Background Brief

Forests and climate change

This background brief has been jointly produced by
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Better management of agricultural lands, forests, and tree resources is an effective response to many of the challenges of climate change. Actions in both the agriculture and forestry sectors can contribute to reducing emissions, and to enhancing resilience and reducing vulnerability of rural populations around the world. Land-use change for agriculture, including tropical deforestation, is a significant source of greenhouse gas (GHG) emissions and an active contributor to climate change. Agricultural systems that replace forests are sources of persistent emissions. The contribution of forests to carbon sequestration and mitigation of emissions is recognized in the international negotiations on Reducing Emissions from Deforestation and forest Degradation (REDD+), related national strategy initiatives, and the many landscape-scale pilot projects under way around the world. A specific mechanism to support reduction of agricultural emissions and emissions from other land uses has not yet been developed, which prevents the creation of international incentives for countries who wish to rely on agricultural emissions reductions as a part of their contributions to global GHG emissions reductions.

Agriculture and land-use change also account for 24 percent of GHG emissions. Deforestation and forest degradation are estimated to be responsible for 11 percent of total global GHG emissions net of reforestation. If sequestration from reforestation and afforestation are excluded, the share of global GHG emissions rises to nearly 20 percent. Agriculture accounts for about 10 to12 percent of the total global anthropogenic emissions of GHGs or between 5.1 and 6.1 gigatons of carbon dioxide equivalent (GtCO_2e) per year. Between 1990 and 2010, emissions increased by around 18 percent, with a greater increase after 2005. Emissions are expected to continue to increase due to increased demand for food as populations grow and shift in diets as societies in developing countries become wealthier and meat consumption increases. There are two types of emissions from agriculture:

- Non-CO_2 GHGs from management operations = 6.3 Gt CO_2e
- Energy-related CO_2 emissions (including emissions from manufacture of fertilizer) = 0.6 Gt CO_2e

A third type of emission from land-use change often associated with agriculture is also large, at around 3 to 10 Gt CO_2e per year.

Between 2000 and 2010, the world lost on average 13 million ha of forest (gross) each year to deforestation – the clearing of forests and subsequent conversion of the land to some other use. Commercial agriculture is responsible for about 50 percent of this loss, and the expansion of subsistence agriculture is responsible for another 30 percent. While the IPCC reported a small decrease in deforestation emissions in the last decade, trends of increasing deforestation in Indonesia despite a moratorium on new logging concessions, and in Brazil following several years of dramatic decreases, are causes for concern.

In addition to their contribution to climate change mitigation, better management of agricultural systems, forests, and trees are also relevant to adaptation, i.e. the reduction of the impacts of climate change on ecosystems and societies. Policy makers and practitioners at national and subnational levels face many challenges in the development and implementation of mitigation and adaptation policies and measures, including REDD+, the Clean Development Mechanism (CDM), Nationally Appropriate Mitigation Actions (NAMAs), National Adaptation Plans (NAPs), National Adaptation Programmes of Action (NAPAs) and other adaptation policies. We focus on providing the knowledge and tools needed to enhance the role of agricultural systems, forests, and trees and their diversity in mitigating and adapting to climate change.

Meeting the demand for food, and commodities more generally, does not need to be at the expense of converting high-conservation-value forests or forests with watershed or other ecosystem benefits. There are opportunities – through integrated agricultural practices, more efficient use of inorganic inputs, investments in degraded lands, and reduction in processing and consumption waste – for making increased food production compatible with REDD+ and the broader agenda of climate resilience and adaptation.

Common misconceptions

Reducing emissions in land-based economic sectors is not as easy as originally thought. Reducing emissions from deforestation and forest degradation was initially proposed as a low-cost and easy means to begin cutting anthropogenic emissions of GHGs in the Stern Report. However, to professionals with experience in tropical forestry, it is not surprising that REDD+ is proving to be much harder to implement than expected. Deforestation and forest degradation have a long history, and powerful interests have a stake in their continuation. The challenge of REDD+ is to solve a fundamental collective action problem: to create a system that provides forest users with economic incentives that reflect the value of the carbon stored in trees as well as the non-carbon-related (social, environmental and governance) co-benefits. Building that system is an ambitious political, economic and social undertaking.

Achieving emissions reductions in agriculture is also fraught with challenges. Analyses by several groups suggest that there is significant technical and financial potential for reducing emissions from this sector. The technical mitigation potential of agriculture (considering all gases and sources) by 2030 is estimated to be between 4.5 and 6.0 $GtCO_2e$ per year. However, mitigating this is expensive, and estimates of the economic potential for emission reductions by 2030 are considerably lower than the technical potential. Emissions reductions between about 8 and 20 percent are achievable, depending on the price of carbon. Thirty percent of this potential can be achieved in developed countries and 70 percent in developing countries.

While the debate around mitigation in the agricultural sector is often couched in terms of a trade-off between climate change mitigation and food security, it is useful to note that food security is rarely an issue of food production and more often a question of availability and access to food. In many parts of the world, the causes of inadequate food access are poverty, environmental stressors and conflict, not production. The recent Technical Expert Meeting on non-CO_2 emissions held a part of the Ad Hoc Working Group on the Durban Platform (ADP) identified that food security can act as a major driver and a co-benefit of policies concerning mitigation from the agriculture sector.

Forests and trees have not been considered in most adaptation policies to date, and this dimension is typically ignored in REDD+ demonstration activities as well as the international REDD+ framework. Sectors that are prioritized in adaptation tend to define strategies in the absence of linkages to other sectors. Agriculture has had more attention because of its dependence on climatic conditions and its vulnerability to climatic variation. Taking an integrated approach through ecosystem-based adaptation (EBA) will improve this situation and will require both mainstreaming adaptation into forest and tree management (so that managers consider climate change threats to forests and trees) and mainstreaming forests and trees into wider adaptation strategies (so that non-forest stakeholders dealing with adaptation consider forests and trees as part of adaptation measures). Although the Agriculture Road Map agreed in Bonn in June 2013 is being undertaken in the context of agriculture and adaptation, it is hoped that these linkages will be brought to light through the engagement of technical experts in that process.

Key points of debate

The main points of debate concern managing trade-offs:

- The projections of greater food demand resulting from the increase in human population (to 9 billion by 2050) suggest that food production may need to increase by between 60 and 110 percent by 2050. The expected growth in the middle class also points to dietary shifts and an increase in animal products in human diets. The debate focuses on one level on changing behavior of consumers – so called demand-side interventions – and improving management of landscapes to reduce negative environmental impacts of forestry and agriculture activities – supply-side solutions.
- Any change to regulating land use will have impacts on current land uses. As mitigation and adaptation programs are implemented, there are challenges of ensuring that local rights are recognized and protected, and that communities do not lose access to and use of land and forests. Livelihoods of rural peoples need to be protected and enhanced through mitigation and adaptation schemes.
- Mitigation and adaptation schemes are agreed and mandated at national levels, but implemented at local and regional levels. There is a need for integrating these national objectives with subnational realities in appropriate ways that take into account local realities and local aspirations for development.
- The international climate change arena has historically focused on adaptation as separate from mitigation. This separation has created separate policy frameworks at the international and national levels as well as separate mechanisms and institutions. An integrated approach to forestry and agriculture (landscape management) can be beneficial and generate greater benefits than a sector-specific approach. Similarly, an integrated approach to climate change action: adaptation-based mitigation could be a no-regrets option if done deliberately and carefully. The challenge has been on how to effectively operationalize this concept and move beyond the traditional separated approach.

Multiple uses of traditional coffee agroforestry support resilience of smallholder farmers in Guatemala

(Schmitt-Harsh et al. 2012)

In the Atitlán region of Guatemala, smallholder coffee agroforestry exists within a mosaic of agriculture, tropical dry forest, and pasture. Although the area under coffee agroforestry is relatively small, approximately 500 ha across the landscape, these multi-strata forests provide many services to farmers including income from coffee, erosion control, and production of timber and other non-timber forest products. Despite recent pressures to convert coffee agroforests to sun coffee, such as increased presence of leaf rust and economic incentives favoring coffee monocultures, farmers in Atitlán continue growing coffee in complex poly-cultures. There is currently no widespread policy incentive encouraging the maintenance of shade trees for the benefit of carbon sequestration. In facilitation of such incentives, an understanding of the capacity of coffee agroforests to store carbon is developed. Recently, a number of studies have documented the importance of carbon storage in coffee agroforests with average above- and below-ground stocks of more than 120 MgC per ha.

Recommendations

- Policy makers need to consider the full range of policy measures, including the establishment of financial incentive mechanisms to promote wider adoption of best practices in forestry and agriculture that reduce GHG emissions and improve resilience to climate variability. For emissions abatement, incentives could be created through processes such as intended nationally determined contributions and modalities such as JI, CDM, REDD+, NAMAs and NAPs. Agricultural mitigation options are gaining importance in the CDM already, and sectoral approaches could also be considered. Integrating land-use emission-reduction schemes to deal with emissions from all land uses in a comprehensive mechanism could increase efficiency and help solve problems associated with leakage and permanence.

- Given the importance of agricultural emissions and the vulnerability of the sector to climate change and climate variations, it will be essential to find ways to produce more food while emitting less GHGs. The science of mitigation in agricultural production systems is maturing and progress can be made if the right incentives are put in place. Those incentives should also include support to national scientific organizations to generate more country- and region-specific knowledge to support better, less-polluting agricultural practices.

- Building on the experiences in REDD+, efforts to reduce emissions from agriculture and other land use will need to consider the following:

  » Safeguarding people's rights and access to land and resources while reducing emissions

  » Drawing on data regarding emissions reductions from different agricultural management practices, identify which of the low-emission agricultural management practices are economically viable and can help conserve ecosystem functions and biodiversity. Following this, incentives and assistance will be needed to promote the practices that can generate multiple benefits at scale

  » Identify opportunities to draw on existing systems to effectively monitor emissions reductions from agriculture and show that this is being achieved in a socially responsible and environmentally sustainable manner, with permanence and without leakage.

- A major challenge is to reduce the vulnerability of forestry and agriculture to climate variability as an integral part of sectoral development planning. This will require developing and implementing "best practice" guidelines for developing appropriate EBA strategies, i.e. strategies for conserving or managing ecosystem services with the objective of reducing the vulnerability of society to climate change. These strategies can complement other adaptation strategies, be cost-effective and sustainable, and generate environmental, social, economic and cultural co-benefits.

- The international processes that are being coordinated by the United Nations can be a motor for change, but ultimately governments, the private sector, and civil society are going to have to work together to implement better land stewardship in real places.

Remaining knowledge gaps

- Further work is needed to improve assessments of GHG emissions from agriculture, to improve management practices to ensure environmental integrity, to design efficient policies to implement GHG mitigation, and to strengthen the potential of agriculture to contribute to producing renewable energy. Better country-specific information on the mitigation potential of different practices for agriculture will help countries design the most appropriate portfolios of mitigation practices. The information on mitigation potential contained in the IPCC AR4, AR5 and FCCC/TP/2008/8 provides a good starting point, but does not provide the necessary level of regional/national disaggregation needed for national implementation.

- Adaptation-based mitigation approaches can meet short-term needs to reduce vulnerability to climate change and enhance resilience while reducing the GHG emissions of land-based sectors. Additional work is needed to understand how to operationalize adaptation-based mitigation, through policies, incentives and mechanisms for coordination, harmonization and cooperation among ministries (especially ministries responsible for agriculture, water, land and forests).

- Identifying synergies and co-benefits in relation to climate change policies, sustainable development, food security, energy security, and improvements in environmental quality would make mitigation practices more attractive and acceptable to farmers, land managers and policy makers. Understanding trade-offs is equally important so that appropriate decisions can be made.

The thematic area on forests, agriculture and land use in the new climate regime explores these opportunities and shares lessons and linkages among sectors in the landscape and how to feature these in a future climate agreement.

Restoring land using trees to increase adaptive capacity

In Kenya, the Regional Development Authorities are implementing catchment conservation programs covering vast areas in the country to promote practices that, among other things, address soil erosion and water loss. One of the interesting approaches was the "fanya juu" and the cutting of drains that was adopted in dry parts of the Machakos, Majueni, and Kitui districts. Because of their success in areas that otherwise would be bare lands, these practices are therefore spreading to other areas of the country. In Machakos for instance, crop yields have increased by 50 percent (or by 400 kg/ha) through the use of fanya juu terraces.

In Mali and Niger, for the past 30 years, the loss of natural vegetation reduced the arid zone ecosystems' resilience to recurrent droughts. As a consequence, local people face famine, poverty, and migration. In an already drought-afflicted region, additional climatic stresses are expected to be detrimental to food security and development. International donor assistance has been provided to these countries to finance reforestation of more than 23,000 hectares of Acacia *senegalensis*, a species native to the African Sahel, on communal degraded land throughout Mali and Niger. Planting of this native species is expected to restore habitat for native fauna and projected to sequester approximately 0.3 Mt CO_2e (metric tons of CO_2 equivalents) by 2017 and 0.8 Mt CO_2e by 2035 in Mali, and 0.24 Mt CO_2e by 2012 and about 0.82 Mt CO_2e by 2017 in Niger. The rehabilitation of degraded land, improves soil fertility, creates jobs, and increases local incomes through sales of high-quality Arabic gum and payments from Credit Emission Reductions (CERs) (Tahia 2010).

Long-term research has shown that fertilizer tree systems (using nitrogen-fixing trees such as *Faidherbia albida*), when intercropped with maize, contribute to increased drought resilience of maize due to the combined effects of improved soil nutrient levels and increased water infiltration into the soil (Garrity et al. 2010). This research on *F. albida* is supported by widespread indigenous knowledge among farmers in Africa regarding the benefits of this tree (among others) through nitrogen fixation and the supply of fodder (Tougiani et al. 2009).

With respect to key cash crops, recent studies have documented the contributions of shade trees to protecting coffee agriculture from climate variability and climate extremes. Specifically, based on research in high-, medium-, and low-shade coffee sites in Central America, Lin (2007 and 2010) found that shade trees have a positive influence on the intensity of fluctuations in temperature, humidity, solar radiation, and soil moisture, all climatic variables to which coffee crops are extremely sensitive.

These studies suggest that in some contexts agro-forested approaches may be more successful than agricultural intensification in addressing some of the climate change threats to society's agricultural systems (Lin et al. 2008). Furthermore, Verchot et al. (2007) found that more diversified farming systems suffer less from climate shocks when measured over the long term. These conclusions are supported by Venema (1996), which used a water resources simulation model to demonstrate that a natural resources management policy could bring larger areas under agricultural production with less water and also enhance the sustainability of food production.

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