Policy Studies Institute(PSI)

Sentinel

Social and Environmental Trade-Offs in African Agriculture

# COMPILED POLICY BRIEFS

May 2022

# Social and Environmental Trade-offs in African Agriculture (SENTINEL)

SENTINEL is an interdisciplinary research project seeking to address the challenges of achieving Sustainable Development Goal (SDG) 2 (Zero hunger), SDG 10 (reducing inequalities) and SDG 15 (conserving ecosystem) in Sab-Saharan Africa (SSA). Over four years, the project aims to co-create knowledge on the impacts, risks, and trade-offs within and between social, economic and environmental dimensions of different agricultural development pathways that relate to SDG 2, 10 and 15. That knowledge will help governments and policy makers to make better-informed decisions about land use and agricultural practices so that food security can be achieved without losing precious biodiversity and without worsening inequality. As an integral part of this research agenda, the Program will build the capacity of both African and UK research organizations to design and deliver high quality, relevant research related to this major challenge both during and beyond the lifespan of the program. The Program focuses on three countries in SSA – Ethiopia, Ghana and Zambia. The program will conduct research and build research capacity under the following major themes: (i) Understanding the past and present - historical trends and current status of agricultural development and its social and environmental impacts, and the major technical, institutional, political and economic determinants; (ii) Building scenarios of future agriculture and land use change: Driving forces that will shape the future of agricultural development; & (iii) Understanding impacts, risks and assumptions and trade-offs: within and between socio-economic and environmental dimensions of alternative scenarios for agricultural development, and the implications for biodiversity loss and ecosystem processes, and for the productivity and resilience of agriculture.

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# Social and Environmental Trade-offs in African Agriculture

## Vision and Objectives

Achieving SDG2 (zero hunger) and SDG15 (ecosystem conservation) in a context of rapid population growth and economic development—and doing so without increasing inequalities (SDG10) —is a major challenge for sub-Saharan Africa (SSA). To address this, decision-making and advocacy need much better information on a number of poorly understood impacts, risks and trade-offs relating to the socio-economic and environmental dimensions of different agricultural development pathways, particularly in light of projected regional changes in climate. Understanding these different dimensions and their interactions requires information about the role of environmental and socio-economic factors that shape agricultural intensification and expansion, as well as the impacts of expansion on the wider environment and its ability to support productive agriculture. In particular, the role of biodiversity (including agro-biodiversity) in delivering vital ecosystem services to people and agriculture needs to be better understood in the context of African food production. Research to date has tended to address these dimensions in isolation, and it is now critical to integrate research efforts across relevant disciplines. As an integral part of this research agenda, the Programme will build the capacity of both African and UK research organisations to design and deliver high quality, relevant research related to this major challenge both during and beyond the lifespan of the programme. The Programme focuses on three countries in SSA – Ethiopia, Ghana and Zambia. It will also have wider impact by working with RUFORUM, a major African university network, and through new partnerships and joint proposals between UK and African partners. Stakeholders at country level include both decision makers and those who can influence decisions in government, business, academia, and civil society. Our Theory of Change (see Pathways to Impact) shows the route to realising this vision from the three Programme objectives on knowledge, capacity and relationships, and how this will contribute to sustainable development. Our interdisciplinary research team spanning agricultural, social and environmental sciences will conduct research and build research capacity under the following major themes:

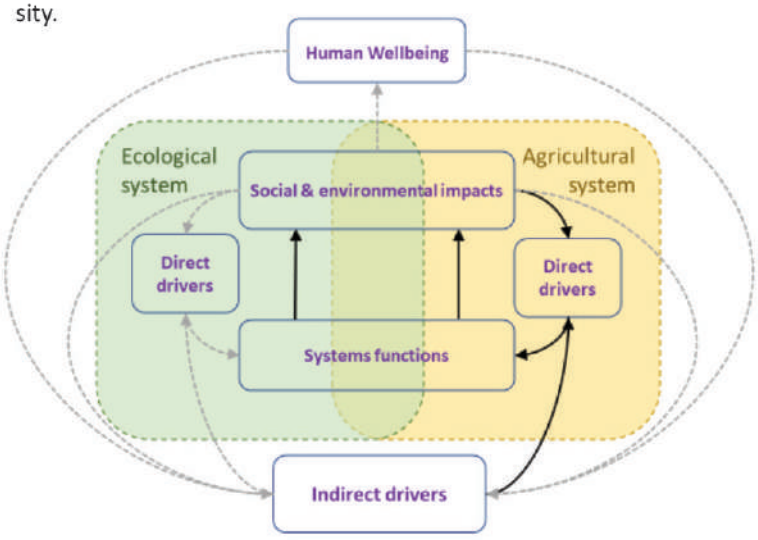
1. Understanding the past and present: Historical trends and current status of agricultural development and its social and environmental impacts, and the major technical, institutional, political and economic determinants;
2. Scenarios of future agriculture and land use change: Driving forces that will shape the future of agricultural development - identifying key impacts, risks and trade-offs within and between socioeconomic and environmental dimensions and plausible alternative scenarios that warrant further investigation;
3. Understanding impacts, risks and assumptions and trade-offs: within and between socio-economic and environmental dimensions of alternative scenarios for agricultural development, and the implications for biodiversity loss and ecosystem processes, and for the productivity and resilience of agriculture.

Development Challenges

Meeting projected increases in food demand while maintaining the health and resilience of agricultural and natural ecosystems is one of the greatest challenges facing Developing Countries

in SSA. Indeed, the significance of this challenge extends far beyond Africa as failure to meet food demands and environmental degradation can be a strong driver of political instability worldwide. This challenge relates very directly to the United Nations Sustainable Development Goals - in particular goals 2, 10 and 15 (themes 1, 7 and 11 of this RCUK call) - and the priorities of the UKAID strategy, including social and gender inequality. SDG 2 aims to achieve food security by 2030, end malnutrition by 2025, double the agricultural productivity of small-scale food producers, ensure sustainable and resilient food production systems and maintain agrobiodiversity. In SSA, growing concerns over the sustainability of food production systems related to degradation of the region's relatively fragile soils and loss of agrobiodiversity are compounded by climate change, which is expected to reduce yields of some key crops – notably maize - by up to 50% in some areas. Vision: Decision makers and other stakeholders in SSA engage effectively with research organisations to design, co-produce and use state-of-the-art research on the impacts, risks and trade-offs within and between social, economic and environmental dimensions of agricultural development with a focus on SDGs 2, 10 and 15. ESRC Reference: ES/P011306/1 Page 1 of 10 Case For Support Case for Support: Social and Environmental Trade-offs for African Agriculture At the same time, food demand is growing rapidly due to population growth and economic development, e.g. the International Food Policy Research Institute's IMPACT model predicts that total demand for cereals in SSA in 2050 will be 2.5x that of 20141 .

Historically, most countries in SSA have increased food crop production more through increasing the cropped area than increasing crop yield, in contrast to Asia, where most of the increase in food production has been achieved through increasing yield per hectare2,3 . SDG15 calls on countries to protect and restore terrestrial ecosystems and their services with specific targets to halt deforestation and loss of biodiversity.




**conceptual model of the Sentinel project**

A number of countries in SSA are defining ambitious targets to reduce deforestation under other international agreements and programmes – notably the Bonn Challenge for Forest Landscape Restoration and the New York Declaration on Forests. However, efforts to address SDG2 and SDG15 are clearly on collision course because agricultural expansion is the main threat to forest conservation, with around 75% of 33 m ha forest lost from 2000 to 2010 caused by conversion of forest to agriculture4 . Moreover, loss of biodiversity and associated ecosystem functions and services (e.g. soil formation, carbon storage, pollination, pest control, rainfall cycles, etc.) will ultimately impinge on the ability of African ecosystems to support productive and resilient food systems5,6 .

There is a long history in SSA of technocrats making unrealistic assumptions about the extent of social and environmental benefits of investments in agricultural development and environmental protection, and under-estimating risks. On the social side there is growing evidence in Developing Countries of negative social impacts from agricultural intensification7 and environmental protection8 particularly on poorer, more vulnerable men, women and children. In terms of environmental risk, targets to substantially increase agricultural production per unit area through "sustainable intensification" (SI), such as Ethiopia's target to increase cereal yield by 47% over the period 2016-20, raise concerns that SI may be ecologically unsustainable and may actually increase pressures to expand into natural forest as the profitability of cereal production increases9 .

The weaknesses of existing policy and planning processes in recognizing and effectively managing the impacts, risks and trade-offs inherent in agricultural development is a matter not only of lack of key information, but also weaknesses in institutional and governance arrangements that constrain dissemination and use of information within countries. Common challenges including sectoral silos, disconnects between local, regional and national levels of government, weak accountability in policy implementation, and weak relationships between research organisations (both in UK and Africa), and with research users. These weaknesses in institutions and governance arrangements reflect deeper structural challenges related to the rule of law, incentives, and powerful interests and narratives that shape discourse. Such challenges must be better understood if the major risks and trade-offs that are the focus of this programme are to be effectively and equitably managed.

This Programme of research and capacity building seeks to address SDGs 2 and 15, and themes 1, 7 and 11 .

Sentinel
Social and Environmental Trade-Offs in African Agriculture

Policy Brief
October 2021

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# Unpicking the socioecological drivers and impacts of agricultural expansion in Ethiopia

Given Ethiopia's increasing reliance on agriculture as a mainstay of livelihoods, agricultural expansion is inevitable. This briefing explores the main agents, drivers and implications – and why policies must balance the trade-offs between the competing objectives of food security, limiting biodiversity loss and protecting social equality.

## Agricultural expansion

The agricultural sector has been an important contributor to Ethiopia's economic growth over several decades and will likely continue to be a key driver of future development. The government has long recognised the importance of transforming agriculture to achieve stability and long-term growth. In the 1990s, the government launched its Agricultural Development-Led Industrialization strategy (ADLI). The strategy puts increased productivity, production and product quality in farming at the heart of its economic development plans.

Photo: Agricultural practices (farming, grazing) and establishing settlements within forested areas. Credit: PSI/Sentinel

### Summary

In Ethiopia, a rapidly growing population, widespread poverty, unemployment, low agricultural productivity and a lack of alternative income sources mean that rural people often expand agricultural land into forested areas, leading to loss of ecosystem services. There is an urgent need for policymakers to strike a balance between increasing food production to meet rising food demand and reduce poverty while meeting conservation objectives. This includes addressing low agricultural productivity and increasing support for research, technological development, extension services and capacity building.

### Background

This policy brief is based on fieldwork findings from reconnaissance surveys in Ethiopia conducted in July 2019 as part of the Sentinel project. The surveys involved a rapid assessment of the socioeconomic and environmental impacts of agriculture across seven communities in Ethiopia.

Partners: Copperbelt University; Policy Studies Institute (PSI); University of Ghana; University of Greenwich NRI Natural Resources Institute; Imperial College London; iied; eci University of Oxford; University of Reading; RUFORUM; UCL

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Agriculture accounts for over a third of GDP, and around three-quarters of the economically active population is engaged in agricultural production.[1] Agricultural production has increased significantly, with increases in agricultural GDP averaging 6.5% per year between 2005/06 and 2018/19, even while agriculture's share in total GDP has fallen. Land area expansion is known to be the primary contributor to increases in agricultural GDP during this period. In more recent years, rising crop yields coupled with continuing agricultural area expansion has contributed to agricultural GDP growth.[2]

Over the last two decades in Ethiopia, more land has been converted from forest and woodland vegetation to produce staple crops. Agriculture is estimated to be the main driver for around 80% of deforestation worldwide, including Ethiopia.[3] Between 2001 and 2019, Ethiopia lost 410,000 hectares of tree cover. Land under cereal production has increased from 7.2 million hectares in 2000 to 10.2 million hectares in 2016. The demand for agricultural commodities is projected to increase inevitably (70–100% by 2050).[4,5,6] However, ongoing gains in crop yields are not keeping pace with population growth and increases in food demand.[7,8] As Ethiopia's agricultural policy aims to ensure domestic food security and economic growth, further expansion seems inevitable in the next decade. However, gains in agricultural production through expansion come at a cost: depleted forest habitats and biodiversity, especially around long-inhabited areas.

Expanding agricultural frontiers into forest margins may pose substantial trade-offs between economic, social and environmental outcomes with significant implications for livelihoods and ecosystem services. A key concern is to understand the economical, equity and environmental trade-offs and synergies in the context of achieving food security for a rapidly growing population without posing significant damage to the environment. This corroborates the agenda of the Sustainable Development Goals (SDGs) of 'zero hunger' (SDG 2), reducing inequality (SDG 10) and conserving ecosystems (SDG 15). This is at the heart of the Sentinel project. These three SDG outcomes are not independent of each other. They interact in both positive and negative ways, creating the potential for synergies and trade-offs. Developing the agricultural sector necessitates tracking these interactions and assessing if the three competing objectives are being achieved without compromising each other's goals.

**Box 1. Background in brief – Ethiopia**

- Ethiopia is the second-most populous country in Africa, with an estimated 109.2 million people and a population growth rate of 2.5%. Ethiopia's population is expected to reach 174 million by 2050.[9]
- About 80% of the population lives in rural areas, of which over 88% inhabits the highlands, where resources are considered exhausted and environmentally degraded.
- About 25.6% of the rural population lives below the poverty line.[10]
- Cereals (teff, wheat, maize, sorghum and barley) account for more than 80% of total cultivated land and 14% of GDP.
- About 14.7% of the country's land area is covered by forest, with woodland and shrubland accounting for another 44.7%.[11]

## Drivers and agents of expansion

Agricultural expansion is a complex issue and is underpinned by a wide array of drivers. Due to the multi-scale and context-specific nature of these drivers, interventions to address them must operate across scale and contexts.[12] The main causes of agricultural expansion include high population pressure and the demand for more food, rising incomes and the demand for cash crops, low smallholder agricultural productivity and the lack of alternative income sources. Furthermore, low institutional capacity, weak natural resource governance and tenure insecurity can push small-scale farmers to move into forests and expand agricultural lands. Availability of forestland for agricultural production is also another factor that encourages expansion of agricultural land.[13] A lack of a well-defined national land-use and planning policy, strategies and guidelines further encourage agricultural expansion.

In July 2019, the Sentinel project conducted reconnaissance surveys[14] across seven communities in Ethiopia (see Figure 1). Data was gathered using a suite of rapid-assessment participatory rural appraisal tools to understand the drivers and impacts of agricultural expansion in six of the pre-selected sites, as well as the potential for future expansion and feasibility of further in-depth research. The survey findings revealed the site-level drivers of agricultural expansion the participants perceived and identified similar motives for expanding the size of crop land areas:

- Different social groups are involved in agricultural expansion into natural habitats including the rich, the moderately rich and the poor, as they aim to increase their agricultural income by expanding into additional and more fertile land.
- Population growth was cited as the key driver for increased demand for new agricultural land. Respondents also identified

other drivers, including labour mobility and migration from nearby areas, settlement processes, unemployment, and the demand for agricultural land by the landless (especially youth, and young men in particular).

- The rise in market prices for some agricultural commodities has pushed farmers to expand their agricultural land to increase crop production and productivity.
- Uncertain property and land-use rights of forested areas are also factors determining expansion into nearby forest areas.
- As livestock populations increase, the need for additional grazing areas is also causing land-use changes and putting pressure on the nearby forest.

By and large, a household's decision to expand its agricultural land rests with the head of the household. Youth and people who migrated to nearby locations were found to be key agents of expansion. We found some patterns that exist in terms of the drivers reported at site level (Figure 2).

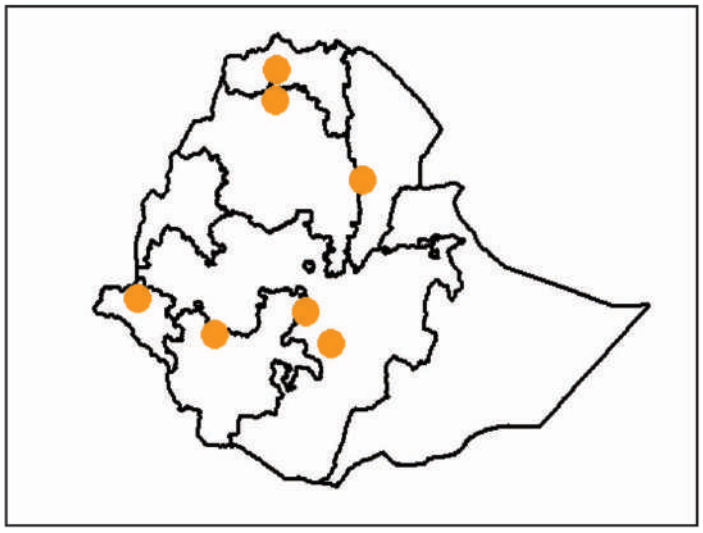

Figure 1. Map showing approximate locations of the seven study sites selected.

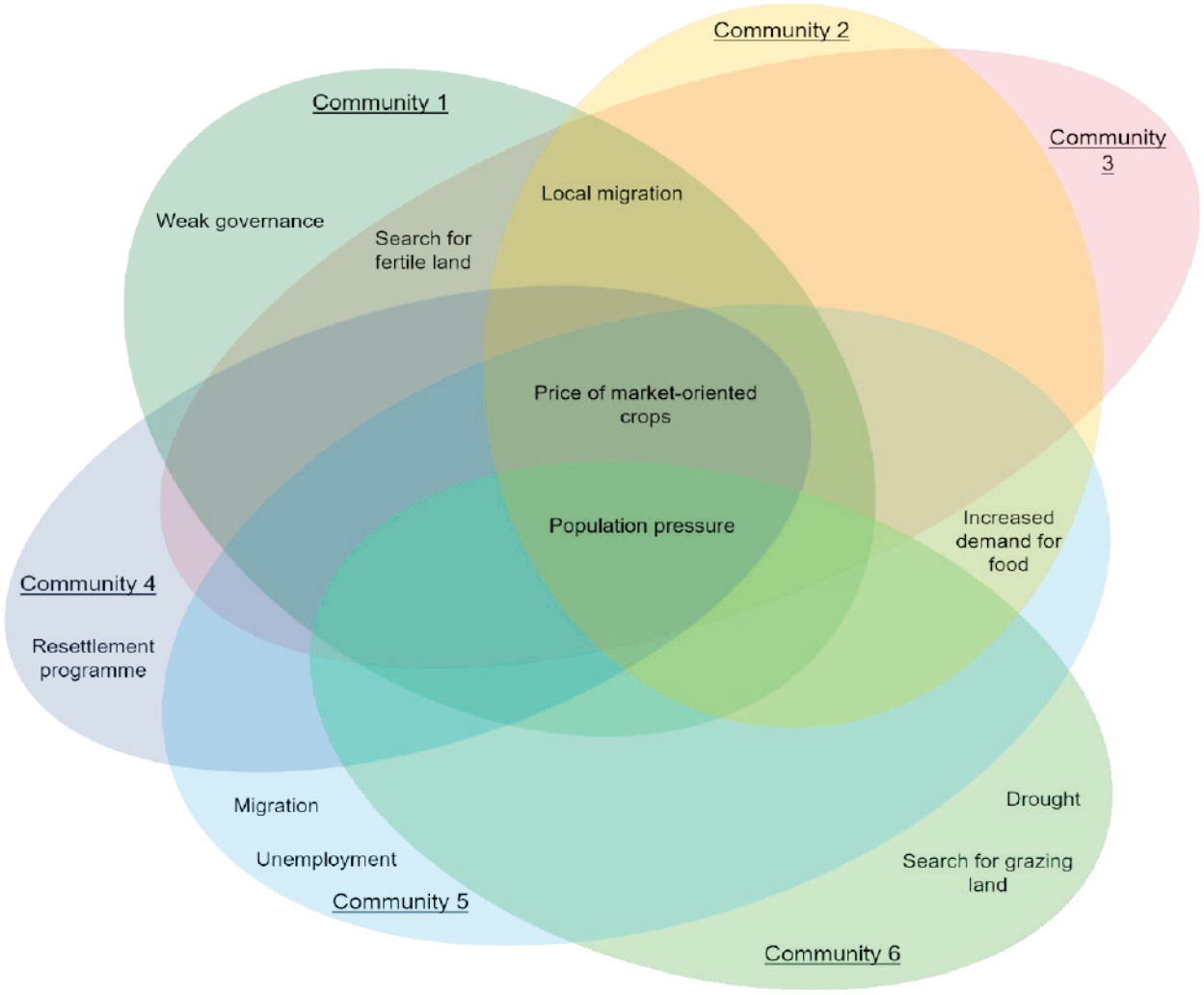


Figure 2. Perceived site-level drivers of agricultural expansion for six of the sites in Ethiopia (sites are not named in order to maintain confidentiality).

# Main impacts of agricultural expansion on people and planet

Agricultural expansion has notable social, economic and environmental influences on individual smallholder farmers and the surrounding community as a whole. Impacts of agricultural expansion are partly understood by the local communities in the six study sites in Ethiopia. Here, we present local communities' perception of the likely impacts of expansion, according to data collected during the Sentinel reconnaissance surveys.

## Socioeconomic impacts of agricultural expansion

In terms of positive socioeconomic impacts, participants reported **increased yields** and **crop diversification**. This has helped rural communities to satisfy their consumption needs, which is equally important for both improving household food security and diversifying risk. But despite these positive gains, community members also reported negative impacts of expansion into natural habitats:

- Rural communities use a variety of forest products as sources of income, including firewood, charcoal production, honey, grass or fodder and medicinal plants. If agricultural expansion into natural habitats continues unchecked, households could lose these benefits.
- Increased rate of exposure to soil erosion and households' vulnerability to flooding and drought.
- Farmers noted that rainfall is becoming unpredictable due to the changing climate, a factor which makes farming riskier.

## Environmental impacts

The localised degree of environmental impacts and land degradation is dependent on the production practices used by local farmers. All interviewed farmers reported a noticeable decline in the diversity and abundance of native species (including a decline in wild honeybee populations). This decline in native species was coupled with a rise in the reported prevalence of invasive pest species (including the fall armyworm *Spodoptera frugiperda*). Much of this species loss and environmental degradation was attributed to factors such as deforestation, land degradation and/or climate change.

All communities reported increasing incidences of flooding or drought (depending on the site), with increasingly erratic rainfall patterns. A further impact assessment of the adjacent forests/ woodlands revealed these areas to be generally highly degraded, often with extensive signs of human use and deforestation activities, and little evidence of regrowth (Figure 3).

Of natural forests adjacent to Sentinel research sites, participants scored 67% as highly degraded.


Figure 3. Extent of forest degradation according to survey participants, based on a rapid 16-point scorecard assessment method. [Green segment indicates 'not degraded'.]

## A way forward

Achieving sustainability commitments entails scaling up collective action through multi-stakeholder partnerships. Achieving SDGs 2, 10 and 15 outcomes are not independent of each other. Rather they interact in both positive and negative ways with the potential for trade-offs. In the Ethiopian context, targeting SDG 2 implies improving food access for about 36 million undernourished people. Increasing food production and ensuring food security remain the highest priorities for the Ethiopian government. As in other developing countries, the reconnaissance surveys indicate that small-scale agricultural expansion is a key factor for the loss of forest habitat and biodiversity. Given the government's national drive for food security, cropland expansion will remain a key strategy to increasing food production.

Moreover, global food demand is expected to double by 2050. Doubling food production in the next 30 years can be expected to result in the conversion of substantial areas of forests into agricultural lands, unless alternative options are in place. Thus, developing the agricultural sector will require tracking the interactions and assessing if the three competing SDG objectives are being achieved without compromising each other's goal.

Having a good understanding of the processes of agricultural expansion and tackling the different drivers of expansion operating at different scales is crucial. Policies, strategies at national level and action plans should consider all land uses in a holistic way and ensure that key objectives among the different sectors do not compete with each other. The government should play a critical role in striking a balance between increasing food production to meet the rising food demand and reduce poverty while also meeting conservation objectives.

However, relying on agricultural intensification alone as a main strategy to solve the biodiversity loss problem is no longer the way forward, unless accompanied by stronger governance of natural resources.[15,16] Policymakers at national and regional levels should start a dialogue with relevant stakeholders so that synergies can be harnessed, and all competing needs balanced. This includes addressing the agricultural sector's low productivity, through

increased support for research, technological development, extension services and capacity building to sustainably increase agricultural productivity. Local perceptions of the importance of nature should be increased, as well as improving natural resource governance and resource-use efficiency. Sustainable farming practices such as improved water management, conservation agriculture and focusing on more alternative approaches such as agroforestry practices should also be adopted. This will be crucial to halting and reversing environmental degradation.

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**Sentinel**

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Sentinel is an interdisciplinary research project seeking to address the challenge of achieving 'zero hunger' in sub-Saharan Africa, while at the same time reducing inequalities and conserving ecosystems.

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Image credits:

Front cover — Blister beetle observed during rapid ecological assessments. Credit: Adam Devenish, Imperial College London/Sentinel.

Page 5 — Farmer herding goats in one of the study sites. Credit: Adam Devenish, Imperial College London/Sentinel.

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# Determinants of farmland expansion in the forest margins in Ethiopia

Forest clearing is a severe problem in most developing nations. To date, much of the deforestation in the tropics is driven by agricultural expansion, primarily as a result of converting forestland for crop production.[1]

## Summary

Farmland expansion is considered a key rural household income strategy, but is a major cause of deforestation.[1,2]

This study found that, regardless of the sources, agricultural intensification mitigates farmland expansion.

The extent of market participation is also an important factor, showing that a market-oriented approach enhances agricultural intensification.

How farmers affect the pressure on forests through incentives on farmland expansion could also make forest conservation more efficient in the future.

## Background

Ethiopia is Africa's 2nd most populous country, with an estimated population of 119 million in 2021. Around 80% of the population rely on agriculture for their livelihood, mainly subsistence & rain-fed farming, and livestock production.

About 14.7% of the country is forested, with another 44.7% woodland & shrubland.[5]

Around 24% lived below the poverty line in 2016 – poverty is a major cause of hunger and malnutrition.[6]

Farmland expansion in the forest frontier is considered a source of household income, but contributes to forest degradation and deforestation.[2,3] This ongoing conversion and loss of natural forests have significant ecological implications, and are therefore a major global concern.

In places like Ethiopia, where forestlands are being converted to farmland at a substantial rate, addressing decisions around farmland expansion also helps to design strategies that affect new entrants and the expansion of farmlands by existing participants. Against this background, the Social and Environmental Trade-offs in African Agriculture (Sentinel) project conducted a household survey across rural communities in Ethiopia to study site-level factors that determine the probability and size of farmland expansion among farm households.

The study used household- and community-level survey data collected from three districts: Asgede-Tsimbela in Tigray region, Adiyo in the Southern Nations, Nationalities, and People's (SNNP) region, and Adaba in Oromia region. A total of 12 villages, four from each district, were selected. The total sample size was 600 households, comprising 50 from each village.

## Farmland expansion on livelihoods

### Socio-economic characteristics

The basic socio-economic characteristics of the farm households in the studied sample show that 88% are male-led, and of the remaining female-led households, only 14% are non-expanders, with 10% being expanders. The average education level of household heads ranges from 3 to 4 years, with only 55% attaining at least primary education level. The mean age of the household heads and family size in adult equivalent is 48 years and 6 respectively. About 82% of the household heads are born in the same village as where the household currently lives. While nearly one fourth of the sample households in Asegede district were born outside the village, the figures are

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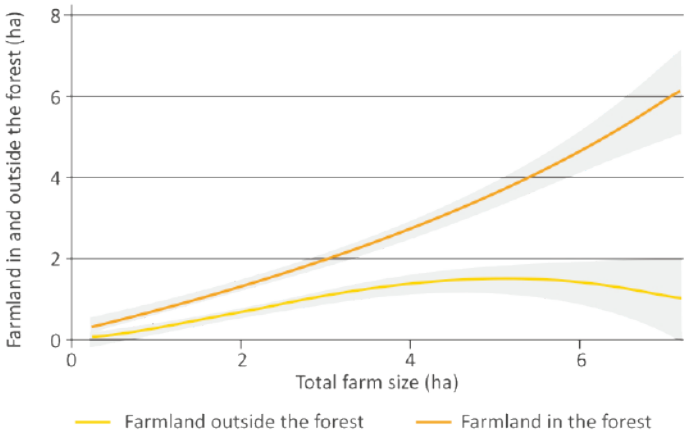
only 17% in Adiyo and 10% in Adaba. Among those born in the village, 52% of households in Adiyo and 58% in Asegede and Adaba have farmlands in the forest. However, 46%, 62% and 80% of households who were born outside the village in Asegede, Adiyo and Adaba districts respectively, have farmland in the forest.

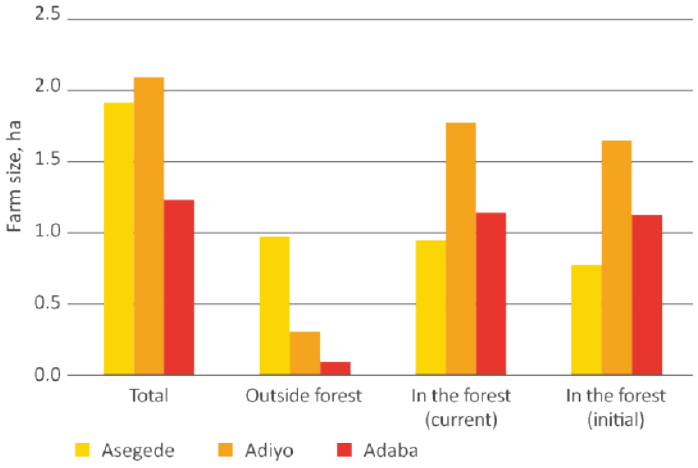
The basic description and summary statistics of variables for all households and parcels of land according to whether the households reported farmland expansion in the forest or not show that the average land size in the forest is 0.73 ha and that about 43% of the households in the study sample currently have farms in the forest. The average land size outside the forest is 0.87 ha (see Figure 1).

**Figure 1. The share of farmlands in and outside the forest area and the contribution to total farm size of the household in the study areas.**



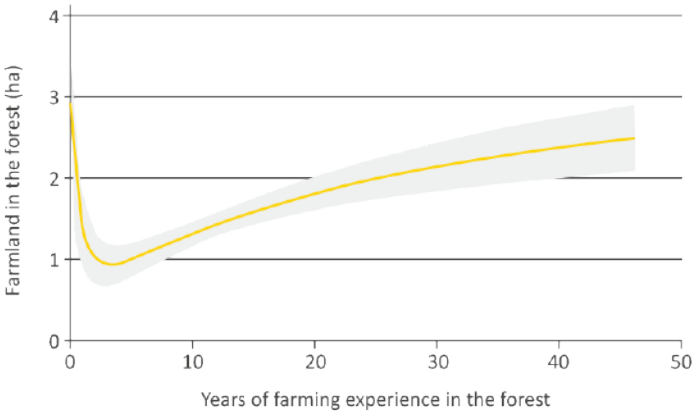

Out of the 968 parcels recorded in this study, about one-third are in the forest areas, with an average parcel size of 0.52 ha. The average farm size of the expander households is statistically higher than the farm size of the non-expander households (1.7 vs 1.4 ha). The results also reveal that the conversion of forestland to farmland is higher in Adiyo *and* Adaba than in Asegede (see Figure 2).

**Figure 2. Farm size in and outside the forest for Adaba, Adiyo and Asegede districts**




The average number of years of farming in the forest is about 15 years, ranging from 1 to 46 years, with 21 years being the average number of years of farming experience. There is also dynamism in farmland expansion in the forest. The initial average farm size in the forest five years ago was 0.67 ha, which has now increased to 0.73 ha. However, Figure 3 shows the positive correlation between years of expansion and average farm area in the forest. Without implying any causal relationship, the average farm size in the forest was higher in the past than during recent times. Moreover, when comparing the initial and current farm size in the forest, we observed that 22% of the expanders have decreased the farm size in the forest, 40% of the expanders have increased the size, and the remaining 38% households maintain the same farm size in the forest. Moreover, the rate at which households expand the initial farmland in the forest (0.74 to 1.79 ha) is higher than the rate at which farm size declines (2.65 to 1.36 ha).

**Figure 3. Farming experience vs farm size in the forest for the expander households**




## Findings: determinants of agricultural expansion

Agricultural expansion is a complex issue and is underpinned by a wide array of drivers. Due to the multi-scale and context-specific nature of these drivers, interventions to address them must operate across scale and contexts.[7] A review of the literature indicates that several factors (such as high population pressure, rising incomes and the demand for cash crops, low smallholder agricultural productivity and the lack of alternative income sources, access to services (such as extension services), proximity to recently expanded land, low institutional capacity, and weak natural resource governance and tenure insecurity) from different perspectives, are responsible for instigating extensive agricultural practice through expanding the size of crop and ranchland areas. Much of the literature on agricultural expansion has thus far focused on the international and cross-regional drivers of agricultural expansion, with far less attention

paid to the small-scale agricultural expansion in a specific context. However, the motives of the expansion vary from context to context, and it is against this background that the Sentinel project conducted a household survey across six communities in Ethiopia to study site-level factors that determine this expansion. The survey findings revealed key important site-level determinants of agricultural expansion:

1. **Markets:** market forces have been an important factor affecting agricultural expansion. Market orientation has a positive and significant effect on the likelihood of farmland expansion; however, the size of the farmland expansion in the forest areas decreases with agricultural commercialisation, once decisions around farmland expansion have been made. A 1% increase in the share of marketed output increases the probability of farmland expansion by about 3%, but decreases the size of farmland in the forest by 1%. This demonstrates that farmers participating in a commercialised production system respond to market signals in an effort to maximise profit and encourage entry into the forest to farm smaller sized farm plots.
2. **Adoption of farm technologies:** the adoption of a combination of farm technologies pushes the farm household's entry into farming in the forest; but, conditional on participation in farmland expansion, the technology intensity index is less likely to influence the household's decision to expand its farm size into the forest. This is likely because adoption of different types of agricultural technologies enhances agricultural productivity in smaller plots.
3. **Agricultural intensification:** through the adoption of more yield-increasing and resource-conserving agricultural technologies, agricultural intensification is likely to increase production per unit area and hence reduce the pressure on forests.
4. **Initial farm size in the forest:** this has a significant and positive effect on the current size of farmland expansion. The result indicates that a unit increase in farmland size in the forest in the initial period increases the current farmland expansion size by about 10%.
5. **Distance to forest:** households near to the forest are more likely to engage in farmland expansion in the forest than farmers further away. This might be because of increased transaction costs when the forest is far away, particularly the cost of transporting bulky materials/inputs when farming.[8] The data shows that expanders' residences are a significantly shorter distance from the forest (about 20 minutes' walking distance) than the residences of non-expanders (walking distance of 37 minutes).
6. **Household wealth:** better asset holding and livestock ownership positively encourage farm households to increase farmland expansion in the forest. Less wealthy (low asset and livestock ownership) farmers are less likely to make on-farm changes, some of which require capital for inputs, due to budget constraints.[9] This is probably because wealthier farmers may have the opportunity to overcome liquidity constraints to implement improved technologies and increased capacity to purchase external inputs and may be more able to take risks and hence demand more farmland in the forest.

## The way forward

The results suggest that agricultural intensification through the adoption of multiple yield-enhancing and resource-conserving technologies and market-oriented production may contribute to land sparing and avoid deforestation. Thus, based on the results, we propose a few pointers for policy:

- The strengthening of market-oriented production approaches, intensive engagement of research & extension systems on the development & diffusion of market preferred products, institutional innovations to alleviate both fixed and variable costs of accessing markets through improved information and transportation infrastructure, and deeper participation of marketing cooperatives and the private sector are crucial.
- A framework for decision making for policy makers and other development practitioners to promote investment in research and development, and the introduction of a number of different technologies (such as new and better crop varieties and resource management practices, and improved crop protection) so as to enhance household food security, are recommended.

## Acknowledgments

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About this brief

This brief is based on results from: Teklewold, H and Gebrehiwot, T (forthcoming). Understanding the impact of farmland expansion on rural household's livelihoods: Empirical evidence from Ethiopia.

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Sentinel
Social and Environmental Trade-Offs in African Agriculture

Policy Brief
March 2022

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# Understanding the impact of farmland expansion on rural households' livelihoods: empirical evidence from Ethiopia

**Ethiopia is highly dependent on agriculture for economic growth, with farmland expansion and intensification being part of the country's growth and transformation strategies to increase agricultural production and meet the rising demand for food.[1]**

Driven by necessity and the desire to improve their lives, smallholder farmers in Ethiopia continue to expand their fields into natural habitats, such as forests and grasslands. The short-term benefits are obvious – more land to cultivate and more crops for consumption or sale. But what are the long-term consequences for the livelihoods of rural people? What are the synergies and trade-offs among the forest- and non-forest-based livelihood options in the context of farmland expansion?

The Social and Environmental Trade-offs in African Agriculture (Sentinel) project conducted a study to examine the impact of farmland expansion on household incomes from crop, livestock, non-farm and forest-based livelihood sources. This policy brief shares findings around four important questions that are salient to the farmland expansion debate:

- How do the incomes from non-forest- and forest-based livelihood options differ between expanding and non-expanding farm households?
- How do the different incomes change if we control factors that influence farmland expansion and the income outcomes?
- What are the impacts of agricultural expansion across time scales? Who benefits or loses, and why?
- How might agricultural expansion affect food security?

The study is based on household- and community-level survey data collected from three districts in Ethiopia: Asgede-Tsimbela in Tigray region, Adiyo in the Southern Nations, Nationalities, and People's (SNNP) region, and Adaba in Oromia region. A total of 12 villages, four from each district, were selected. The total sample size was 600 households, comprising 50 from each village. The survey was conducted between April and June 2020, using structured questionnaires administered by trained enumerators who could speak the local language of the study areas. We also conducted a focus group discussion (FGD) across six communities to study the impact of farmland expansion on household incomes from crop, livestock, non-farm and forest-based livelihood sources.

## Key messages

Farmland expansion is a key rural household income strategy; however, it is also a major contributor of global forest loss.[2,3] 92% of deforestation in Africa between 2001 and 2015 was due to smallholder-led agriculture expansion.[4,5]

A rising population means that cultivated areas in most developing countries are expected to increase by more than 47% by 2050, with as much as two thirds of this new agricultural land coming from deforestation and wetland conversion.[6]

There are significant differences in household income from forest- and non-forest-based livelihood options between households that expand and those that do not. Farmland expansion into forest areas leads to an increase in crop and livestock income, but a decrease in forest income and non-farm income. There is therefore a trade-off between different income sources.

The loss of grazing areas leads to stall feeding, thereby increasing milk yields, which in turn results in more income for women, who are mainly responsible for milking.

Partners:
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Funded by:
GCRF Global Challenges Research Fund; UK Research and Innovation

# Impacts of agricultural expansion on livelihoods

## Farmland expansion and household income

The basic socio-economic characteristics of the rural households show that 88% of farm households in the study sample across the three districts are male-headed. Among those households which have farmland in the forest, 10% are female-headed and 90% are male-headed. The average education level of the household head ranges from three to four years, with only 55% of the heads having at least primary education. The mean age of the household heads is 48 years and family size of adult equivalent is six.

Figure 1 compares levels of participation in different forest-based activities for households that expanded their cropland into forest areas with those that did not. The data reveals that participation in various forest-based activities is common, with more than 64% of sampled households participating in at least one forest-based activity. Timber and fuelwood collection are the major forest-based activities in all study areas. There seems to be an overall preference to allow livestock to graze in the forest rather than collect fodder from the forest. In particular, households that expanded carry out more forest-based activities compared to those that did not expand. The travel time to nearby forests – one-way walking – averaged around 15 minutes for households who expanded. However, the distance to nearby forests is more than double for the non-expanders.

**Background**

- Ethiopia is the second-most populous country in Africa, with an estimated population of about 119 million in 2021, and is growing by about 2.7% annually. Its population is expected to surpass 200 million by the end of 2049.[7] About 80% of the population relies on agriculture for its livelihood, mainly subsistence and rain-fed farming and livestock production.
- About 14.7% of the country's land area is covered by forest, with woodland and shrubland accounting for another 44.7%.[8]
- About 24% of the population lived below the national poverty line in 2016; poverty is the cause of hunger and malnutrition.[9]

**Figure 1. Participation (%) in forest-based activities in the forest**

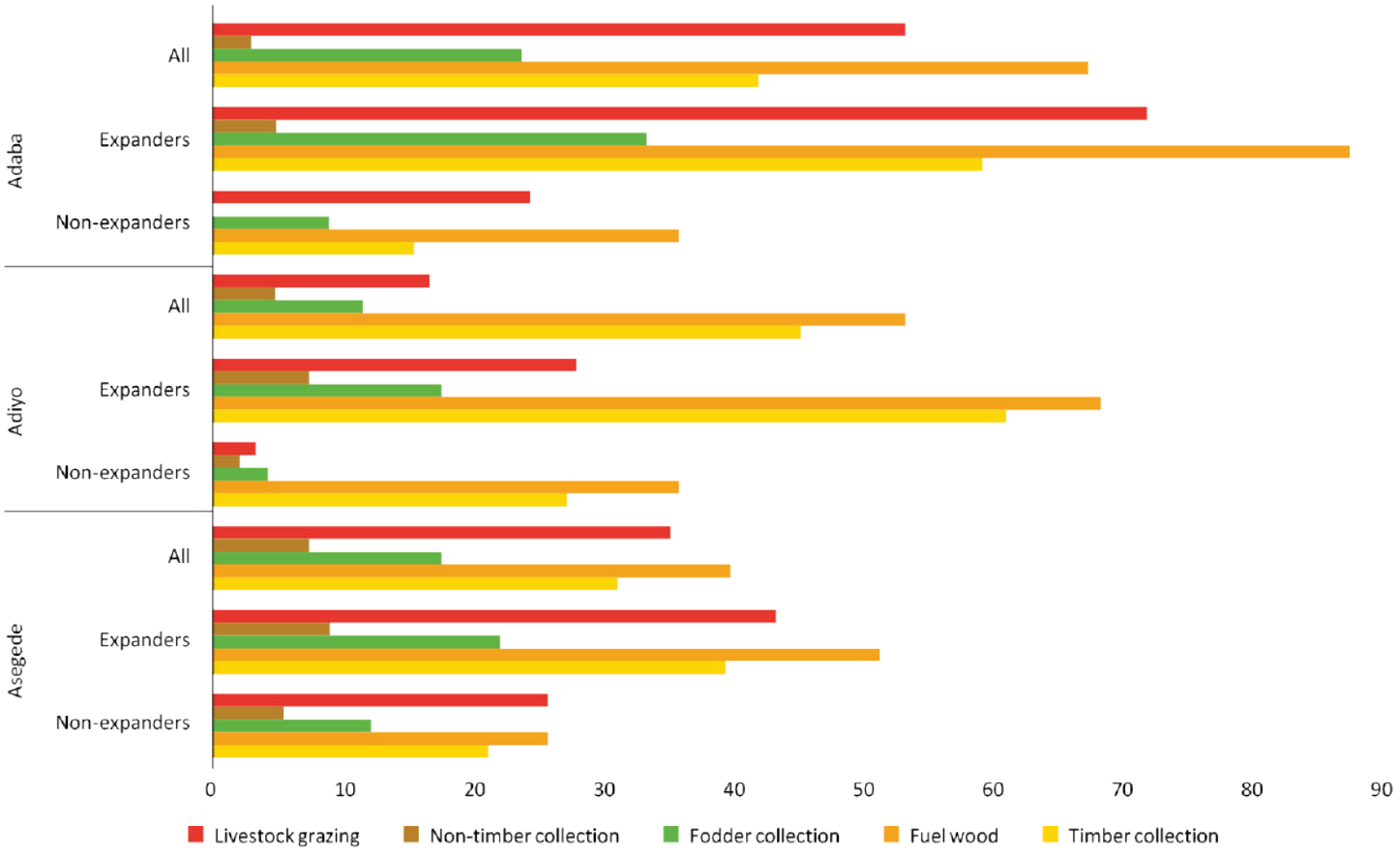

**Table 1. Distribution of household income by sources and farmland expansion**

| Variables | Description | Districts | | | Overall | | |
|---|---|---|---|---|---|---|---|
| | | Asegede | Adiyo | Adaba | Non-expanders | Expanders | All |
| Total income ('000 Birr) | Income derived from different sources | 57.41 (36.49) | 67.96 (35.46) | 71.40 (46.44) | 60.41 (37.95) | 69.64 (41.38) | 65.58*** (40.14) |
| Crop income ('000 Birr) | Income derived from annual and perennial crop production | 36.12 (22.46) | 44.75 (25.69) | 36.30 (25.08) | 38.74 (24.89) | 39.32 (24.66) | 39.06 (24.75) |
| Livestock income ('000 Birr) | Income derived from sale of livestock and livestock products | 13.39 (17.61) | 11.58 (13.67) | 21.93 (21.34) | 12.69 (14.84) | 17.93 (20.41) | 15.63 (18.35)*** |
| Forest income ('000 Birr) | Income obtained from timber and non-timber forest products, honey, charcoal, etc. | 4.03 (8.62) | 6.08 (10.34) | 5.72 (7.67) | 3.52 (8.62) | 6.66 (9.02) | 5.28 (8.98)*** |
| Off-farm income ('000 Birr) | Non-farm income, off-farm employment, social-protection, etc. | 3.87 (8.63) | 5.53 (12.21) | 7.43 (24.49) | 5.45 (16.46) | 5.74 (16.72) | 5.61 (16.59) |
| Farmland expansion[a] | Share of households who have farm in the forest (%) | 54.77 | 53.77 | 59.59 | – | – | 56.04 |
| Intensity of farmland expansion[b] | Share of farm size in the forest (%) | 29.19 | 46.57 | 55.99 | – | 77.78 | 43.89 |

Note: *** represent statistically different at 1% significance level. Numbers in parenthesis are standard deviations.

[a] Participation in farmland expansion is defined as the proportion of households in the sample who have farms in the forest.
[b] The intensity of farmland expansion is defined as the share of farm size in the forest out of the household's total farm size.

Basic household earnings and income shares by livelihood category show that all households in the sampled population receive income from all sources (crop and livestock production, and forest income). However, the data show that the contributions of the different income sources differ across the study areas. We observed a slight variation in mean earning shares from forests in Adiyo (6.1%), followed by Adaba (5.7%) and Asegede-Tsimbila (4%) (Table 1). The forest is a potential source of farmland, and forest clearing was common in all study areas. About 56% of all farm households surveyed expanded their farmland (Table 1), clearing on average 0.87 ha of land. The study further shows that expanded farms derive a higher income than non-expanded households.

## Findings: impacts of farmland expansion

Agricultural expansion has significant social, economic and environmental impacts on individual smallholder farmers and the overall community, which are understood to a degree by the local communities in the study, as outlined by participants in the rural household survey. The key findings from the survey are as follows:

- Households participating in farmland expansion experienced an increase in their average household income of 12.34 and 3.27 thousand Birr from crop and livestock respectively. At the same time, a decline of 3.59 and 2.94 thousand Birr in forest and non-farm income respectively was recorded.
- Farmland expansion into forest areas has led to an increase in income from crops and livestock, but a decrease in forest and non-farm income. There tends to be a trade-off between different income sources, with farmland expansion a win-or-lose option to enhance household food security, since it comes at the expense of forest conservation and income opportunities from non-timber forest products.
- Farmland expansion has increased the income of all farm households, with expanded farm households benefiting the most. It is however misleading to conclude that all farm households that expand have a higher income. Farmland expansion is not the only explanation for variations in household income from different livelihood options.
- In Adiyo district, agricultural expansion has led to a reduction in expenditure on fertilisers. The loss of grazing areas has resulted in stall feeding, which has increased milk yields, and as

a consequence, this income has increased, which has benefitted women in particular, since they mostly control the income from milk.

- Ten years ago, honey was produced in the forest, mainly by traditional means, with a good yield. However, this has now been substantially reduced due to forest clearance. Deforestation has led to a decline in food for honeybees, which has in turn meant fewer honeybee colonies and consequently less honey being produced.[10]
- Dominant trees within the forest, such as dokima (*Syzygium guineense*) and kosso (*Hagenia abyssinica*) are declining fast as forests are cleared for cultivation. Dokimo is used primarily for forage and kosso is used as a medicinal plant. Some female participants in Adiyo district noted:

  *We used to collect a variety of medicinal plants whenever our children get sick. But now almost all are gone due to deforestation. Medicinal plants are vital for us as we have almost no access to health facilities. The medicinal plants are not only used for people but also for our livestock. Thus, we (both human and livestock) are affected by the decline in medicinal plants.*

## Impacts on food security and diversity

- Ten to fifteen years ago, women used to collect a variety of edible plants from the forest and the men used to hunt meat in the wild. Today, the food consumed comes mostly from the farm and market. Agricultural expansion into forests has resulted in a decrease in the diversity of available food and has had negative impacts on nutrition, which has affected children in particular.
- Hunting grounds are declining as forests are being farmed, with wild animals disappearing. This is linked to a reduction in tourism activities.

## Farmers' perceptions of the winners and losers of agricultural expansion

- Well-off men are often the main beneficiaries of expansion, because they have the capital to invest in cultivating large areas for commercial farming. Male farmers tend to prioritise cash crop farming over food crop farming, while female farmers tend

to prioritise food crops.

- In addition to the loss of harvestable forest products, the whole community is negatively affected by deforestation-related soil erosion, weather fluctuations, and a decline in crop productivity. Poor farmers who are dependent on livestock are negatively affected by the loss of communal grazing land due to agricultural expansion. In Adiyo, soil degradation, reduced pollination and a loss of biodiversity appear to be harming most households in the medium term, regardless of whether or not they expanded. In Adaba, participants noted a decrease in tree cover associated with changing rainfall, with run-offs further exacerbating soil degradation.
- Competition for land has made households expand beyond their capacity in a bid to secure land for their children.
- Farmers use a wide range of forest products for construction and non-timber forest products for income generation. Agricultural expansion has reduced the availability of forest resources, such as thatch, which was previously used for building, but which has now disappeared due to forest clearing. The youth are particularly affected by this as they previously collected and sold thatch.
- Timber is a major source of income, especially for the poor and the youth, but it is becoming less available. Wood for building is now scarce and more expensive than in the past.
- This decline in the availability of fuelwood and construction materials has increased the workload of both women and men as they have to travel longer distances to collect these resources. Farmers reported a decrease in the quantity of fuelwood collected from the wild, with a female farmer indicating that it is difficult to get fuelwood around their homesteads due to land being cleared for farming, and it is now prohibited to collect fuelwood from the forest reserve. This has particularly impacted women, since they are responsible for collecting fuelwood and cooking for their households:

  *We used to collect fuelwood from the forest which is falling from the branch of forest trees for household cooking purposes and to sell some for income.*

- Communal grazing systems were dominant in the 1980s; however, due to the conversion of grazing areas to farmland, none of the households currently practise communal grazing. This shortage of grazing areas has significantly reduced livestock production, primarily affecting poor farmers.
- The shortage of feed for livestock due to disappearance of communal grazing land in Adiyo has affected milk yields.

## The way forward

Exploring the resource-use patterns of farm households that expand into the forest areas has highlighted the importance of forests for the household economy and for rural food security. The differences in income between farm households that expand and those that do not, confirm the importance of expansion as a determinant of household income generation. Farmland expansion has increased the incomes of wealthier men, but decreased the incomes of poorer women and youth, and led to an increased burden on women responsible for fuelwood collection. Access to wild plants, important for health and food security, has also been reduced, which has had a negative impact on children's nutrition and has led to a decline in ecosystem services, such as pollination, soil fertility, crop productivity and fodder.

Clearly a trade-off exists between increased household income and decreased nutrition, health security, biodiversity and ecosystem services. This needs to be given particular attention in agriculture and environmental policymaking in Ethiopia if agriculture is to continue to be a major sector of the rural economy. The trade-offs between farm-based income and forest-based income and livelihood benefits suggest the need to further scrutinise options on how to balance the choices between conserving forests and ensuring household food security.[11]

By and large, reducing farmland expansion is one way forward. Ethiopia's population is expected to surpass 200 million by the end of 2049, resulting in an increased need for food. It is still possible to reduce some of the negative impacts of farmland expansion into forest frontiers if the following policy pointers are taken into consideration:

- Improve land management and productivity on existing farmland, and in particular address land degradation using appropriate regeneration activities that build on local knowledge.
- Promote community-based land use planning that explicitly takes into account all the benefits from forests, factoring them into decisions to ensure more equitable outcomes. This could involve protecting areas of forest that provide high levels of ecosystem services for sustainable use by communities.

## Acknowledgements

We are grateful to the communities in Ethiopia who volunteered to take part in this research.

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About this briefing

This briefing is based on results from:

Teklewold, H and Gebrehiwot, T (forthcoming) Understanding the impact of farmland expansion on rural household's livelihoods: empirical evidence from Ethiopia.

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Sentinel
Social and Environmental Trade-Offs in African Agriculture

Policy Brief
March 2022

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# Reducing the biodiversity impacts of agriculture in Ethiopia

This policy briefing recommends policies that minimise agricultural expansion in areas of high biodiversity value and sustainable agricultural practices to maintain healthy and sustainable food systems.

## The intimate relationship between biodiversity and agriculture

There is a close link between biodiversity and agriculture. Agriculture requires that surrounding ecosystems are healthy and resilient to support valuable ecosystem services.[1,2] Some species act as natural pest controllers, reducing the pests and pathogens that threaten crops. For example, the fungal hyperparasite *Lecanicillium lecanii* provides a biocontrol service by reducing the severity of coffee leaf rust (*Hemileia vastatrix*) in Ethiopia.[3] Other species act as pollinators for crops. For example, arabica coffee is pollinated by many bees and fly species in Ethiopia, which supports temporal coffee yield stability.[4]

Policymakers must promote the conservation of Ethiopia's areas of high biodiversity value (see Box 1) to maintain the ecosystem services that support agriculture. For example, if crops are grown in areas of high biodiversity value or in ways that do not support biodiversity-friendly farming, the health and resilience of ecosystems will be degraded, and farmers will lose valuable ecosystem services that support agriculture. In Ethiopia, agricultural intensification has reduced natural pest control[3] and pollination[5] ecosystem services for coffee production.

Ethiopia's National Biodiversity Strategy and Action Plan (NBSAP) 2015–2020[6] recognises this close link between biodiversity, ecosystem services and agriculture. Furthermore, the NBSAP regards the valuation of ecosystem services as a necessary means of promoting conservation, sustainable use, and access to benefits.[1]

## Methodology

Global-scale datasets – from EarthStat, the IUCN Red List, FAOSTAT, Birdlife International, WWF, Key Biodiversity Areas, and the Observatory of Economic Complexity – were used to map areas in Ethiopia where both biodiversity value and crop production are high.

The research team at University College London (UCL) used these maps to identify the spatial overlap between areas of high biodiversity value and areas of crop production. These are hotspots of trade-off risk – areas where environmental goals might be at risk of conflict with plans for agricultural development.

### Key messages

Minimise agricultural expansion and intensification in high biodiversity value areas. Use maps highlighting the overlap between crops and areas of high biodiversity to identify regions where agriculture-biodiversity trade-off risks are highest.

Policymakers should use strategic spatial planning to minimize agricultural expansion in areas of high biodiversity value, such as forests, in alignment with Ethiopia's Green Economy Strategy. Consult maps that use crop-specific land use classifications instead of broad 'cropland' or 'agriculture' land use classes to develop agricultural spatial plans.

When agricultural production occurs in or near areas of high biodiversity value, such as protected forests, policymakers should promote the use of biodiversity-friendly agriculture.

Certain crops, particularly bananas, coffee, and maize, are grown close to high biodiversity value areas and pose the highest risk to Ethiopia's biodiversity. Therefore, policymakers should pay particular attention to promoting the sustainable production of these crops.

Partners: Copperbelt University; Ethiopian Policy Studies Institute (PSI); University of Ghana; University of Greenwich NRI Natural Resources Institute; Imperial College London; iied; eci University of Oxford; University of Reading; RUFORUM; UCL

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# Reducing the biodiversity impacts of agriculture in Ethiopia

Bananas, coffee and maize are among the most important crops in Ethiopia.[7] They also occupy an extensive footprint within and surrounding areas of high biodiversity value (Figure 1). These crops currently pose the highest risk to biodiversity in Ethiopia because of the large amount of land used to cultivate them within or surrounding the areas of the highest biodiversity value.

Policymakers should minimise agricultural expansion and intensification in areas of high biodiversity value. Where this is unavoidable, policymakers must promote biodiversity-friendly farming practices to reduce negative ecological impacts from agriculture in these areas.

Ethiopia's Green Economy Strategy[8] specifies that policymakers minimise agricultural expansion into forest ecosystems. The strategy therefore aligns with this policy brief's recommendations that policymakers reduce agricultural development in areas of high biodiversity value, including forest ecosystems.

A focus on self-sufficiency or international trade will not necessarily determine the impact of agriculture on biodiversity. It is more important where and how crops are grown, rather than whether they are consumed domestically or traded internationally.

Ethiopia already uses several biodiversity-friendly agricultural practices, including planting nitrogen-fixing trees, which has positively affected soil micro-organism diversity in planted forest systems, as well as improved fruit and vegetable varieties, the use of organic manure, and integrated pest management. These practices increase crop yields and improve nutrition.[1]

Many biodiversity-friendly practices are relatively complex and require a good understanding of the local ecosystem. They can be knowledge-intensive, context-specific, and provide benefits in the long term. Research should be promoted that investigates which biodiversity-friendly agricultural practices deliver environmental, social and economic benefits in areas of high biodiversity value in Ethiopia.

**Box 1. Definitions**

- **Agriculture-biodiversity trade-off risk:** meeting agricultural production needs puts biodiversity conservation at risk and vice versa. For example, a farmer expanding their cropland may encroach on pristine forests and put biodiversity at risk. A socioeconomic-focused goal is met by increasing production, but a conservation-focused goal is compromised. All agricultural production harms biodiversity to some extent, but farmers can reduce this impact by avoiding production in areas of high biodiversity value and using biodiversity-friendly farming practices.
- **High biodiversity value area:** a region with the top 10% of species in the country by area.
- **Ecosystem services:** the benefits that humans derive from ecosystems. Ecosystem processes, such as pollination, support ecosystem services, in particular the production of crops. In combination with human activities including cultivation, harvesting, transport and land preparation, ecosystem services produce goods, for example flour, that humans value.
- **Biodiversity:** the variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems, and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems.[9]
- **Vertebrate biodiversity:** this research focused on vertebrate biodiversity on land only, which is the variety of life in groups of birds, mammals, reptiles, and amphibians.

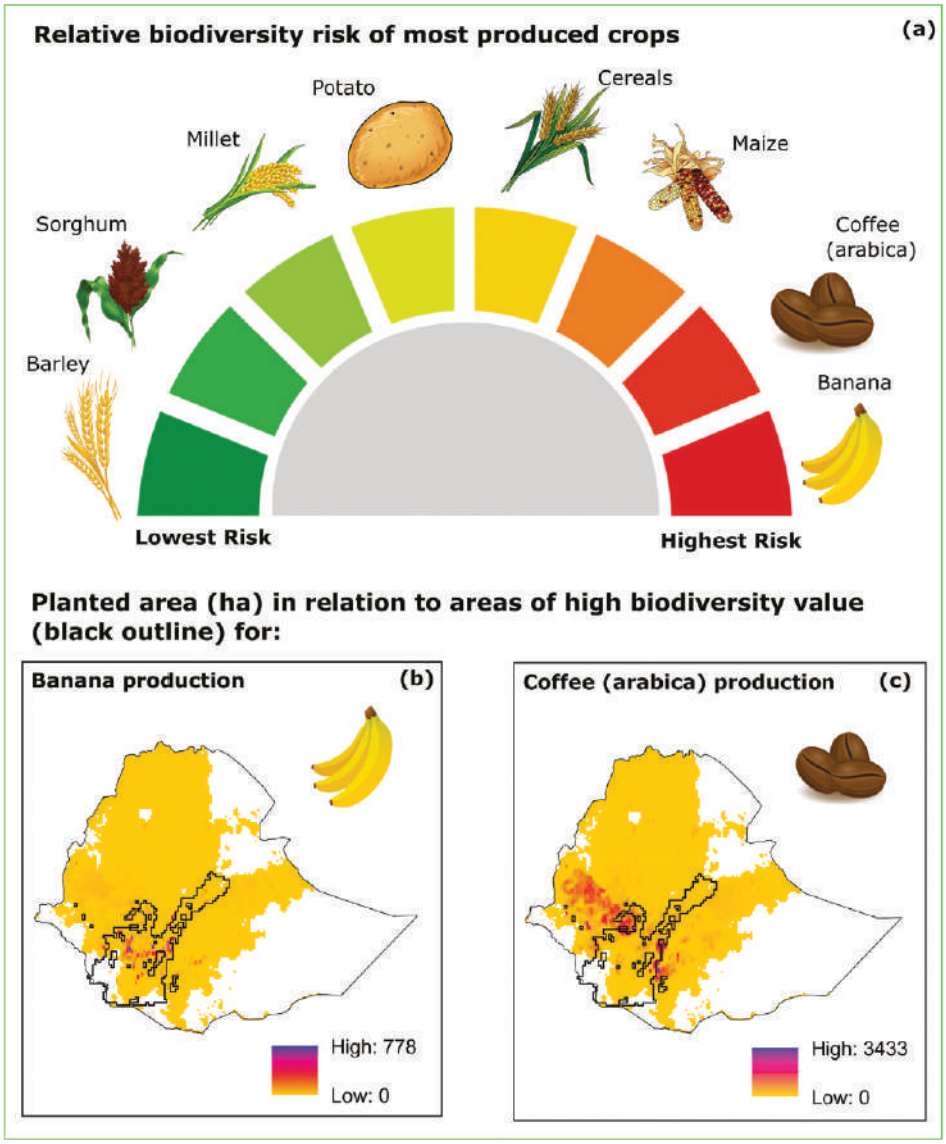


**Figure 1. The relative biodiversity–agriculture trade-off risk, identified as the spatial overlap between areas of high biodiversity value and areas of crop production in Ethiopia. (a) The highest production volume crops (tonnes in 2020)[7] in terms of the relative risk to biodiversity. The planted areas of bananas and arabica coffee overlap with high biodiversity value areas to the greatest extent and pose the most significant threat to biodiversity in Ethiopia. The planted area (ha) per 10 km² of these two crops in relation to Ethiopia's high biodiversity value areas (black outline) are shown in (b) and (c), respectively.**

The Microbial Biodiversity Directorate of the Ethiopian Biodiversity Institute promotes the conservation and sustainable use of the country's biodiversity. This institute should be engaged in research and policy development on biodiversity-friendly agricultural practices in Ethiopia.

## High biodiversity value areas in Ethiopia

The areas of the highest biodiversity value are scattered across the central and southwestern regions of the country (Figure 1, b and c). These areas are of high value because they support the country's highest number of vertebrate species.

The country contains 10 ecosystems, and 18 major and 49 minor agro-ecological zones that support a great diversity of animal, plant, and microbial genetic resources, making the country one of the world's biodiversity hotspots.[6]

Ethiopia possesses an estimated 6,000 species of higher plants, of which 10% are endemic. In addition, the country reports 284 wild mammal, 861 bird, 201 reptile, 200 fish, 63 amphibian, and 1,225 arthropod species. Of these faunal resources, 29 wild mammal, 18 bird, 10 reptile, 40 fish, 25 amphibian, and 7 arthropod species are endemic to Ethiopia.[6]

## Conclusion

Ethiopia's ecosystems support biodiversity and ecosystem services, such as pest control and pollination, which are essential for maintaining healthy and sustainable food systems. Agriculture threatens ecosystems that are crucial for biodiversity. Policymakers should prioritise agricultural expansion in areas outside of Ethiopia's high biodiversity value areas, so that food production can continue into perpetuity without degrading the biodiversity and ecosystem services on which it depends.

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# Sentinel

**Social and Environmental Trade-Offs in African Agriculture**

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About this briefing

This policy briefing describes the risk of agricultural production to biodiversity in Zambia. It is aimed at policymakers in agriculture, environment, and planning.


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Sentinel
Social and Environmental Trade-Offs in African Agriculture

SNAPP

Policy Brief
May 2020

www.sentinel-gcrf.org

# Food and forests: understanding agriculture and conservation trade-offs in Ethiopia

In Ethiopia, as in many countries in Africa, policymakers need to better understand and manage the major trade-offs — existing and future — between two competing objectives: increasing agricultural production to meet growing domestic food demand and conserving nature.

**Figure 1. Change in cereal yield and cultivated area, Ethiopia 1994–2014 (based on FAO data[3])**

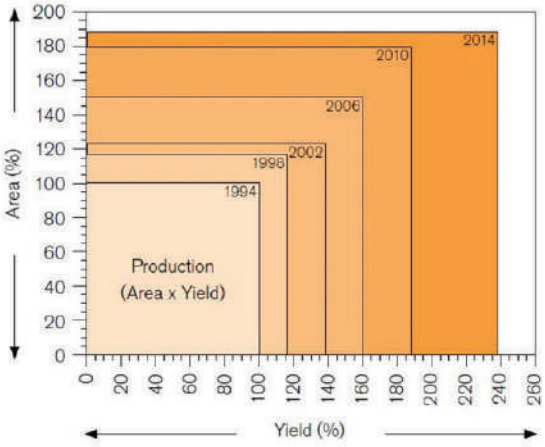
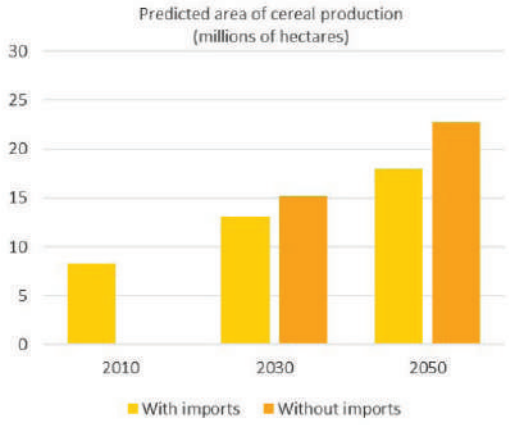



**Figure 2. Cereal area with and without imports (from IFPRI's IMPACT model[2])**




## Competing policy objectives and implications for land use

Cereal production in Ethiopia increased 4.5x between 1994 and 2014 (see Figure 1). Based on the IMPACT model of International Food Policy Research Institute (IFPRI)[2], van Ittersum et al. in their paper "Can sub-Saharan Africa feed itself?" note that food demand in Africa is projected to triple over the period 2010–2050 — a growth rate much higher than in other continents.[4] This growth in demand is a function of improving food security and increasing consumption of meat as well as population growth. In Ethiopia, cereal demand is predicted to grow by a factor of 2.6 over this period which will continue to drive expansion of the cereal area.

Ethiopia has long recognised the importance of agriculture sector transformation for stability and growth. Over two decades ago, Ethiopia put agriculture at the heart of its economic development by launching its Agricultural Development Led Industrialization (ADLI) strategy. Agriculture continues to be central to national development planning, and in the last 10 years Ethiopia has achieved remarkable increases in crop production largely through increasing yields per hectare (ha). For example, over the period 2007–2017 cereal production increased by a factor of 2.15 (i.e. more than doubled) from a 76% increase in yield and a 22% increase in the cropped area.

## Summary

Agricultural expansion is the number one driver of the loss of nature and its biodiversity and ecosystem services.[1] But efforts to rapidly reduce these losses must recognise the political and economic realities of developing countries striving for economic growth and poverty eradication in the face of climate change. How to balance the competing objectives of agricultural production (SDG 2) and nature conservation (SDG 15) is a critical challenge for sustainable development, and there is growing recognition that success will require transformative change.

## Background

In contrast to the situation in Latin America and parts of Southeast Asia, in most countries in Africa it is the expansion of staple food crops to meet growing domestic demand rather than export commodities which drives the loss of nature and its biodiversity and ecosystem services. In Ethiopia, the expansion of cereal production over the period 2010–2050 is projected to far exceed that of any other crop type.[2]



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The current agricultural strategy — the second Growth and Transformation Plan (GTP II) — aims to increase agricultural productivity by a further 47% over the period 2016–2020 so that the country can achieve and maintain national self-sufficiency in staple food crops. Most of this growth is still in the smallholder sector but large-scale commercial farms are increasingly significant, and disproportionately so in terms of environmental impact since the allocated land has been mainly in the country's more forested areas in the west (see Figure 3).

The United Nations Food and Agriculture Organization (FAO) estimates that the average annual deforestation rate from 1990 to 2010 was 0.93%, and during this period Ethiopia lost 18.6% of its forest cover.[6] Meanwhile, the REDD+[7] readiness preparedness plan estimated annual forest clearing rates for the country's three most-forested regions at 1.16% in Oromia, 1.28% in Gambela and 2.35% in the Southern Nations, Nationalities, and People's Region (SNNPR).[8] Government projections in 2011 indicated that if no action is taken to change the country's development path, 9 million ha would be deforested between 2010 and 2030.[9] This would be most of the natural forest outside of protected areas.

Agricultural expansion is the most significant economic driver of deforestation and biodiversity loss in Ethiopia as in most other countries in Africa. An in-depth study of the drivers of deforestation was conducted for the Ethiopia's Forest Reference Level submission to the United Nations Framework Convention on Climate Change (UNFCCC).[10] This indicates that 53% of the deforestation that takes place is conversion to agriculture and grassland (see Figure 4). In accordance with UNFCCC standards the term 'agriculture' refers to crop production, and 'grassland' refers to improved or unimproved grazing.

The IMPACT model[2] predicts that the country will produce 83% of its total requirement for cereals in 2050 and will import the remaining 17%. Under this scenario, and assuming no increase in yield/ha from the 2008–2012 average, the area of cereals would expand by only 2.2x rather than the 2.7x expansion needed if the country was to become self-sufficient in cereals (see Figure 2). However, the country is aiming for self-sufficiency in staple food crops and Figure 5 shows the area of cereal production that would be needed to achieve this for different scenarios of crop yield.[4] The dotted yellow line shows the total area of land suitable for cereal production including areas of forest outside protected areas.[11] Even if cereal yields could reach 50% of the potential maximum — not very likely given the increasing frequency of drought — most of the potentially suitable non-forest and forested land would be used by 2050. Suitability is defined in purely agroecological terms. If the profitability of cereal production is also taken into account, the area of suitable land is substantially reduced as some of the land has poor market access. Under current conditions of environmental governance, it may be hard to ensure that agricultural expansion takes place in areas that are less important for biodiversity and ecosystem services but also less profitable for farming.[12]

**Figure 4. Land uses replacing forests over the period 2000–2013 (as % of total forest loss over this period) — graph reproduced from Ethiopia's Forest Reference Level submission, 2016[10]**

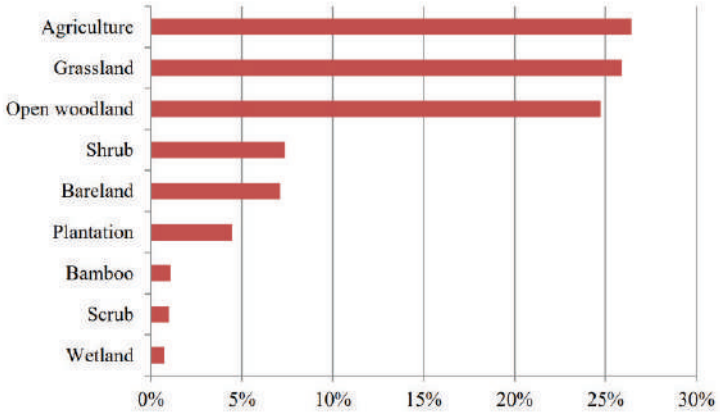
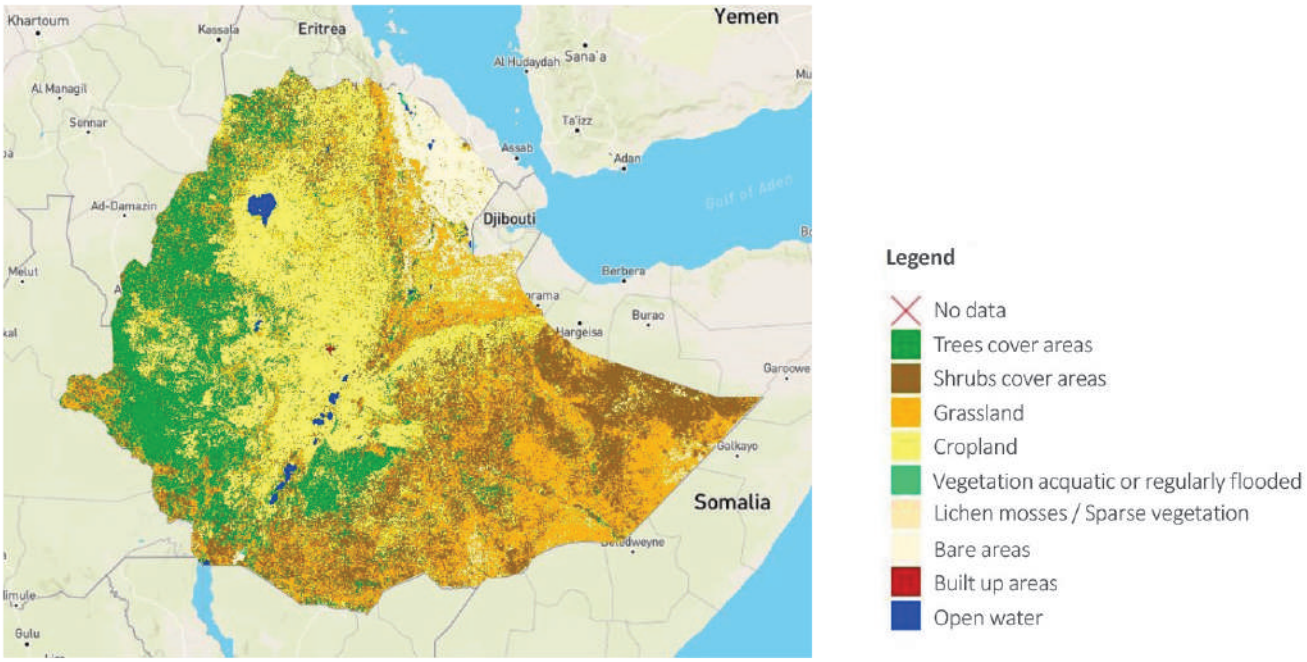



**Figure 3. Ethiopia land cover (map developed using RCMRD SERVIR Eastern and Southern Africa[5])**

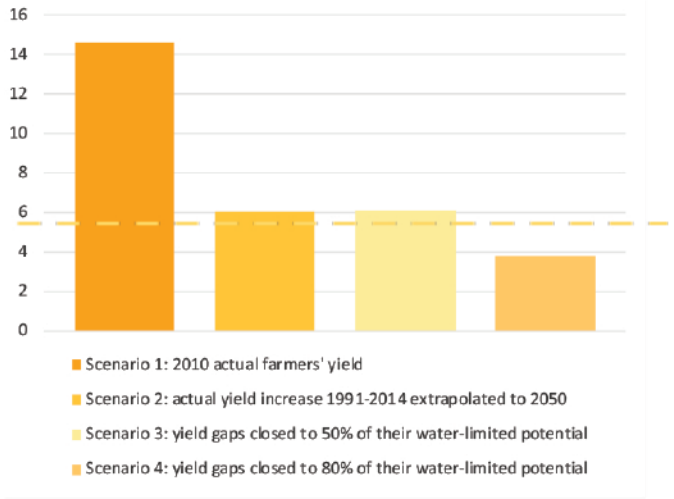


**Box 1. Ethiopia in brief**

Ethiopia is the second most populous country in Africa after Nigeria, with an estimated 104.9 million people and a population growth rate of 2.5% (2017). Some 80% of the population lives in rural areas. It comprises 111.5 million ha (over 1.1 million km$^2$), of which 74 million ha is deemed suitable for agriculture. Ethiopia is fundamentally an agrarian country. Although the transformation towards a more manufacturing and industrially-oriented economy is well under way, the agriculture sector continues to dominate the economy, accounting for 36% of gross domestic product (GDP), 73% of employment, and nearly 76% of export earnings.[13] Major agricultural exports include coffee, sesame seeds and flowers. The majority of the agriculture sector is made up of smallholder farmers who live off less than one hectare of land.

Over the past decade, the country has experienced sustained rapid and inclusive economic growth, averaging 10.4% per year since 2004.[14] Extreme poverty fell from 55% in 2000 to 33% in 2011. Ethiopia's rapid and sustained growth has been driven by agriculture and service sector growth. In 2016, the agriculture sector accounted for 41% of GDP while the service sector accounted for about 43% of GDP.

**Figure 5. Cereal area (Mha) required to be self-sufficient by 2050 (reproduced from van Ittersum et al., 2016)[4]**




## Are agricultural and environmental policies working for trade-off management?

In Ethiopia, policymakers continue to devise agricultural development, environmental and conservation policies based on an insufficient understanding of the trade-offs — existing and future — between the competing objectives of producing more food and the conservation of nature and its biodiversity and ecosystem services. This is all too clear with the current agricultural strategy proposing expansion of the cropped area by nearly 4% with at least 2.5% coming from forested land.

Meanwhile, the government has committed under the New York Declaration on Forests to halving deforestation by 2025 and to huge programmes of tree planting and forest landscape restoration.

At present, the highest rates of conversion of natural forests are in the west of the country where 1.7 million ha of land was allocated to large-scale commercial agriculture over the period 2002–2012. Although national environmental policy requires that environmental impact assessments (EIAs) be conducted to inform appropriate impact mitigation actions, the assessments have in many cases been little more than a paper exercise.[15] Another great concern is about commercial farming measures to intensify agriculture to increase productivity. In situations of relatively weak environmental governance, these tend to increase rather than reduce the pressure on forests – through an effect known as Jevons paradox.[16]

Within the smallholder sector there have been major improvements in productivity (yields/ha) in recent years — a 76% increase between 2007–2017. This is a reflection of a major investment in agricultural extension and the supply of fertiliser and other agricultural inputs. In contrast to large-scale commercial agriculture, the risk of intensification being a driver of deforestation is less because of land-use regulation at local government level, including processes to restore degraded semi-natural communal lands and village-level land-use planning.[17] Nonetheless, in a country where the average farm size is less than 1 ha – too small for subdivision amongst the next generation – there is intense demand for new land from the younger generation which is a major factor in deforestation levels remaining amongst the highest in Africa.

**Box 2. Commitments under regional agriculture policies**

Ethiopia is one of the signatories of the Comprehensive Africa Agriculture Development Programme (CAADP). It was launched during the second Africa Union Assembly held in 2003 in Maputo, Mozambique. Parties have committed to allocating at least 10% of their national budgets to agriculture to achieve 6% annual growth of the agriculture sector.[18] Ethiopia has also endorsed the Malabo Declaration on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods. The declaration includes targets to end hunger, halve poverty, and ensure at least 30% of farm/pastoral households are resilient to climate shocks in Africa by 2025.[19] Ethiopia is one of the leaders in Africa in progress towards meeting these targets.

Protected areas represent an extreme form of land-use control. Ethiopia's protected areas account for an estimated 14% of land[20] and generate substantial tourism opportunities and ecosystem services. However, many of these protected areas are threatened by:

- Settlement and farming within the parks or adjacent to them
- Deforestation

• Mineral extraction, and
• Forest fires.

Despite major efforts to control illegal encroachment of people, their farming and/or livestock, the biodiversity status of some key protected areas continues to deteriorate.[21] If targets to reduce and reverse deforestation and biodiversity loss remain in place, agricultural and conservation policies are on a collision course. This can be seen as a failure to recognise the major trade-offs that exist. We might ask why these are not recognised given that they are very visible in the national development plans. Research on this topic in other countries[22] has identified three possible explanations:

• Trade-offs may be invisible to people working in their sectoral siloes (e.g. ministries for agriculture or the environment).

• Perceptions of what is a win or a loss may be very different according to knowledge, values, beliefs or well-being etc.

• Trade-offs may be deliberately hidden for a variety of reasons including win–win solutions being more socially, psychologically and politically attractive or because the topic is taboo.

Barriers to recognising, understanding and better managing the trade-offs include:[15]

• Weak functional links and coordination between different organs of government ministries (for example, investment authorities, agriculture and forestry). Sectoral ministries promote their mandates, but mechanisms to align these mandates have often been weak. Cross-sectoral synergy in policy, joint planning and implementation is rare. Lack of coordination among the relevant institutions (investment, agriculture, environment, energy, forestry) is contributing to increased deforestation and loss of biodiversity.

• Overlapping mandates and activities between different government bodies. For example, rehabilitation of degraded areas is undertaken by both the Ministry of Agriculture (MoA) and the Environment, Forest and Climate Change Commission (EFCCC).

• Discrepancies exist at various levels (national, sub-national and local) in the capacities, responsibilities and priorities of key stakeholders in making and implementing land-use decisions.

• Frequent restructuring or institutional reorganisation of ministries with changing mandates has created problems. Collaboration among line ministries (for example, between the Ministry of Agriculture and Natural Resources, MoANR, and the Ministry of Environment, Forest and Climate Change, MoEFCC) is still relatively weak. The changing mandates have caused confusion over land management, especially for reforestation on degraded agricultural land.

• In some cases, information necessary for the effective management of risks and trade-offs (for example, spatial data on deforestation and threats to biodiversity) exists but is publicly unavailable; in other cases, this information is lacking.

• At the regional level, environmental bureaus and agencies have a wide range of environmental responsibilities and roles, some of which overlap with sectoral mandates. These responsibilities and roles are not, however, matched with adequate human and technical resources. All regional states and local governments (zones, woredas and kebeles) face technical capacity constraints to effectively set, implement and/or enforce environmental laws, regulations and standards.

• There is a lack of or weak implementation capacity at woreda level, even though policies and institutional frameworks for sustainable natural resource management are largely in place.

• There is also a lack of government commitment at sector level: GTP II, and its strong alignment with the Climate Resilient Green Economy (CRGE) strategy, suggests that biodiversity is fairly high on the federal government's policy agenda. But this does not seem evident at the sector levels, such as in agriculture and forestry. In addition to the challenges posed by institutional change, there is a lack of appreciation among forestry and agriculture policymakers of the importance of biodiversity.

**Box 3. Commitments under global environment and conservation policies**

Ethiopia has ratified all the key international environmental conventions including the Convention on Biological Diversity (CBD), Convention on Wetlands (Ramsar Convention), Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and the Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC). Under UNFCCC, Ethiopia is a recognised leader in Africa with its pioneering Climate Resilient Green Economy (CRGE) strategy published in 2011. This strategy aims to make Ethiopia a middle-income country by 2025 while keeping greenhouse gas emissions at the current level of 150 Mt $CO_2e$.[9] This is an ambitious target in comparison with the 400 Mt $CO_2e$ greenhouse gas emissions that would result if the country chose to pursue conventional development.

GTP II suggests that biodiversity is fairly high on the government's policy agenda. Indeed, cognisant of the problems of biodiversity loss, the government implemented its first National Biodiversity Strategy and Action Plan (NBSAP) over the period 2005–2010 to guide national efforts in conservation, sustainable utilisation and fair access (through benefit sharing). The second NBSAP (2015–2020) is being implemented, with national targets considered when determining the spatial priorities to establish and safeguard protected areas, reduce agricultural expansion, increase forest cover, and manage wetlands.

## Looking ahead: key messages

A number of good policies exist in Ethiopia for the sustainable management of land and natural resources. There has also been the political will at high levels to support this. But there are disconnects between policies of different sectors which leave agriculture and environment on a collision course with negative impacts both for people and the environment.

The challenge in recent years has been not so much commitments from high-level politicians but rather the major disconnects between policy commitments of different sectors that are incompatible and, in reality, already colliding. This has serious negative impacts on the environment (as there is little or no attempt to mitigate the trade-offs). But there are also, in many cases, negative impacts on people whose well-being is dependent on ecosystem services that are lost and/or traditional smallholder agriculture that is displaced. In other words, even where the environmental dimension of the trade-off is recognised there is potentially an important social dimension that is still overlooked.

The way forward begins with a better understanding of these trade-offs and an open discussion about the competing objectives — and how these trade-offs could be better managed. In all countries we have studied, there is a need for horizontal and vertical policy integration. But this may be particularly the case in Ethiopia, which has a federal government system that grants a high level of autonomy to different regions of the country and lessens the power of central government to ensure effective coordination and coherence.

Policymakers and planners must engage the full range of stakeholder interests in processes involving trade-off management, notably land-use planning and the management of protected areas. Particular attention needs to be paid to the engagement of stakeholders who have a strong interest in the outcome but little influence, and who are therefore more likely to lose out, such as poorer people who are more dependent on use of common pool resources and youth who have no farmland. Given the extreme pressure on land, this will require not only biophysical interventions such as improved farming practices and land-use planning to increase productivity but also improvements in governance and other measures to enhance stakeholder engagement in trade-off management that are fundamental to transformative change.[12]

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## About the Science for Nature and People Partnership (SNAPP)

The mission of SNAPP is to deliver evidence-based, scalable solutions to global challenges at the intersection of nature conservation, sustainable development, and human well-being.

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**Sentinel**

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# About The Environment and Climate Research Center (ECRC)

## About The Environment and Climate Research Center (ECRC)

ECRC is a strategic partnership aimed at fulfilling the Policy Studies Institute (PSI's) mandate and long-term objectives in support government policies in environmental economics and climate change. The goal has been to develop a dynamic research center of excellence on the economics of climate and environment in Ethiopia that responds to current and future demands for knowledge in policy making; that adheres to the fundamental principles of academic integrity; that contributes to domestic capacity building and mobilization; and that is built on the fundamental principles of partnership and collaboration. The center has four core programs aimed at filling key knowledge management gaps in the CRGE implementation:

1) Policy Research and Impact Evaluation (PRIE) program;
2) Policy Interaction and Communication (PIC) program;
3) Data Management and Knowledge Repository (DMKR) program;
4) Capacity Building (CB) program.

Although these programs were designed based on the implementation of CRGE, the anatomy of the programs are generic enough for ECRC to build its subsequent efforts of aiding implementation and evaluation of policy actions relevant to Home Grown Economic Reform (HGER) and Ten Year Prosperity Development Plan (TYPDP).

The Environment and Climate Research Center (ECRC) was officially established on February 23, 2015 and instituted as a special research center within the Ethiopian Development Research Institute (EDRI) now the Policy Studies Institute(PSI). PSI has partnered with the Environment for Development Initiative (EfD) and the Global Green Growth Institute (GGGI) to establish the Environment and Climate Research Center (ECRC). The research center aims to conduct rigorous policy-oriented research on the economics of climate and environment, undertake impact evaluation of Climate Resilient Green Economy (CRGE)-related interventions, provide evidence-based policy advice, compile and disseminate knowledge and data, serve as a research-policy interaction hub, as well as contribute to capacity building on the economics of climate change and environment.

ECRC builds upon the long-standing collaborative research program with EfD, the Environmental Economics Policy Forum for Ethiopia (EEPFE), a pioneer project in Ethiopia's environment and climate policy research.

### ECRC's vision, mission, functions, programs and thematic areas of focus

| Vision | Mission | Functions | Core Programs |
|---|---|---|---|
| Contributing to poverty reduction and sustainable development in Ethiopia, by being a leading policy research center on the economics of climate and environment | Rigorous research on inter-linkages between climate change and environment and different sectors of the economy | Undertake real-time policy oriented research and impact evaluation of CRGE's implementation | Policy Research and Impact Evaluation (PRIE) program |
| | Develop a databank on Ethiopia's green growth experience | Serve as an active and dynamic forum for the interaction between policy makers, researchers and other stakeholders | Policy Interaction and Communication (PIC) program |
| | Effective interaction between the research environment and policy making | Compile, synthesize and share data and knowledge on Ethiopia's green growth experience | Data Management and Knowledge Repository (DMKR) Program |
| | Develop domestic capacity on the economics of climate change and environment | Build capacity around the economics of climate change and CRGE in Ethiopia | Capacity Building (CP) program |

**Thematic areas**

| Sustainable Agriculture | Sustainable Forest Management | Sustainable Energy Transition | Sustainable Urbanization | Green Industrialization | Sustainable Water Management |
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