Role of agricultural research in mitigation of climate change in LAC region

By
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In the developing world, improving agriculture is vital for meeting the challenges of hunger, poverty, inequality, and environmental degradation. Latin America and the Caribbean (LAC) include more than 30 countries with a population close to 600 million people. LAC has 23% of the world's arable lands, 31% of its water resources, 23% of its forests and 46% of its tropical forests. LAC is an actor of increasing importance in the global food supply and it has an enormous potential to contribute to its own and global food security and sustainable and equitable development. Agricultural research for development (ARD) is essential to achieve it (GCARD, 2010).

LAC has around 15 million family farms that represent 85% of the total farms in the region and generate 35-45% of the agricultural GDP and an even bigger portion of the jobs. Over 44% of the population in LAC is currently below the poverty line, with the proportion rising to 64% in rural areas. The agricultural environments of LAC are highly diverse in their resource endowments, production systems, and market orientation. Within LAC, there has been complete evolution from agriculture-based through transforming to urbanized economies. Research for development efforts made in LAC for generating global public goods are not only highly relevant to its own agricultural development but also are likely to be useful in many parts of Africa and Asia.

Agriculture is the human enterprise that is most susceptible to climate change. Subsistence agriculture in the tropics is particularly vulnerable, as smallholder farmers do not have adequate resources to adapt to climate change. However, there are significant opportunities for agricultural mitigation of climate change, particularly in LAC region compared with other regions of the world. Many agricultural practices such as agroforestry systems and integrated crop-livestock systems may play a significant role in reducing the emission and mitigating the atmospheric accumulation of greenhouse gases (GHG). These systems could help smallholder farmers adapt to climate change while contributing to restoration of degraded lands.

Eco-efficient agricultural production uses resources more efficiently to produce more food, enables family farms to be more competitive, and delivers sustainable increases in productivity, while avoiding natural resource degradation and negative externalities. Integration of crops and livestock was a common approach to agricultural production throughout the world before modern industrialization in the 20th Century. Greater integration of crop and livestock systems may impart major benefits to the environment and to development of sustainable agricultural production systems. The agricultural revolution over the next 40 yr has to be the eco-efficiency revolution, with which scarce resources of land, water, nutrients, and energy are used. A major challenge is that this greater output and efficiency has to be achieved without further GHG emissions while maintaining or restoring agroecosystems.

Tropical hillsides and lowlands are the most important agroecosystems of LAC. They sustain a large rural population. Hillsides cover three quarters of all land in southern Mexico, Central America and parts of the Caribbean region. Andean hillsides cover 96 million ha (Mha) in Peru, Ecuador, Colombia and Venezuela. They constitute the main source of water, forest and biodiversity for lowlands and, more importantly, they constitute the main resource for domestic food supply of maize, beans, potatoes and cassava. With over 250 Mha, savannas represent one of the last frontiers in the world for agricultural expansion of integrated crop-livestock systems. Of the approximately 300 Mha of the Amazon basin, 44 Mha cover the forest margins agroecosystem with livestock production as a major land use.

It is estimated that 75% of agricultural land in Central America and 45% of land in South America show degradation problems. Land degradation results in different combinations of losses of productivity, biodiversity, soil nutrients, soil carbon stocks, and soil biota. Food insecurity and low income are also serious problems in both hillsides and lowlands. Developing knowledge and best-bet technologies to reverse land degradation, improve food security and reduce poverty in these two regions with low fertility soils are the major challenges facing agricultural research.

Tropical hillsides agroecosystem: One of the best-bet technologies for this agroecosystem is the Quesungual Slash and Mulch Agroforestry System (QSMAS). It is a smallholder production system with a group of technologies for the sustainable management of vegetation, soil and water resources in drought-prone areas of hillside agroecosystems of the sub-humid tropics. QSMAS integrates local and technical knowledge and provides resource-poor farmers with an alternative to the non-sustainable, environmentally unfriendly slash and burn (SB) traditional production system. CIAT and its partners determined the key principles behind the biophysical resilience of QSMAS and its capacity to increase and sustain crop production and alleviate water deficits on steeper slopes with risk of soil erosion. Evaluation of QSMAS performance compared to the traditional SB system in terms of water dynamics (including crop water productivity), nutrient dynamics, and greenhouse gas fluxes (including global warming potential) indicated that the application of the four principles behind QSMAS productivity and sustainability (no SB, permanent soil cover, minimal disturbance of soil, and improved fertilizer practice), has positive effects on the soil-plant-atmosphere continuum, soil quality, water availability, landscape regeneration and on the environment. There is need to validate the suitability of this system in other tropical areas of LAC to enhance support for livelihoods and to reduce vulnerability of rural areas to climate change.

Tropical lowlands agroecosystem: In savanna agroecosystem of Colombia, by using the concept of building an arable layer through improved carbon sequestration and combining this soil management technology with acid soil adapted cultivars of both forages and crops in integrated crop-livestock systems (agropastoral systems), farmers have the tools and technologies to transform the low fertility acid soils in the Andean foothills (Piedmont) and well-drained savannas (Altillanura) to increase agricultural productivity and mitigate climate change. In addition, CIAT and partners discovered an effective natural inhibitor of nitrification in the root-exudates of the tropical forage grass *Brachiaria humidicola*. Acid soil-adapted improved forage grass options with ability to regulate nitrification in soil and to reduce emission of N_2O to the atmosphere can make significant contribution to improve nitrogen use efficiency of crop-livestock systems. The integration of these carbon and nitrogen technologies can improve the economic and ecological sustainability of crop-livestock systems in low fertility acid soil regions of LAC.

Tropical forest margins agroecosystem: The Amazon Basin is the world's largest tropical ecosystem and gene bank. Yet the region suffers deforestation, its natural resources are being degraded, and vulnerable rural communities are being threatened. Uncontrolled timber extraction, non-sustainable SB agriculture, large-scale commercial agriculture and inappropriate pasture management are causing considerable emissions of GHG. To confront these challenges, the Amazon initiative ecoregional program (AI-ERP) is created in 2006 with a number of partners from Brazil, Colombia, Peru, Venezuela, Bolivia together with CATIE and CGIAR and its activities began in 2008 to address: (i) mitigation and adaptation to climate change; (ii) sustainable production in deforested and degraded lands; (iii) maintenance of forest ecosystem services and human well-being and (iv) development of market-value chains for Amazonian products. These research efforts aim to provide guidelines for policies, and develop technological and institutional innovations, which would help maintain environmental services, improve living conditions in the Amazon Basin, and simultaneously encourage sustainable land use.

Lessons learned: Three major lessons were learned and these include: (i) opportunities for agricultural mitigation of climate change exist in both tropical hillsides and lowlands agroecosystems of LAC; (ii) Integrated crop-livestock systems with improved eco-efficiency are the best-bet technological options; (iii) improved carbon sequestration in soil, reduced methane emissions from animals through the use of improved forage options, and reduced nitrification in soil are possible solutions to agricultural mitigation of climate change in LAC.

Need for future investments: To realize the biophysical mitigation potential of LAC there is immediate need for substantial funding in three major research for development areas: (i) Capacity building in NARS in eco-efficient agriculture and agricultural mitigation of climate change; (ii) incentives for farmers to restore degraded lands and for better use and conservation of production resources; and (iii) policies and mechanisms that benefit smallholder farmers through payment for environmental services. The estimated initial funding requirement is about US$50 to 100 million for over 5 years (improved germplasm-40%; eco-efficient agroecosystems-30%; institutional innovations-30%).

GCARD, 2010. The GCARD Process in Latin America and the Caribbean Final Synthesis. FORAGRO, GFAR, IICA, PROCISUR, pp. 16.