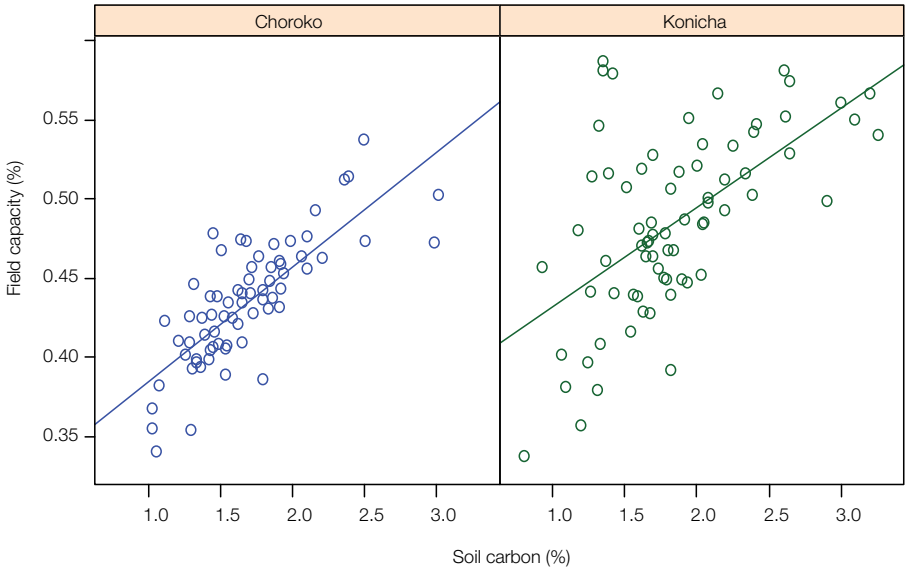

Figure 1. Field capacity is the amount of water a soil can hold after rainfall. The increased trend due to soil carbon suggests more water could be available for crops. The situation in two *kebeles* – Choroko and Konicha – in Halaba district, SNNPR, is shown.

2. Increasing number of extreme weather events affects soil fertility.

Climate change and an increase in the frequency of extreme weather events pose a significant risk to maintaining soil fertility, with increased soil erosion, and long-lasting soil carbon and nutrient losses. Our results show that in areas such as Halaba (Figure 2), soil carbon may not recover for over 10 years after extreme weather conditions, such as the El Niño event. This could lead to long-term reductions in the yields of all the major crops grown, with a 12% average reduction in production over a decade.

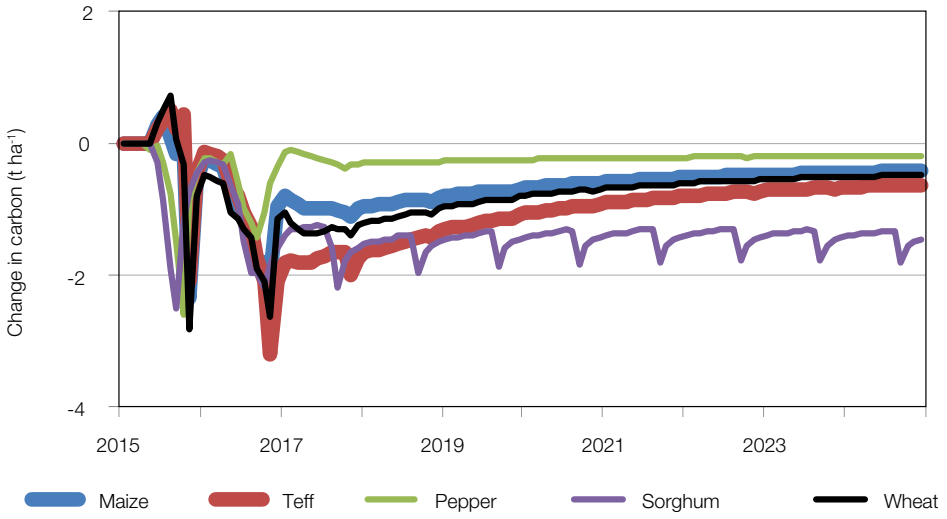

Figure 2. Impact of the El Niño event on soil carbon for major crops grown on typical soils in Halaba district, SNNPR, relative to 2014 carbon values: for simulations using real weather data 2005-2016, with soil carbon recovering very slowly after the extreme weather event.

3. Supporting livelihoods helps restore soils and the adoption of conservation measures.

Our research explored how soils and individual livelihoods interact, and the role the government agencies can play in supporting farmers to maintain and improve their soils. The research highlighted the following:

- Soil conservation measures known to help combat soil erosion have not been universally adopted or maintained by farmers. For example, engineered structures, such as soil bunds, were observed on only 50% of the farms.

- There is a clear relationship between household wealth and soil fertility, with poorer households having less fertile soils and being less likely to adopt soil conservation measures.
- Informal labor-sharing arrangements by farmers, and training and farm visits by development agents positively influenced the adoption of soil conservation and fertility practices. For example, being a member of traditional labor sharing was associated with a 50% increased chance that an additional soil and water conservation structure would be constructed by a farmer.

4. Treating manure before application enhances its effectiveness in restoring soil fertility.

Our research explored the importance of adding manure to restore soil carbon and soil properties, and how treating manure before application influences the retention of carbon. The research highlighted the following:

- Adding animal manures to the soil can reverse soil degradation. For example, if the farms in Halaba were able to apply 0.3 to 0.9 tonnes/hectare/year of manure, this would counteract the impact of the El Niño event on soil degradation.
- Treatment before application increases the retention of carbon and availability of nutrients to plants, which would significantly improve the impact on crop productivity (Figure 3).
- Relatively few farmers use available treatment methods, such as composting (Figure 4), or more capital-intensive methods, such as biogas digesters or pyrolysis.
- The availability of organic manures and other organic resources used for soil improvement is limited because households use these resources for fuel and other purposes. However, seasonal availability could also be a reason for limited access to these resources.

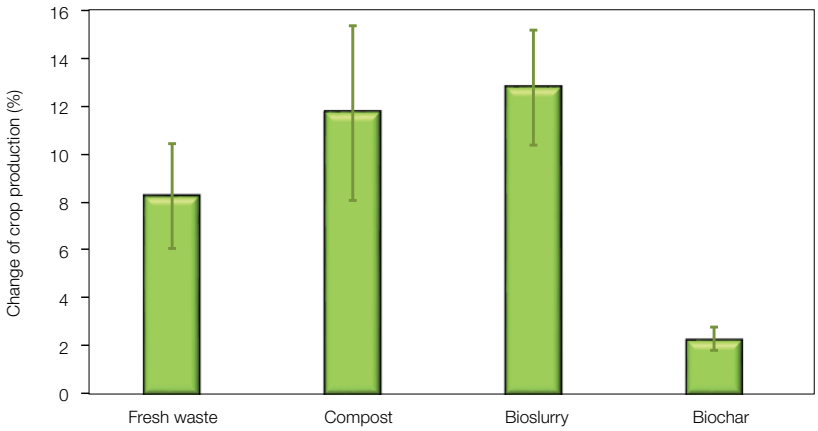

Figure 3. Simulated impacts of applying organic wastes on average yield in Halaba show that the use of bioslurry and compost provides the highest increases in crop production.

- Considering methods that serve dual purposes of providing household energy and producing organic fertilizers could allow household energy demands to be met while also improving the soil.
- Biogas digesters produce a nutrient-rich organic fertilizer as well as a clean household fuel. However, households need to have sufficient funds to invest in the digester (USD 500-2,000, depending on the design), and water (around 40 liters per day) to feed the digester.
- Pyrolysis cookstoves are cheaper (less than USD 50) and do not require water. They produce a recalcitrant organic fertilizer (biochar), but important nitrogen is lost during the process. However, if biochar is used to soak up animal urine that would otherwise be lost, an effective organic fertilizer could be produced.

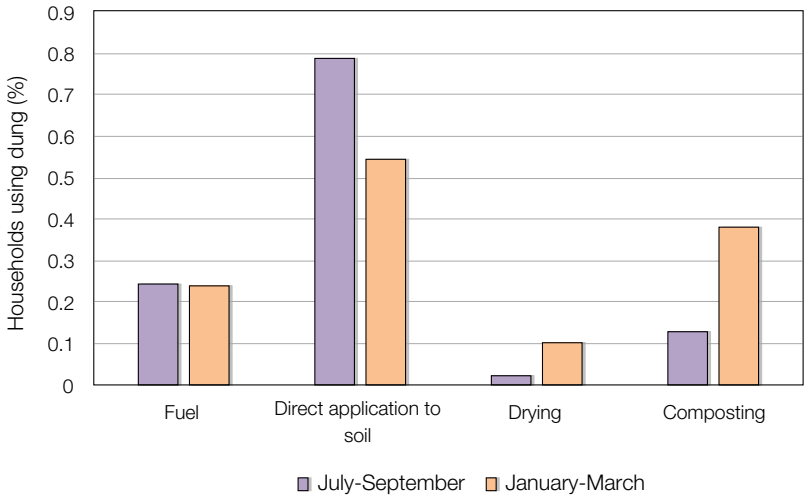

Figure 4. Use of dung by households in two *kebeles* in Halaba district, SNNPR. This shows that the direct application of dung to soil is the most common practice, with the use of dung for fuel also being significant.

Recommendations

- There needs to be more focus on maintaining and improving soil quality by increasing the organic matter content of soils, and highlighting the importance of this when providing agronomic advice.
- Investment in soil management practices that improve soil quality should be recognized as having a poverty and gender dimension, with incentives and other support measures targeted at the most vulnerable groups.
- The incentives for investment in, and maintenance of, medium- and long-term soil conservation measures by farmers need to be strengthened.
- Promote the use of organic resources for soil improvement over other uses. Alternative sustainable household energy sources should be further promoted.
- The evidence for improved effectiveness of organic manure after composting and other treatment methods should be reinforced, where possible drawing on participatory approaches with farmers in addition to extension and education.

Acknowledgements

The research on soils, ecosystems, organic resources and livelihoods has been conducted over the last 5 years (2013-2018) by a team of scientists from Hawassa University (Ethiopia), Southern Agricultural Research Institute (SARI) (Ethiopia), International Water Management Institute (IWMI) (Ethiopia), The James Hutton Institute (UK) and the University of Aberdeen (UK). The researchers gratefully acknowledge support from various UK government agencies: Department for International Development (DFID), Economic and Social Research Council (ESRC), and Natural Environment Research Council (NERC). Specifically, the *Alternative carbon investments in ecosystems for poverty alleviation* (ALTER) project funded by the NERC-DFID-ESRC Ecosystem Services for Poverty Alleviation (ESPA) program (Grant: NE/K010425-1), the *Building Resilience in Ethiopia's Awassa region to Drought* (BREAD) project funded by the DFID-NERC El Niño program (Grant: NE/P004830/1), and the *Improving organic resource use in rural Ethiopia* (IPORE) funded by ESRC and NEXUS Network (Grant: ES/P002501/1).

Contacts

Hawassa University: Tewodros Tefera (teferatewodros@yahoo.com); **International Water Management Institute:** Wolde Mekuria Bori (w.bori@cgiar.org); **The James Hutton Institute:** Helaina Black (helaina.black@hutton.ac.uk); **Southern Agricultural Research Institute:** Getahun Yakob (getahunyakob@gmail.com); **University of Aberdeen:** Jo Smith (jo.smith@abdn.ac.uk), Euan Phimister (e.phimister@abdn.ac.uk).

The International Water Management Institute (IWMI) is a non-profit, scientific research organization focusing on the sustainable use of water and land resources in developing countries. IWMI works in partnership with governments, civil society and the private sector to develop scalable agricultural water management solutions that have a real impact on poverty reduction, food security and ecosystem health. Headquartered in Colombo, Sri Lanka, with regional offices across Asia and Africa, IWMI is a CGIAR Research Center and leads the CGIAR Research Program on Water, Land and Ecosystems (WLE).

IWMI International Water Management Institute

IWMI is a CGIAR Research Center and leads the: CGIAR RESEARCH PROGRAM ON Water, Land and Ecosystems

International Water Management Institute (IWMI)
127 Sunil Mawatha, Pelawatte, Battaramulla, Sri Lanka
Mailing Address:
PO Box 2075, Colombo, Sri Lanka
Tel: +94-11 2880000 Fax: +94-11 2786854 E-mail: iwmi@cgiar.org
Web: www.iwmi.org

Printed: June 2019