Chapter 3

Cost-effective natural resources management

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Introduction

This chapter presents contexts and problems on several aspects related to target 2 of Sustainable Development Goal 12 (SDG 12), which refers to "Achieving sustainable management and efficient use of natural resources by 2030". It also describes and discusses the main products, processes and services that the Brazilian Agricultural Research Corporation (Embrapa) has made available to agroindustrial chains and to Brazilian society, in order to contribute to the target achievement and to input provision for indicators assessment. They were divided into the following themes: water use efficiency in agriculture, soil conservation, efficient plant genetic resources use, fertilizer use, and systemic product and process assessments.

Contexts and problems

The Millennium Ecosystem Assessment (Ecosystems..., 2005) has warned the world about its dependence on natural capital and has identified that ecosystem services have degraded more rapidly and profoundly over the last 50 years than in any other analogous period in the history of mankind. The assessment anticipates further declines for the coming decades, especially in the light of population growth, economic expansion, and global climate changes.

Sustainable consumption and production mean doing more and better with less. It is about decoupling economic growth from environmental degradation, thus increasing the efficiency of natural resources use and promoting sustainable lifestyles.

However, sustainable consumption and production cannot happen without information. How can we say that we have a sustainable agriculture if we do not have information about each of its productive activities, if the little information available is not used to produce knowledge and make decisions, and if, according to some agents, providing information can be understood as an impediment to the planning and implementation of its productive activities? There is nothing to be handled and managed without information. The complexity of agriculture, combined with a lack of information flow among researchers, professionals, policy makers, and consumers, exacerbates the difficulties of having sustainable consumption and production.

Agricultural activities demand different types of renewable and nonrenewable natural resources and are directly related to several ecosystem services (water supply, formation and cycling of soil nutrients, pollination, erosion and pest control, etc.). Brazil has many of these resources in quantity and quality. Therefore, because of these assets, Brazil stands out from other countries. Using these assets based on sustainable management and focusing on use efficiency, will result in their conservation and continuity, and in Brazil holding its position as a major food producer for its population and the world with a unique focus on nature and human capital valuation. However, unplanned and inefficient use will lead to environmental degradation and production migration, with environmental, social and economic conflicts as liabilities.

Water as an asset

Global water scarcity has been reason for concern and discussion at different levels of society. By 2030, global demand for food will grow by 50% and for fresh water by 30%. Even without taking the effects of climate change into consideration, water availability is expected to decline by 50% by 2050, due solely to population growth (Ringler et al., 2010). According to the National Water Agency of Brazil – ANA (Agência Nacional de Águas, 2016), water use in rural areas represents 83% of total Brazilian demand, with 72% dedicated to irrigation. The irrigable area in Brazil is approximately 29.6 million hectares.

In terms of water quality, although urban pollution is the main source of degradation, diffuse pollution from rural areas can have a strong impact on regions with extensive agricultural areas. Therefore, the contamination risk of surface and underground waters is very high. As a consequence, damages to the aquatic biodiversity, to human health, and to the country's economy occur (Prado et al., 2017). Climate changes entail uncertainty and complexity to production in rural areas, thus demanding a greater variability in water availability and potential changes in agricultural aptitude due to changes in temperature and rainfall. Water management is the transforming element in this adaptation process (Prado et al., 2017).

Soil as an asset

Today, 33% of the world's soils are moderately to severely degraded due to erosion, salinization, acidification, and chemical pollution. Successive losses of productive soils should harm food production, food security, increase price volatility, and potentially lead millions of people to hunger and poverty (Marques Filho, 2016).

Although it has not been considered a priority in governmental agendas in the past (Guerra et al., 2014), soil conservation has received more attention recently, which resulted in the development of several agricultural production systems currently in use in Brazil. Among these, stand out the no-tillage system (NTS), integrated crop-livestock system (ICL), and crop-livestock-forest system (ICLF) (Machado; Silva, 2001).

Adequate soil and water use in agriculture also involves the efficient use of fertilizers and reduction of pesticides, as well as conservation actions aimed at reducing erosion processes and silting up of bodies of water. However, there are many challenges in order for policies and laws to be effective, and for conservation programs and projects to be expanded, encompassing the vast territory of Brazil and making sustainable consumption and production a reality.

Contributions of Embrapa to achieving the goal

On the items below, the products, processes and services that Embrapa has made available to agroindustrial chains and to Brazilian society, in order to contribute to the achievement of SDG 12 and to provide input for its indicators assessment, are presented.

Water use efficiency in agriculture

Among agricultural practices, irrigation is the largest consumer of water, in order to produce a large amount of food per liter of water. Irrigation requires technical knowledge and equipment acquisition, without which excessive use of water and energy and potential negative environmental impacts will occur. Embrapa encourages the adoption of good irrigation practices, validates technical indexes for its improved efficiency, and designs equipment and support systems for irrigation to reach maximum efficiency. Some related products and services are: strategies for reducing water use in irrigated rice, software for efficient water use and saving on crop irrigation in the Cerrado, training in irrigation use and management (IrrigaWeb) and the Sistema Brasileiro de Classificação de Terras para Irrigação (Brazilian Land Classification System for Irrigation).

As livestock activities are also great water consumers, research on rainwater harvesting for watering animals and cleaning facilities has been carried out, as well as research on reusing effluents from animal production.

Soil conservation

Soil conservation has not been treated with due diligence and seriousness in Brazil, except for a few Brazilian states as Paraná. As a consequence, annual soil losses in Brazil reach 500 million tons by erosion, thus causing an average loss of reservoir storage capacity of 0.5% per year, which is quite high. Also many rivers reach the sea with a very reduced flow due to silting, as one can see in Paraíba do Sul and São Francisco rivers.

Over the last decades, however, more sustainable and integrated production systems have advanced. In production areas of important commodities such as soybeans, corn, and cattle, NTS, ICL, and ICLF should be highlighted. As for ICLF, a research and development network was built in order to monitor and disseminate it, in which Embrapa plays the main role.

The Ecosystem Services in Agricultural Landscape Network (Prado et al., 2015) is also closely related to sustainability in the rural environment, since it aims to develop knowledge and tools to support actions and policies for restoration, maintenance and expansion of environmental services, and to strengthen sustainable production systems.

Another initiative is the Brazilian Soil Survey Program (Pronasolos), which started with an Embrapa Special Project. The work involves the Ministry of Agriculture, Livestock and Food Supply (Mapa), Embrapa, universities, research institutes and companies and specialized agencies. Its aims at investigating, listing, documenting, interpreting, and providing soil information for understanding, managing, conserving, and maintaining this resource to the nation.

Efficient plant genetic resources use

Native plants use contributes to the sustainability of production systems, as they are adapted to local environmental conditions, bring greater genetic diversity, and provide more environmental services. There are numerous examples of genetic breeding programs and native Brazilian species cultivars released by Embrapa, ranging from Amazonian and Cerrado fruits to native forages for the Center-South area of Brazil. Besides that, native species cultivars have been released for ornamentation purposes. Greater efficiency in the use of renewable and non-renewable natural resources and conservation of ecosystem quality will be achieved through the development of cultivars that are more effective in nutrient use and aluminum-tolerant; through the management including soil correction and fertilizer use in appropriate amounts; through the development of processes for efficiency-enhanced fertilizer production.

Fertilizer use

Fertilizer application is a key factor for maintaining crop productivity and transforming lands with low natural chemical fertility into productive lands, but this also means greater consumption of natural resources, energy and greenhouse gas emissions. Therefore, replacing traditional fertilizers with environmentally friendlier technologies are one of the objectives of Embrapa. Biological nitrogen fixation (BNF) in soybean and other crops made Brazil a worldwide reference for microorganisms use in agriculture for nutrient supply. In addition to that, microorganisms and microbial processes (such as phosphorus – P – solubilization, potassium – K –, growth regulators, nutrient-absorption facilitators such as mycorrhizal fungi) are being increasingly explored. Embrapa also operates in systems with fertility-built soils, no-tillage, creating modern cultivars with high productive potential.

Systemic product and process assessments

The Life Cycle Assessment (LCA) is a management tool that allows evaluating the environmental performance of products throughout their entire life cycle. In the national agricultural sector, LCA can contribute to promoting a cleaner agriculture and to defending Brazilian agricultural products in the international market. Embrapa carries out projects to promote the application of a tool to assess the technologies created by the Company, and the creation of a national LCA research network whose main objective is, among others, assess production systems of some of the most important products of Brazilian agribusiness: sugarcane, soy, corn, mango, eucalyptus, and beef cattle. Currently, Embrapa is conducting research on LCA for products such as beef and fruit farming.

Another tool used by Embrapa is the water footprint approach, which assesses the water efficiency of a product or process. Water footprint is defined as the volume of water directly and indirectly consumed to manufacture a product. The footprint assessment is an analytical tool, helping understand how the product is related to water demand and scarcity. Since 2009, Embrapa has developed projects that assess the water efficiency of agricultural products, and is the first in Brazil to use this type of approach to agricultural products. Embrapa develops water footprint research for the following products: beef cattle (Palhares et al., 2017), broiler chickens (Drastig et al., 2016), pork (Palhares, 2014), and cattle milk (Palhares; Pezzopane, 2015). The uniqueness of studies by Embrapa, compared to international studies, is that the former are made taking the productive and environmental realities of the various Brazilian production systems and hydrographic units into consideration, which makes it possible to make firmer decisions regarding natural resource management.

Final considerations

For an efficient natural resources management in agriculture, it is necessary to combine different sectors of society, public and private governmental and non-governmental institutions , and to have farmers as allies, by valuing their key role in efficiently managing the natural resources in their farms and in the countryside as a whole.

Products, processes, and services created by Embrapa research must be increasingly validated by society and disseminated, so that they can be efficiently used by farmers and decision makers.

Furthermore, knowledge related to this target 2 of SDG 12 must improve in terms of developing low cost and easy to handle or apply products, processes, and services for farmers or decision makers.

Another important issue is to promote a greater integration of water, soil, and biodiversity as themes for both research and public policies and the natural resources management in agriculture by integrating concepts, approaches, and methods.

References

AGÊNCIA NACIONAL DE ÁGUAS (Brasil). **Conjuntura dos recursos hídricos no Brasil**: informe 2016. Brasília, DF, 2016. 218 p.

DRASTIG, K.; PALHARES, J. C. P.; KARBACH, K.; PROCHNOW, A. Farm water productivity in broiler production: case studies in Brazil. **Journal of Cleaner Production**, v. 135, p. 9-19, 2016.

ECOSYSTEMS and human well-being: synthesis. Washington, DC: Island Press, 2005.

GUERRA, A. J. T.; FULLEN, M. A.; JORGE, M. C. O.; ALEXANDRE, S. T. Soil erosion and conservation in Brazil. **Anuário do Instituto de Geociências**, v. 37, p. 81-91, 2014.

MACHADO, P. L. O.; SILVA, C. A. Soil management under no-tillage systems in the tropics with special reference to Brazil. **Nutrient Cycling in Agroecosystems**, v. 61, n. 1-2, p. 119-130, 2001.

MARQUES FILHO, L. C. **Capitalismo e colapso ambiental**. 2. ed. Campinas: Ed. Unicamp, 2016.

PALHARES, J. C. P. Pegada hídrica de suínos e o impacto de estratégias nutricionais. **Revista Brasileira de Engenharia Agrícola e Ambiental**, v. 18, n. 5, p. 533-538, 2014.

PALHARES, J. C. P.; MORELLI, M.; JUNIOR, C. C. Impact of roughage-concentrate ratio on the water footprints of beef feedlots. **Agricultural Systems**, v. 155, p. 126-135, 2017.

PALHARES, J. C. P.; PEZZOPANE, J. R. M. Water footprint accounting and scarcity indicators of conventional and organic dairy production systems. **Journal of Cleaner Production**, v. 1, p. 1-14, 2015.

PRADO, R. B.; FIDALGO, E. C. C.; FERREIRA, J. N.; CAMPANHA, M. M.; VARGAS, L. M. P.; PEDREIRA, B. C. C. G.; MONTEIRO, J. M. G.; TURETTA, A. P. D.; MARTINS, A. L. S.; DONAGEMMA, G. K.; COUTINHO, H. L. C. Pesquisas em serviços ecossistêmicos e ambientais na paisagem rural do Brasil. **Revista Brasileira de Geografia Física**, v. 8, p. 610-622, 2015. Número especial IV SMUD.

PRADO, R. B.; FORMIGA, R.; MAEQUES, G. F. Uso e gestão da água: desafios para a sustentabilidade no meio rural. **Boletim Informativo da Sociedade Brasileira de Ciência do Solo**, v. 43, n. 2, p. 43-48, maio/ago. 2017.

RINGLER, C.; BRYAN, E.; BISWAS, A. K.; CLINE, S. A. Water and food security under global Change. In: RINGLER, C.; BISWAS, A. K.; CLINE, S. A. (Ed.). **Global change**: impacts on water and food, water resources development and management. Berlin, Heidelberg: Springer-Verlag, 2010. p. 3-15.