Chapter 6

Challenges and solutions to fight climate change

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Introduction

Climate change is a major threat, thus reinforcing the importance of the Sustainable Development Goals (SDG). If SDGs are not achieved, health risks, water supply, food production, nutrition, biodiversity and energy security of human societies around the world would be worse, especially for societies living in densely populated urban zones and vulnerable areas. Embrapa has been revealing how significant challenges posed by climate change are (they have been reducing agricultural productivity in recent decades in several regions) and proposing strategies to promote sustainable development by investing in the development of new technologies and strategic planning to mitigate greenhouse gas (GHG) emissions and ensure the adaptation of Brazil's agroecosystems. Achieving a universal understanding of the risks posed by climate change and social awareness on the topic will be of paramount importance. In this context, Embrapa, with its national reach and ability to produce and adapt technologies to varied realities, will be fundamental for the sustainability of Brazilian agriculture.

Embrapa

Embrapa is a national reference when it comes to measuring GHG emissions and conducting mitigation studies because it holds a framework of experimental data, organized knowledge and analytic tools for strategic planning and construction of scenarios to quantify the effects of adopting technologies. Embrapa has been active in disseminating agricultural GHG emissions domestically and in leading

several quantitative studies of agricultural system emissions, evidencing, as a rule, lower emissions of Brazilian agroecosystems than those estimated by analyses based on models and default factors produced abroad. Embrapa also stands out in supporting public policy design having supported the definition of Nationally Appropriate Mitigation Actions (NAMAs), ABC Plan and Nationally Determined Contributions (NDC) of Brazil, and in joining important studies coordinated by the World Bank. By expanding and adopting technological solutions recommended in these policies, agroecosystems may have increased adaptive capacity to climate change impacts and reduced GHG emissions. Monitoring the long-term effectiveness of these actions is also critical, as changes in carbon stocks are measurable over the decades. The increase in carbon stocks is one of the main bases of agricultural contribution to Brazilian NDCs. In order to support such initiatives, the Plataforma Multi-institucional de Monitoramento das Reduções de Emissões de Gases de Efeito Estufa (Multi-Institutional Platform for Monitoring Greenhouse Gas Emission Reductions) was created in 2016 at Embrapa Environment in Jaguariúna, state of São Paulo, in order to monitor Brazilian agriculture greenhouse gas emission reductions and soil carbon stock changes.

Promoting resilience and adaptation to climate risks requires planning and developing human resources, as well as technological tools to produce knowledge and estimates about the risks to different agroecosystems in different Brazilian regions. This task is extremely complex given the continental dimension of Brazil and the diversity of crops and productive systems. Although national and international research initiatives are under way, Brazilian capacity for determining potential climate change impacts is still limited to a small number of agricultural crops. Expanding crops included in the Zoneamento Agrícola de Risco Climático (Climatic Risk Agricultural Zoning – Zarc) and developing and parameterizing new biophysical models will be key in this process. However, the lack of experimental data for model parameterization for several agricultural crops is still an important bottleneck for reducing the uncertainties of such models. In order to advance in this area, the following are needed: increasing investments in basic research, in organizing long-term experimentation networks at Technological Reference Units (URTs) – with public and private partners – for monitoring environmental conditions (agro/micrometeorological experiments); expanding the capacity of phenotyping platforms; and expanding experiments on Free Air CO_2 Enrichment (FACE), also considering the effects of warming concomitantly to atmospheric enrichment of CO_2 (Free-Air Warming and CO_2 Enrichment) and including additional crops and different production environments. These actions may help better understand

and model growth/productivity interactions, abiotic factors and management practices in agroecosystems.

Advances and challenges

Once climate risks to agricultural production systems are identified and quantified, technologies, products and services will be adapted to minimize exposure to these risks and, at the same time, enhance the resilience of agroecosystems in a climate change context. Along with integrated and intensive management practices, plant and animal breeding programs will be fundamental to develop genotypes adapted to future climatic conditions. In plant production, research groups have been focusing on efforts to advance knowledge and create agricultural practices and processes to develop cultivars that are water deficit tolerant, photosynthetically and nutritionally efficient, and resistant to aluminum toxicity in acid soils. For this, continuous funding of basic research, pre-breeding and final stage development of cultivars is fundamental.

Animal genetic breeding, particularly of zebu and its crossbred groups, is expected to generate animals more tolerant to thermal stress and more resistant to parasites associated with high temperatures, at the same time as improving meat quality and animal productivity. Gains related to soil and rumen microbiology, particularly with respect to non-symbiotic biological nitrogen fixation, thus reducing synthetic sources input, and reduced enteric methane emissions are important knowledge frontiers in which Embrapa must invest and whose potential future contribution is promising. Today, Brazil sets the standard for zebu genetics, known for rusticity, heat and parasite tolerance, thus opening the way for sustainable production in the tropics.

Improvements in adopting integrated and intensive systems of production (integrated crop-livestock-forestry system – ICLF) should significantly contribute to mitigating GHG emissions and adapting Brazilian agriculture to climate change. Continuing research and studies in long-term URTs will be necessary to support public policies to encourage the adoption of integrated and intensive systems. Embrapa has been creating and keeping multidisciplinary URTs with interinstitutional experiments, in collaboration with several universities and the private sector, in order to contribute to a better understanding of integrated and intensified agroecosystems. Diversified production and better use of local skills will contribute to regional adaptations of the agricultural sector to climate change. Adopting agroforestry systems and maintaining native species in agroecosystems

are important for recovering degraded areas and conserving biodiversity and environmental services, which may open up debates on public policies related to payment for environmental services, and particularly climate regulation services.

One of the great advantages of aquaculture production systems (mariculture, fish farming, etc.), both in freshwater and brackish or salty environments, is the fact that it is more energy efficient than meat production sectors. In Brazil, there are large areas available and not occupied by this activity. However, there are few studies on GHG emission balance for these systems. Integrating aquaculture and vegetable production (aquaponics) is a great opportunity for sustainable food production to adapt to climate change with low impact on Brazil's GHG emissions.

Final considerations

The sustainable transformation of Brazilian agriculture increasingly involves actions to adapt to climate change impacts and to mitigate GHG emissions or increase GHG sequestration. Because of the scope of the problem in space and time, advancing knowledge by Embrapa over the last decades and the interaction with society and other education and research institutions are crucial to support public policy design aiming at developing viable alternatives for Brazilian production. These policies will be instrumental in enhancing the adaptability of society and the economy to climate risks by creating conditions and opportunities for businesses linked to climatic resilience.

Embrapa will play a major role in supporting the evolution and design of new sectoral policies, which should, in the near future, evolve into programs and projects supported by systemic, scientifically grounded and integrated analyses that allow the continuous and transparent quantitative monitoring of results. Research results should lead to innovations and technologies for Brazilian agribusiness that allow efficient management of natural resources so as to improve socioeconomic conditions and promote greater social equity. Brazilian agribusiness should be coherent and integrated with SDGs and the objectives of multiple public policies, in which climate change issues will evolve in tune with the efficient use of public and private resources for sustainable development of varied local realities of Brazil.