



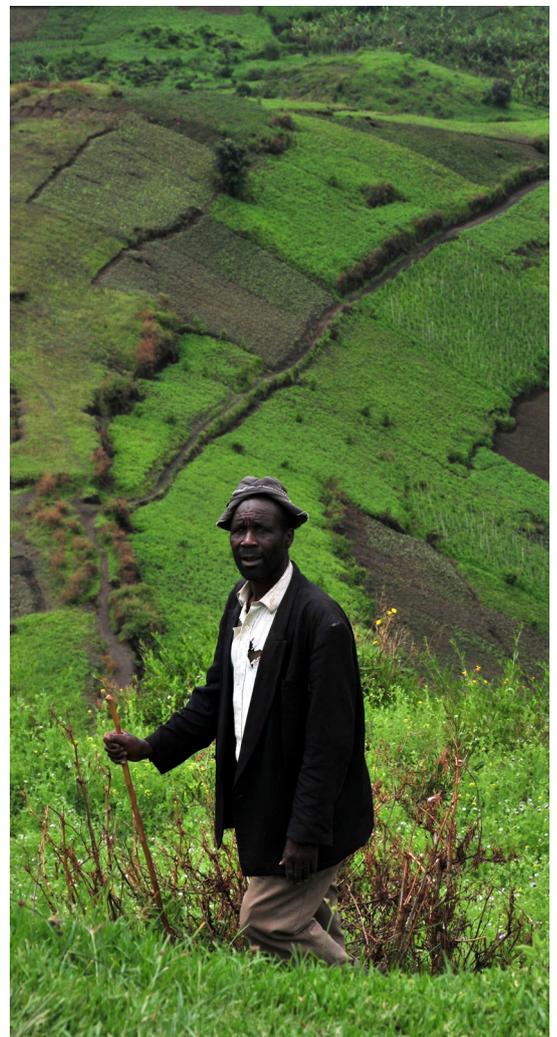
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Actions needed to halt deforestation and promote climate-smart agriculture

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Key messages

- ▶ Integrated action across Reduced Emissions from Deforestation and forest Degradation (REDD+) and agriculture is necessary to achieve mitigation and food security outcomes.
- ▶ 'Climate-smart' agriculture that achieves the triple-win of food security, adaptation and mitigation will strengthen the impacts of REDD+.
- ▶ REDD+ must address the needs of smallholder farmers to avoid exacerbating poverty and local food insecurity.
- ▶ Financing is currently insufficient for agriculture to tackle climate change and food security challenges in support of REDD+.
- ▶ Governance for forest conservation should include provisions for improved sustainability and productivity of agriculture.
- ▶ Agricultural development policies and REDD+ should be aligned with national climate change action plans.
- ▶ The role of forest-based ecosystem services in sustainable agriculture requires more recognition in land-use planning.



A farmer in Southwest Uganda, where agricultural expansion has been a main driver of deforestation. 'Climate-smart agriculture' can achieve food security, adaptation and mitigation goals while strengthening the impacts of REDD+. Photo: N. Palmer (CIAT)

Introduction

Agriculture needs to feed 9 billion people by 2050. This will require a 70–100% increase in food production (Godfray et al. 2010). Given climate change, a new kind of agriculture is therefore essential, one that must meet the triple challenge not only of ensuring food security, but also of adapting to future climate change and contributing to climate change mitigation.

Meeting these challenges will require coordination with the mechanism known as Reduced Emissions from Deforestation and forest Degradation (REDD+) and other efforts to conserve forests. REDD+ will have to limit the expansion of agriculture if it is to be successful (Nepstad et al. 2009; DeFries et al. 2010). Agriculture is a primary driver of deforestation in most countries, including in Brazil and Indonesia, where 61% of global deforestation occurs. Projected increases in demand for food and bioenergy by 2050 will increase pressure on forests further (von Braun 2007).

However, restricting agricultural expansion could have negative consequences for food security and economic development. The needs for increased food production and economic development will be among the highest in countries in the tropics—in many cases the same countries where the REDD+ mechanism is important. Projections suggest that agricultural land reserves will be exhausted as early as the late 2020s, and almost certainly by 2050 (Lambin and Meyfroidt 2011).

The REDD+ process will need to take agriculture completely into account, but a recent analysis of country REDD+ readiness proposals shows that although countries acknowledge the importance of agriculture as a driver of deforestation, their proposed strategies and actions remain very general. More tangible, detailed measures that build on existing efforts and are calibrated to local conditions will be necessary to better manage agricultural drivers (Kissinger 2011).

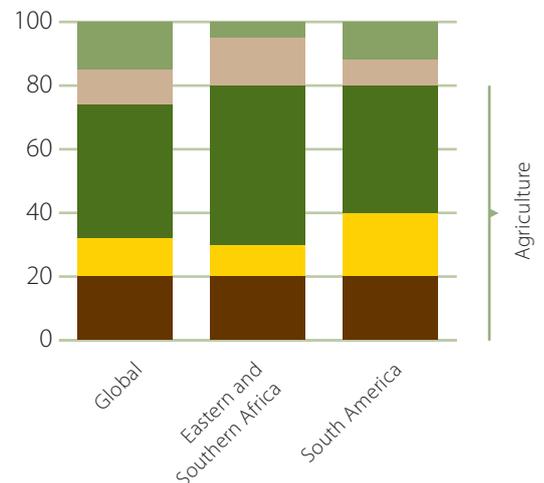
In this brief we examine what actions can be taken to achieve food security and economic development while halting deforestation. We make recommendations about how climate change mitigation can be achieved in an integrated way across the agricultural and forestry sectors.

Agriculture is a driver of deforestation

Agriculture contributes to about three-quarters of tropical deforestation (Figure 1). Although much of this deforestation is the result of both small-scale agriculture and industrial or commercial agriculture, ranching is also an important driver of deforestation. The drivers of deforestation differ significantly amongst regions and amongst countries within regions, which highlights the necessity of tailoring policies and plans for REDD+ and climate-smart agriculture to national and local contexts. Drivers also change over time, as demonstrated by the increasing importance



Figure 1: Agriculture as the main driver of global deforestation (% area). Two regions are also shown to illustrate the differences among regions. (Source: Blaser and Robledo 2007). Note: These figures are illustrative; different datasets show somewhat different patterns, and many drivers of deforestation are intertwined in complex sequences of causality.



of commercial agriculture globally. In a recent workshop hosted by the Common Market for Eastern and Southern Africa (COMESA) and the Terrestrial Carbon Group, participants emphasized that the drivers of agricultural expansion—such as global markets, trade policy, population levels, consumption patterns, migration policies or road building—must be also addressed when dealing with agriculture as a driver of deforestation. The drivers of agricultural activities vary in different places and the incentives for reducing the expansion of subsistence smallholder and industrial agriculture will also differ.

Most studies of land-use change predict that the expansion of croplands and grasslands will continue to be the dominant cause of land-use change in the future (Smith et al. 2010). The crop area in low-income countries is expected to expand between 2–49% by 2050 (Balmford et al. 2005). Increasing population and dietary shifts will be the primary drivers of the demand for agricultural land. Part of the demand for land will be driven by expanded production of biofuels, which is in turn driven by subsidies, fuel-mix standards, and other policy instruments (van Gelder and German 2011; Schoneveld et al. 2010). Forest and other natural areas are predicted to decline to accommodate the expansion. In addition, the potential of uncontrolled fires has to be considered for agriculture-forest landscapes, whether they are intentional (to clear forestlands) or unintentional (that is, started in agricultural areas but spreading to degraded or dried-out forests).

These trends are in direct conflict with policy aims to reduce climate change by avoiding the loss of carbon stored in tropical forests. In addition, forest loss has repercussions on livelihoods in general and sustainable agriculture in particular because of the various ways in which forests are essential for the provision of many important goods and services. These include the regulation of hydrological services (including the quantity, quality, and timing of water available for irrigation); pollination by forest-based bats

and bees; and maintenance of soil fertility and erosion control. Importantly, forests can help buffer communities against the extreme weather events likely to become more frequent with climate change, and are thus a critical element of ecosystem-based adaptation strategies (Locatelli and Pramova 2011).

Future agricultural conversion will depend not only on the demand for food but also on the manner in which it is produced, and the level of yields per hectare (land-use intensity). The use of improved technology, management and inputs such as fertilizer, pesticides and water has probably reduced the amount of land used to meet food needs in the past, although the extent of this reduction remains a matter of dispute. Globally, total crop yields—mostly cereal and oil crops—increased by 135% between 1961 and 2005 while cropland increased by only 27% (Burney et al. 2010). There is still vast potential for increasing productivity in many parts of the world, particularly in Africa. However, possible negative effects of intensification on the environment could weaken capacities to produce food in the long-run (Godfray et al. 2010). **Sustainable intensification** should therefore be a primary goal.

Sustainable intensification – increasing yield per unit of land to meet today's needs without exceeding current resources or reducing the resources needed for the future.

Sustainable intensification by increasing crop yields per area is only one of several pathways to increasing food security. In some circumstances, the most appropriate directions for sustainable and equitable development will be improving the production potential of diverse agroforests, complex woodland-fallow-and-crop mosaics, and other more extensive but high-carbon and high-biodiversity production systems (Perfecto and Vandermeer 2010; Scherr and McNeely 2008).

Food security and poverty alleviation imperatives

Despite increased food production in the last half-decade, according to the Food and Agriculture Organization (FAO) of the United Nations, 925 million people were hungry in 2010. Hunger in South Asia and sub-Saharan Africa was exceptionally high (von Grebmer et al. 2010). To address current hunger, food production is not the only challenge. Agriculture will also need to be adapted to future climate change and contribute to climate change mitigation.

Addressing issues of inequitable and poor distribution of food, as well as improvements in storage and processing can go a long way towards helping to extend food security. However, food needs are also projected to increase by 70–100% by 2050 when the global population reaches 9 billion. Scenarios to 2050 suggest that improved agricultural productivity, as part of a strategy for widely distributed economic growth, will be important to offset the negative effects of climate change on food security (Nelson et al. 2010). Other strategies for meeting future food needs include maximizing crops' full potential yields worldwide; increasing the production limits of crops through more efficient plant physiology; changing people's diets to rely on more efficient foods; reducing waste; and increasing sustainable aquaculture (Godfray et al. 2010)¹.

Climate change will require an agriculture that is more resilient and adapted to changing conditions, as well as contributes to the mitigation of climate change. Achieving triple wins for food security, adaptation and mitigation is the goal of climate-smart agriculture. In a recent publication, FAO set out an agenda for achieving climate-smart agriculture that includes working across the forestry and agriculture divide (FAO 2010).

¹ Sustainable aquaculture should not be at the expense of carbon-rich mangroves.

Climate-smart agriculture seeks to maximize synergies and minimize trade-offs in addressing food security, development and climate change adaptation/mitigation challenges.

Feeding people in decades to come therefore will require fundamentally new approaches to securing food, including producing more food on less land in more sustainable ways and improving carbon-rich production agroforestry and forest management systems for food. Farmers in forest areas will face particular challenges as poorly designed REDD+ mechanisms could restrict their access to land and forests that previously helped meet their basic food needs or contributed to national economic development. Halting agricultural expansion by subsistence farmers without alternative sources of livelihoods could exacerbate poverty. Stopping expansion by commercial farmers without improving their existing production systems or providing alternatives could affect national economic development and food security, and would certainly be politically difficult to implement.

Managing the agricultural frontier

Past efforts to protect forests by managing the advance of the agricultural frontier suggest that managing the porous forest-farm interface depends on a mix of institutional, market, technological and demographic factors. Institutions related to land tenure, zoning of land, forest governance and enforcement of forest boundaries are critical. Forest conservation and livelihoods have been improved most often where enforcement of forest boundaries was strong (Agrawal et al. 2011). Economic modelling also indicates for the Amazon that enforcement of existing forest boundaries is likely to be less costly than payments for environmental services (PES) to farmers for the production they would need to give up when they can no longer use forest land taken for conservation purposes (Börner et al. 2011).

Producing more crops from less land is a significant means of jointly achieving mitigation and food production in agriculture, assuming that the resulting spared land sequesters more carbon or emits fewer greenhouse gases than farmland. However, intensification often leads to local expansion of agriculture if increased demand for production is possible and labour is available (Angelsen 2010). Increased efficiencies due to intensification can perversely increase incentives for expansion (Ewers et al. 2009; Rudel et al. 2009). Intensification therefore requires pairing with policies and price incentives to strengthen its impacts on land sparing (Angelsen and Kaimowitz 2000).

There are large areas of land that are degraded and, where feasible, these should be targeted for agricultural expansion. Such targeting is especially important where agricultural expansion threatens carbon- and biodiversity-rich ecosystems such as the peat swamp forests of Southeast Asia (Wetlands International 2011).

Intensifying agriculture through the use of higher inputs can also lead to higher total emissions in the long run (in the atmosphere and per hectare) due to, for example, increased use of fertilizers, water, energy use or animal feed. The level of carbon sequestered in spared land will reach a limit over time, while the emissions from increased fertilizer use, for example, would continue to increase incrementally each year. In Vietnam, for example, emissions from increased paddy rice cultivation and pig rearing are predicted to overtake mitigation from carbon sequestered from avoided deforestation after 20 years (Leisz et al. 2007).

Agricultural improvements that also minimize impacts on the climate while maintaining or intensifying production are a priority. Sustainable agricultural land management (SALM) approaches to increase organic matter in the soil, and agroforestry should be explored

further for their potential for delivering food security, adaptation to climate change and mitigation of climate change (FAO 2010). Effort should be made to maximize these synergies and minimize trade-offs through targeted research, financing and location of production zones and projects.

Nepstad (2011) argues that one option for ensuring that agriculture does not undermine efforts to curb deforestation is to support commodity roundtables that embrace the certification of both large and small producers in key industries, for example, soy and palm oil. Farmers who clear forests or savannas to plant their crops would not get certified. Complementary efforts include the certification of internationally marketed forest products to ensure that they have been legally and sustainably produced.

Some elements that underpin the joint achievement of food security and climate change mitigation include: (a) the opportunities for sustainably intensifying agricultural production and avoiding conversion of high carbon landscapes, (b) the technical compatibility of food production and measures that reduce greenhouse gas emissions or sequester carbon, (c) the need for inexpensive measurement and monitoring for GHG budgets across landscapes, and (d) the economic feasibility of and incentives for changing farming and land-use practices without compromising investments in food security (Vermeulen et al. 2010). Innovation and capacity strengthening will be required in all four areas.

Actions needed

How can we stop deforestation, so as to maximize mitigation outcomes from REDD+ while also enhancing food security under a changing climate?

We identify five actions necessary to achieve positive outcomes for forest-agriculture landscapes and countries and urge early action on these to build experience for widespread implementation.

The five priority actions are:

- 1) Develop strategies to better integrate REDD+ and sustainable agricultural development.
- 2) Identify and implement incentives for 'climate-smart' agriculture.
- 3) Disseminate existing knowledge regarding the role of forests in supporting food security and sustainable agricultural production, and invest in further research to illuminate synergies and trade-offs.
- 4) Enhance forest governance and institutional arrangements to for forest conservation.
- 5) Substantially increase the finance available to meet the climate change and food security challenges faced by the agriculture sector.

Strategies to better integrate REDD+ and sustainable agricultural development

The above actions represent a portfolio approach. It is crucial that all these actions be effective, and together they should have synergistic effects. Agricultural intensification solely for the purpose of food production, or protection of forests solely for the purpose of climate change mitigation, will not create sustainable forest-agriculture landscapes. Integrated action is needed across REDD+ and agriculture to achieve both mitigation and food security outcomes (Rudel et al. 2009; Seymour and Angelsen 2009). Broader frameworks that consider multiple

desirable outcomes across both forestry and agriculture should guide policy and projects on the ground. National agricultural development policies and REDD+ will need to be aligned within broader low-carbon development strategies and comprehensive climate change action plans at the national level (Meridian Institute 2011).

There are limited decision support tools on which to base strategies that balance food security and mitigation goals across the forestry and agriculture sectors. Such tools are urgently needed now by national decision makers (Box 1). The tools need to clarify trade-offs, and need to address a range of agricultural activities including livestock, cropping, fisheries, bioenergy and forestry.

Box 1: Example of the kind of tool needed for making investment choices at national level

FAO has initiated FAO-MOSAICC (Modelling System for Agricultural Impacts of Climate Change). This is a system of models designed to carry out each step of the impact assessment from climate scenarios downscaling to economic impact analysis at national level. The four main components of the methodology are a statistical downscaling method for processing GCM (Global Circulation Models) output data, a hydrological model for estimating water resources for irrigation, a crop growth model to simulate future crop yields and finally a CGE (Computable General Equilibrium) model to assess the effect of changing yields on national economies.

Incentives for climate-smart agriculture

A recent report reviews the lessons learned to date from REDD+ and the implications for developing incentives and financing for climate-smart agriculture (Negra and Wollenberg 2011). REDD+ funding, as well as climate finance, more broadly, and financing for agricultural development (for example, farm credit, input

subsidies, extension), can be used to provide incentives for climate-smart agriculture that don't undermine forest conservation. In some cases these could be appropriately directed towards covering the opportunity costs of farmers that protect farm forests or participate in community-based forest conservation (including through fire prevention and management), while in other cases they may provide the extra incentives for farmers to switch to technologies and practices that are more climate-smart but which have, for example, higher up-front costs, such as planting trees for agroforestry.

Some of the agricultural incentives could be directed towards ensuring intensified production. For example, cattle ranching is responsible for much of the deforestation in the Amazon and must therefore intensify on a diminishing area of pastureland (Nepstad et al. 2009). Some investment will need to be directed towards climate risk management so that intensification investments are not undermined by climate shocks (FAO 2010). Wherever appropriate, agricultural incentives should be directed at moving agricultural expansion away from forestlands that provide high levels of ecological services and onto degraded lands that are below their productive potential.

Although there are many technologies and practices that can 'be taken from the shelf' and promoted immediately through appropriate incentives and information, there is nevertheless the need for more work on how these technologies and practices must be adapted to better capture synergies, and how they must be adapted to future climates.

Building on knowledge about the relationship between forests and food security

Forest protection is often presented as an impediment to agriculture and food security,

when in fact forests provide a largely hidden source of income and employment to rural communities, as well as ecosystem services necessary for sustainable agricultural production.

We know, for example, that forests and trees make significant direct contributions to the nutrition of poor households. A 2008 review of the literature on bushmeat affirmed that rural communities in the Congo Basin derived a significant portion of protein and fats in their diets from hunting wildlife from forests and forest edges. Forested watersheds and mangrove ecosystems also support the freshwater and coastal fisheries on which many communities depend. In addition, many fruits, nuts, grubs, mushrooms, honey and other edibles are produced by forests and trees. Forests also provide an important source of cash income with which to purchase food. A recently published database of income survey results from some 6000 households (CIFOR 2011) confirms that, on average, families living in and around forests derive between one-fifth and one-fourth of their income from forest-based sources. Information about these kinds of food sources and incomes from such 'hidden harvests' is not usually captured in national statistical accounts.

More importantly, however, maintaining forests as part of agricultural landscapes is critical for sustainable production. For example, native pollination services are estimated to affect the size, quality, and/or stability of harvests for 70% of global crops (Ricketts et al. 2008). Projections of the potentially devastating consequences of reduced rainfall on Brazil's booming agricultural sector due to deforestation in the Amazon are sufficiently dire to focus the attention of national policy makers, with or without REDD+ revenues (WHRC N.D.). In addition, forests are the home of wild relatives of many economically important crops, thus constituting a reservoir of genetic variation that will be

increasingly important for adaptation to climate change.

Policy makers need to be made aware of the many ways in which forests support rather than constrain agricultural production and, more broadly, food security. Further research could provide more specific guidance on synergies and trade-offs that should be considered in land allocation decisions.

Enhance forest governance and institutional arrangements for forest conservation

As indicated in the CIFOR publication "Realising REDD+" (Angelsen et al. 2009), a whole range of sound governance arrangements will be needed if REDD+ is to be successful. These include new institutions to implement payment mechanisms linked to monitoring, reporting, and verification (MRV) systems for achieving mitigation targets; improved practices to minimize opportunities for corruption in new revenue flows; and optimal decentralization of decision making.

Of potentially the most significance to managing the agriculture/forestry interface are governance reforms related to clarification and strengthening of resource tenure, more transparent and equitable land-use planning and enforcement, and better co-ordination across sectoral agencies and levels of government. Even though Brazil is a leader among nations in recognizing forest management rights of individuals and communities (Sunderlin et al. 2008), Börner et al. (2011) estimate that fully half of the forest area in the Brazilian Amazon that is economically feasible for protection through REDD+ payments would be disqualified due to land tenure 'chaos'. Directing agricultural expansion to already deforested areas in countries such as Indonesia would require significant government intervention to resolve conflicting claims over degraded land. Co-operation among ministries of forestry and agriculture and local government agencies would also be crucial for the success of relevant permitting processes.

Interventions must be sensitive to the needs of smallholder or disadvantaged farmers and local forests, farms and ecosystems (FAO 2009). Rights to land, resources and carbon will need to be clearly defined (May and Millikan 2010), and the risk of rights violations proactively monitored and managed (Seymour 2010). In particular, law enforcement efforts should be appropriately targeted so as to prioritize large-scale, destructive forest crime rather than relatively benign subsistence activities (Colchester 2006). Smallholders and disadvantaged farmers—including women and indigenous groups—should participate in decisions at all levels and maintain the right to free, prior and informed consent to REDD+ activities. Capacity for conducting needs assessments, participatory planning, identification of constraints to adoption of and support for implementation of new approaches will need to be developed.

A strong science base – across physical, socioeconomic, and political sciences -- is critical to ensure the success of REDD+. For example, there are still gaps in the understanding of land-use changes on emissions, and more biophysical research is required. Economic analysis could provide a better understanding of the implications of incentives for agriculture in forest areas, as such incentives could drive up opportunity costs for REDD+, making REDD+ less viable. In addition, a better understanding of the political economy of agricultural drivers of forest loss, as well as how constituencies for business-as-usual can be converted to constituencies for change, is essential.

Substantially increase the finance available to meet the climate change and food security challenges faced by the agriculture sector

FAO has argued that sustainable transformation of the agriculture sector, necessitating combined action on food security, development and climate change, will be costly and will require large-scale investments to meet these projected

costs (FAO 2010). Uncertainties about potential losses, catastrophic risks and increased costs of inaction associated with climate change indicate that immediate and more aggressive transformative action is needed. Financing is thus urgent. They have argued that the available financing, current and projected, is substantially insufficient to meet the challenges faced by the agriculture sector. Synergistically combining financing from public and private sources, as well as those earmarked for climate change and food security, are innovative options to meet the investment requirements of the agricultural sector.

Conclusions

Mechanisms for forest protection and improved agricultural practices will require close co-ordination. Meeting future food needs will require developing approaches to climate-smart agriculture that best suit the needs of diverse farmers in different places.

Sustainable intensification of agriculture (the increase of yields per unit of land or other input) will be one strategy for producing more food in places where land is limited. The role of forests in supporting such intensification should be recognized and further clarified. For intensification to also reduce conversion of carbon-rich forests, strong institutional measures will be needed, especially for enforcement of forest boundaries. Intensified agriculture will also have to be more resilient to climate change, and reduce its impacts on climate change and the environment. Perennial and intensified annual-crop agriculture that adopts sustainable agricultural land-management approaches may be able to sequester significant amounts of carbon in the soil and above-ground biomass.

National agricultural development policies and REDD+ must be aligned within broader low-carbon development pathways and

comprehensive climate change action plans at the national level to avoid spiralling incentives for undesirable land use, as well as manage opportunity costs for REDD+. A combination of governance arrangements with both positive incentives and regulations and sanctions is required. A sound science base is necessary to improve the array of climate-smart technologies and practices currently available, and to identify appropriate incentives for achieving the triple wins of food security, adaptation and mitigation. Major new financial resources will be needed to transform the agricultural sector.

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