A community forestry awareness campaign in a primary school of Butisongo, Democratic Republic of Congo.

Photo: Axel Fassio/ Cifor-Icraf

Adapting agriculture for a safe planet

The Agriculture, Forestry, and Other Land Uses (AFOLU) sector accounts for almost a quarter of global greenhouse gas emissions, provides a carbon sink and renewable resources for substitution of fossil fuels, offers several co-benefits and has synergies with the Sustainable Development Goals. Despite its immense potential for climate mitigation at low cost, the lack of climate financing and other barriers are preventing the sector from realising its full potential for reducing greenhouse gas emissions.

By K. N. Ninan

The Sixth Assessment report of the Intergovernmental Panel on Climate Change (IPCC) depicts a gloomy picture of the climate situation with the last decade from 2010 to 2019 recording the highest decadal absolute increase in greenhouse gas (GHG) emissions since 1850. Global net anthropogenic GHG emissions in 2019 were on average around 59 gigatonnes of carbon dioxide equivalent ($GtCO_2$-eq.), of which 64 per cent was due to carbon dioxide (CO_2) emissions from fossil fuels and industry, 11 per cent due to net CO_2 emissions from land use, land use change and forestry, 18 per cent from methane (CH_4), 4 per cent from nitrous oxide (N_2O) and 2 per cent from fluorinated gases (F-gases). Without accelerated mitigation actions by countries, the world is most likely to overshoot the goal of limiting global warming to the 1.5°C or 2°C above pre-industrial levels agreed at the Paris Climate Summit in December 2015, with median global temperatures likely to rise to 2.2–3.5°C by 2100. If this happens, it will aggravate the frequency and intensity of natural disasters and extreme weather events, with adverse consequences for human and natural ecosystems, human well-being and good quality of life. What is distressing to note is the gross inequalities in emissions. The global wealthiest 10 per cent contributed about 36–45 per cent of global GHG emissions. The share of developed countries to these emissions (excluding net CO_2 emissions from land use, land cover change and forestry) in 2019 was as high as 57 per cent, as against just 3.3 per cent by least developed countries (LDCs).

The AFOLU sector

In 2019, the Agriculture, Forestry and Other Land Uses (AFOLU) sector contributed almost a quarter of global GHG emissions (22 %), next to the industrial (23 %) and energy (34 %) sectors. Besides, the AFOLU sector (managed land) is an important carbon sink, absorbing almost a third of global anthropogenic CO_2 emissions, and provides biomass resources that can substitute for fossil fuels. The sector is noteworthy for emitting non-CO_2 gases, namely methane (CH_4) from enteric fermentation by ruminant livestock and nitrous oxide (N_2O) from manure application, nitrogen deposition and nitrogen fertiliser use in the agricultural sector which increased by around 4.2 $GtCO_2$-eq. per year and 1.8 $GtCO_2$-eq. per year respectively during the period 2010–2019. Land also plays an important role in climate through albedo effects – incoming sunlight reflected back into space – and evapotranspiration, although the role of these two factors in total climate forcing is unclear. The sector provides several co-benefits, such as enhancing biodiversity and ecosystem services, and has synergies with the Sustainable Development Goals (SDGs).

According to the Sixth Assessment Report of the IPCC, the AFOLU sector can provide 20–30 per cent of global mitigation potential needed for a 1.5°C or 2°C pathway towards 2050. About 30–50 per cent of the estimated mitigation potential can be achieved at below 20 US dollars (USD) per tCO_2-eq. But despite its potential for climate mitigation at low cost, co-benefits and synergies with the SDGs, the lack of climate financing, and institutional, social and other barriers are preventing the sector from realising its full potential in reducing GHG emissions.

Mitigation achievements and potential

The AFOLU sector's contribution to global net mitigation has so far been modest. It delivered about 0.65 $GtCO_2$-eq. per year of mitigation from 2010 to 2019, which is around 1.4 per cent of global total GHG emissions during this period. Forestry-related measures accounted for the major share (>80 %) of this emission reduction. The total emission reductions or offsets attributed to the AFOLU sector over the period 2007–2018 were 7,897.4 $MtCO_2$-eq. (metric tonnes of carbon dioxide equivalent) from mitigation measures such as Clean Development Mechanisms (CDM), voluntary carbon standards, compliance markets and reduced deforestation. Of this, reduced deforestation/ REDD+ accounted for 6,894.5 $MtCO_2$-eq., i.e. 574.5 $MtCO_2$-eq. per year out of a total of 658.1 $MtCO_2$-eq. per year. Mitigation measures such as establishing and respecting tenure rights and community forestry, improved agricultural and forest management, biodiversity conservation, payment for ecosystem services, joint regulatory efforts, etc. have contributed to this modest achievement. So far, 0.7 billion USD per year has been spent on mitigation in the AFOLU sector, which is well below the 400 billion USD per year – an amount less than current subsidies provided to the agricultural and forestry sectors – needed by 2050 to deliver about 30 per cent of the global mitigation effort.

In the nationally determined contributions (NDCs) pledged by countries to the United Nations Framework Convention on Climate Change (UNFCCC), AFOLU mitigation measures have been assigned an important role. As per the IPCC report, the sector can deliver close to a third of the global mitigation needed for reaching the 1.5°C or 2°C pathway target towards 2050, with the largest share of the economic potential being contributed by forests and other natural ecosystems, followed by agriculture and demand-side measures such as shifting to healthier diets and reducing food loss and waste.

Most options are available and ready to deploy

Based on integrated assessment models (IAMs) and global sectoral studies, the Sixth Assessment Report of the IPCC estimates the likely

Estimated technical and economic potential for selected mitigation options in the Agriculture, Forestry and Other Land Uses (AFOLU) Sector up to 2050

Mitigation options	Technical potential – mean and range in $GtCO_2$-eq. per year up to 2050	Economic potential – mean and range in $GtCO_2$-eq. at USD 100 per tCO_2-eq.	Confidence level
Forest and other ecosystems			
Reduce deforestation and degradation	4.5 (2.3-7)	3.4 (2.3-6.4)	Medium
Afforestation/ reforestation/ forest restoration	3.9 (0.5-10.1)	1.6 (0.5-3.0)	Medium
Improved forest management	1.7 (1-2.1)	1.1 (0.6-1.9)	Medium
Fire management of forests, grasslands, savannahs	0.1 (0.09-0.1)	0.05 (0.03-0.1)	Low
Conservation of grasslands and savannahs	0.2 (0.1-0.4)	-	Low
Conservation and restoration of peatlands	0.8 (0.4-1.7)	0.4 (0.2-0.6)	Medium
Conservation and restoration of coastal wetlands	0.5 (0.05-3.1)	0.1 (0.05-0.1)	Medium
Agriculture			
Enhanced soil carbon management in croplands	1.9 (0.4-6.8)	0.6 (0.04-0.1)	Medium
Enhanced soil carbon management in grasslands	1.0 (0.2-2.6)	0.9 (0.3-1.6)	Medium
Biochar	2.6 (0.2-6.6)	1.1 (0.3-1.8)	Medium
Agroforestry	4.1 (0.3-9.4)	0.8 (0.4-1.1)	Medium
Enteric fermentation	0.8 (0.2-1.2)	0.2 (0.1-0.3)	Medium
Improved rice management	0.3 (0.1-0.8)	0.2 (0.05-0.3)	Medium
Crop nutrient management	0.3 (0.06-0.7)	0.2 (0.05-0.6)	Medium
Manure management	0.3 (0.1-0.05)	0.1 (0.09-0.1)	Medium
Bioenergy and BECCS	5.9 (0.5-11.3) #	1.6 (0.5-3.5) #	Medium
Demand-side measures			
Shifting to healthier diets	3.6 (0.3-8.0) 1.7 (1-2.7) @	2.5 (1.5-3.9)	Medium
Reduce food loss and waste	2.1 (0.1-5.8) 0.5 (0.0-0.9) @	-	Medium
Improved and enhanced use of wood products	1.0 (0.04-3.7)	0.4 (0.3-0.5)	Medium

$GtCO_2$-eq. = gigatonnes of carbon dioxide equivalent; tCO_2-eq = tonnes of carbon dioxide equivalent; USD = US dollars. Since greenhouse gases (GHGs) consist of different gases such as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and other gases, they are converted into carbon dioxide equivalent using the global warming potential (GWP100) of the different gases estimated over 100 years.
BECCS = Bioenergy with Carbon Dioxide Capture and Storage
@ Feasible potential if you consider diverted agricultural production
# Refers to net carbon dioxide removal (CDR) in BECCS
Source: Gert-Jan Nabuurs et al. (2022). Agriculture, Forestry and Other Land Uses. Chapter 07 in J. Skea, P. Shukla et al. (eds.). Climate Change 2022: Mitigation of Climate Change Report, IPCC, Geneva, Switzerland.

range of global land-based mitigation potential at around 8–14 $GtCO_2$-eq. per year between 2020 and 2050 at 100 USD per tCO_2-eq. which is half of the technical potential. Between 30 and 50 per cent of this potential can be achieved at less than 20 USD per tCO_2-eq. Most mitigation options are available and ready to deploy. The economic potential is estimated to be the highest in tropical countries due to the large potential from reducing deforestation and sequestering carbon in forests and agriculture.

Among mitigation options reducing deforestation and degradation, afforestation/ reforestation and improved forest management have an immense potential for mitigation. In the NDCs, reducing deforestation has been assigned a major role for realising the Paris climate goals. In the agricultural sector, enhancement of soil carbon management in croplands and grasslands, biochar, agro-forestry, enteric fermentation, improved rice, crop nutrient and manure management can contribute significantly to mitigation. Options for areas with a significant potential are referred to in the Table on page 39.

Carbon stock measurement in mangrove forests.

Photo: Aulia Erlangga/ Cifor-Icraf

Unsustainable agricultural and soil management practices have led to a deterioration of soil quality, productivity and their carbon holding capacity. An IPBES assessment on land degradation and restoration by Luca Montanarella et al. in 2018 notes that over the past two centuries, soil organic carbon, an indicator of soil health, has seen an estimated 8 per cent loss globally (176 gigatonnes of carbon, GtC) from land conversion and unsustainable land management practices. Projections to 2050 predict further losses of 36 GtC from soils, particularly in sub-Saharan Africa. These losses are projected to come from the expansion of agricultural land into nature areas (16 GtC), degradation due to inappropriate land management (11 GtC), the draining and burning of peatlands (9 GtC) and melting of permafrost. Improved agricultural management practices such as shifting to improved crop varieties, crop rotation, use of cover crops, perennial cropping systems including agro-forestry systems, integrated production systems, crop diversification, agricultural technology, reduced tillage intensity and residue retention, improved water and rice management, biochar application, management of vegetation, livestock and fire can enhance soil quality, productivity and soil carbon storage.

Biochar can enable carbon dioxide removal (CDR) and emissions reduction as well as enhance soil properties, productivity and resilience to climate change. Land management practices such as agro-forestry, which seek to combine growing of trees with agricultural crops and livestock rearing, have several co-benefits, with an estimated economic potential of around 0.8 $GtCO_2$-eq per year at up to 100 USD per tCO_2-eq.

Unlike other sectors, the AFOLU sector generates non-CO_2 gases such as methane and nitrous oxide, whose global warming potential is higher than that of CO_2. Emerging technologies like vaccines or inhibitors have the potential to substantially increase the CH_4 mitigation potential beyond current estimates. Poor implementation of mitigation measures can however result in maladaptation with adverse consequences for biodiversity and ecosystems, water and food security, lives and livelihoods.

Barriers

The effective implementation of AFOLU mitigation measures can be inhibited by a wide range of factors. Here are some examples:

Socio-economic and cultural factors: Lack of resources and providing alternative incomes and livelihoods to rural communities who depend on forests, agriculture and other ecosystems are major constraints for implementing AFOLU mitigation measures. Poverty and rising inequality pose a big challenge for making agriculture climate-resilient. A study of climate change and rural poverty trends in India by the author noted that climate change will not only lead to a decline in crop yields but also aggravate poverty levels. In their NDCs, 82 parties to the United Nations Framework Convention on Climate Change (UNFCCC) cited poverty, inequality and other social issues as constraining the implementation of mitigation measures. Tradition and cultural values as well as local contexts can hamper efforts to shift to sustainable and healthy diets that have a low carbon footprint.

Governance and institutional factors: Weak governance, accountability and institutional barriers pose a challenge for implementing mitigation measures. Lack of property rights, insecure tenure, lack of participation of indigenous and marginalised communities in decision-making and governance failures at different levels can undermine incentives to increase productivity and incomes, and discourage the adoption of forest and farm conservation practices. Although climate-smart agriculture was promoted with a view to make agriculture sustainable and climate resilient, experience with climate-smart cocoa production in Ghana indicates that a lack of tree rights and other barriers discouraged cocoa growers from undertaking land improvement measures, which affected the successful implementation of the project (see Box).

Technological factors: Monitoring, reporting and verification is another barrier. There is need to improve methods to measure changes in tree and carbon density on site using satellite data. Monitoring and verification of soil carbon storage projects are difficult.

Ecological factors: Mitigation measures need to be carefully implemented by considering their likely impacts on biodiversity and ecosystem functioning, environmental quality, water and food security, livelihoods and human well-being. The loss of biodiversity and ecosystem services will affect the resilience of ecosystems to climate change and make them more vulnerable to natural disasters and weather-related climate extremes. Coastal afforestation can lead to re-acidification and damage aquatic biota.

Risks, trade-offs and synergies: There are risks, trade-offs and synergies with ecosystem services and the SDGs. Mitigation policies should try to minimise trade-offs and maximise synergies as well as consider scale and contexts. While mitigation measures such as reforestation and conservation of forests and other ecosystems may enhance biodiversity and ecosystem services, others, like large-scale deployment of bioenergy crops, may be detrimental to biodiversity, food and water security, livelihoods and rights of local and indigenous communities in areas where they compete with land used for food production and other livelihood activities.

Without accelerated mitigation the world will miss reaching the Paris global climate goals. If this happens, global GDP is likely to decline by 1.3-4.2 per cent by 2050, make us more vulnerable to natural disasters and weather-related climate extremes, and jeopardise achievement of the SDGs.

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References: **www.rural21.com**

Climate-smart cocoa production in Ghana

The climate-smart cocoa (CSC) production programme was introduced in Ghana in 2011 and implemented by Ghana's Forestry Commission and the national cocoa board (Cocobod) in partnership with the private sector (Touton) and NGO representatives (Nature Conservation Research Centre) with the aim of reducing cocoa-induced deforestation and GHG emissions and improving productivity, incomes and livelihoods of smallholder cocoa producers in the country. It brought all stakeholders together, i.e. the government, private sector, local farmers and civil society or NGOs, to facilitate the sustainable intensification of cocoa production. The creation of a community-based governance structure was expected to promote benefit sharing, forest conservation, adaptation to climate change and enhanced livelihood opportunities.

The programme involved distributing shade tree seedlings that can protect cocoa plants from heat and water stress, enhance soil organic matter and water holding capacity of soils, and provide other assistance with agroforestry, giving access to extension services such as agronomic information and agro-chemical inputs. The shade tree seedlings were distributed by NGOs, government extension agencies and the private sector free of charge or at subsidised prices, and were expected to reduce pressure on forests for growing cocoa plants. The CSC programme was mainly targeted at small farmers who constitute about 80 per cent of the total farm holdings in Ghana. Although the government extension agency undertook mass spraying or mass pruning of cocoa farms they found it difficult to access the 800,000 cocoa smallholders spread across the tropical south of the country.

Critical enablers

The role assigned to local government mechanisms such as Ghana's Community Resource Management Area Mechanisms (CREMAs) was expected to give a voice to smallholders, who are an important stakeholder in Ghana's cocoa sector. CREMAs are inclusive because authority and ownership of natural resources are devolved to local communities who can thus have a voice in influencing CSC policy, thereby ensuring equity and adapting CSC to local contexts. However, ensuring the long-term sustainability of CREMAs will help to make them a reliable mechanism for farmers to voice their concerns and aspirations, and ensure their independence as a legitimate governance structure in the long run. The private


Photo: Adobe Stock

sector was assigned the important role of popularising climate-smart cocoa production in Ghana. However, whether this will work to the advantage of smallholder cocoa producers remains to be seen.

Critical barriers

The policy intervention overlooks the institutional constraints characteristic of the cocoa sector in Ghana, where small farmers are dominant and have skewed access to resources and markets. Lack of secure tenure (tree rights) where the ownership of shade trees and timber vests with the state as well as bureaucratic and legal hurdles to register trees in their cocoa farms are major constraints that impede the realisation of the expected benefits of the CSC programme. This is a great disincentive for small cocoa producers to implement CSC initiatives, nurture the shade tree seedlings and undertake land improvement measures.

The state marketing board has the monopoly in buying and marketing of cocoa beans including exports which impeded CREMAs or farming communities from directly selling their produce to multinational corporations (MNCs) and traders. However, many MNCs have been involved in setting up CREMAs or similar structures, extending premium prices and non-monetary benefits (access to credit, shade tree seedlings, agrochemicals) thus indirectly securing their cocoa supply chains. A biased ecological discourse about the benefits of climate-smart agriculture and sustainable intensive narrative, complexities regarding the optimal shade levels for growing cocoa and dependence on agrochemicals are issues that affect the success and sustainability of the project intervention. Dominance of private sector players, especially MNCs in the sector, may be detrimental to the interests of smallholder cocoa producers.

The example is based on the findings of a study entitled "Climate-smart Cocoa in Ghana: How ecological modernisation discourse risks side-lining cocoa smallholders" by F. Nasser et al., published in Frontiers in Sustainable Food Systems, Volume 4, Article 73, 2020, pp.1–17.