soil humidity, will require more accuracy in the conduct of various agricultural practices.

Despite the success of Brazilian agriculture, the adoption of modern technologies still affects a limited contingent of producers. A more productive inclusion requires greater investment and innovative strategies in the creation and transfer of knowledge and technology. Above all, this will help the most vulnerable producers to participate in this growth path.

Among other factors, mechanization and automation will play a role in the coming decades in response to population aging (World..., 2013); to the migration from rural areas to cities and the reduced or insufficient contingent of young labor in the field; as well as to education limitations in several countries (as in Brazil). These processes together contribute to the shortage of skilled workers in the field. Increasing both the supply and the adoption of these technologies in rural areas are a decisive factor in increasing the productivity of work in the field (Contini et al., 2010), besides making agriculture more attractive to young people compared to the offered, or expected options in the urban area. Research and innovation systems should be prepared to respond to more multidisciplinary agriculture and to the challenge of young labor force migration to the cities.

The multifaceted characteristic of Brazilian agriculture (food safety, bioenergy, climate changes, green chemistry, rural development, international trade agreements, among others), with information processed faster and challenges that do not respect national borders (pests, diseases, climate changes, among others), reinforces the dependence on knowledge, technology and innovations. All these facts highlight the urgency of a broad effort to technology transfer and rural extension, so as to allow greater inclusion of technological and productive innovations in the field.

An inexorable fact is that the agricultural sector will be increasingly pressured to broaden efficiency in the use of fertilizers, agrochemicals and other inputs and resources, especially water. It is necessary to produce more, with an optimal level of inputs utilization, or produce the same quantity with a lower level of inputs.

The quest for continuous improvement of productivity and efficiency of economies should consider increasing formalization (and empowerment) of micro and small enterprises, always focusing on decent employment of human capital.

Final considerations

Therefore, research and innovation companies on agriculture have the potential to contribute to job generation and economic growth without harming future generations. Embrapa plays an important role in this process, contributing to the agriculture sector in general, through technological solutions, training and/or support to public policies formulation. The results of these contributions can be materialized through productivity, quality, and value-added gain, or solutions to the sector problems, among other factors.

It is important to remember that agriculture also contributes to the generation of urban jobs, such as suppliers of machinery and inputs in the logistics, agroindustry and marketing sectors. Therefore, by supporting productive activities, agricultural research activates the multiplier effects throughout the economy. In addition, this potential goes beyond the generation of traditional agricultural jobs. The new interactions that take place in innovation systems, marked by the involvement of diverse actors, as well as by innovation in products and processes, entrepreneurship and creativity and, mainly, by intensive use of Information and Communication Technologies, take the results of agricultural research farther away, generating jobs in many sectors.

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Chapter 3

Increasing productivity and improving the conditions of the rural worker

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Introduction

This chapter addresses the target of SDG 8.2, which advocates,

> Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labor-intensive sectors (United Nations, 2018).

Embrapa generates knowledge and technological assets for the sustainability of Brazilian agriculture, whose main objective is the incessant search of new paradigms of economic development. Thus, increasing productivity with technological solutions that contribute to the economic growth of agricultural sector, coupled with the improvement of rural working conditions, must meet the guiding principles of sustainable development proposed by Sachs (1993). Namely: meet the basic needs of citizens; be supportive of future generations; seek the effective participation of the population involved, which is constituted by the true actors of the development process; have as a target the incessant search for the preservation of natural, renewable and/or non-renewable resources, as well as the environment in general; create a social system that guarantees stable work, with decent remuneration for all, social and personal security, and cultural preservation; and promote educational projects and plans at all levels, for the entire population.

Embrapa is concerned to reach these paradigms, whose main aspect is social well-being, so it develops technologies and technological solutions for the economic growth of the Brazilian agricultural sector, emphasizing the main problems of the rural population. Thus, it is important to search for solutions to the chronic problems of Brazilian agriculture, such as low margins of commercialization

of small-scale farm products, short-term sales concentration, production surplus risk with the consequent price deterioration, difficulty in placing products on the market, among others. Thus, it is necessary to implement technological solutions that add value to the final product with improved income for families, production diversification, opportunities for new market niches for agricultural products that were not commercially exploited, development of more productive new cultivars, geographic indications, use of collective trademarks, access to new markets and improvement of products and processes, among others.

Technological solutions for the economic growth of the agricultural sector

Embrapa annually publishes its social report, in which registers the main actions developed by its various research centers, for the benefit of its internal collaborators, the communities where it operates and the Brazilian society. The social report documents the economic, social and environmental impacts of the technologies developed by Embrapa and adopted by the Brazilian society. Some examples of these technological assets that contribute to the sustainability of Brazilian agriculture, which have been registered for more than 2 decades, are based on: more productive and nutritious plant cultivars that are resistant to pests, diseases and bad weather; more productive and adaptable to different environments animal breeds; new machinery, equipment and production systems; computer programs and applications; new cultivation processes, animal production and pest and disease control; geographic information systems to map regions and monitor land use; among others. Some examples of technological solutions developed by Embrapa that contributed to the economic growth of Brazilian agriculture, such as the integrated crop-livestock-forestry system (ICLFS); Integrated Soybean Pest Management (IPM-Soybean); the efficient water use in irrigated rice production; the Management of Milk Production Systems (Gisleite); the Carbon Neutral Brazilian Beef concept, among others, are available on the technological solutions page on the Embrapa's web portal.

The economic impacts generated by the 117 technologies and around 200 cultivars published in Embrapa's social report sheet in 2017 (base year 2016) showed that the it obtained a social profit of US$ 10.71 billion[1]. Net operating

[1] Values related to December 30, 2016: US$ 1.00 corresponded to R$ 3.2585 (Taxa…, 2016).

revenue resulted in a benefit-cost ratio of 11.37, that is, each dollar invested in Embrapa generated US$ 11.37 for Brazilian society (Embrapa, 2017).

When analyzing the returns of investments made by Embrapa in the generation of technologies monitored and evaluated since 1997, investing in research is a good business, given that, in 2016, the average internal rate of return (IRR) of Embrapa's investments were 38.2%, indicating high profitability compared to the return of most of the investments and financial applications available in the market. This high profitability rate shows that Embrapa is important for the economic growth of Brazilian agriculture, since this indicator significantly influences the composition of the economic growth index.

Another indicator that attests the significant contribution of Embrapa to the economic and social growth of Brazilian agriculture is the new job generation index. In the last decade, 775,238 new jobs were generated due to Embrapa technologies analyzed in the social report sheet. This is a parsimonious value, since it refers only to the number of new jobs created each year only by the analyzed technologies. As Embrapa has traditionally been developing job-creating technologies, the real number of generated jobs is actually much higher.

With regard to productivity, Embrapa has developed throughout its existence a range of technologies that enabled a substantial increase in the productivity of Brazilian agriculture. The 2016 social report lists only a sample of successful cases, which in this chapter will be used as examples. Nevertheless, the number of technologies and technological solutions and/or processes developed by Embrapa, which contribute to the increase of the Brazilian agricultural productivity, is much greater.

In 2016, the technologies that contributed to increase the average productivity of national agriculture and food supply for the Brazilian population generated an economic impact of approximately US$ 4.30 billion (Embrapa, 2017). As an example of success, the new passion fruit cultivars stand out, including hybrids BRS Gigante Amarelo and BRS Sol do Cerrado, which, besides being more palatable, have generated employment and income. The average productivity of Brazilian passion fruit trees is 14 t/ha, and these new cultivars reach the level of 40 t/ha. Another example is the implementation of acai handling technology, which allowed doubling its production and requiring very little resource input, thus benefiting the population of riverine and extractive people in Amazon. In both examples, Embrapa contributed decisively to increasing the export of these products.

Still related to productivity increase, the BRS Amélia sweet potato cultivar stands out; besides being tasty, it promotes food safety and increases producers' incomes. Its average productivity is 32 t/ha, that is, 2.36 times higher than the average production in Brazil. BRS Estribo Johnson grass, which, in addition to being more productive, has a high tilling capacity, presence of a thinner stem, flexible handling for continuous or rotational grazing conditions, and a longer cycle of use.

Technological solutions for improving working conditions in agricultural production

Sustainable agricultural production implies the increasing use of technologies dedicated to improving working conditions, a constant Embrapa concern.

Concerned with the reduction of exhaustive work and the elimination of unhealthy and inadequate activities in agricultural production, Embrapa has been continually developing technologies aimed at improving working conditions in Brazilian farming production, especially with regard to activities that require intensive labor use and increase worker productivity.

An example is the upright compact classifier (Figure 1), which was developed for fruit improvement and classification for small and medium producers. This equipment reduces the painfulness of the work in the classification process and does not require water use. These aspects make it possible to increase work efficiency and improve conditions in the conduction of productive activity (Classificadora..., 2015).

The table for vegetable selection (Figure 2) is another technology that enables the improvement of the productive process of vegetables, with reduction of labor pain and labor costs (Lana, 2014). The following examples are also worthy seeing: threshing machines for rice and bean crops (Silva et al., 2002); Sembra 2000 (Sembra..., 1999), a specific sowing system for direct planting system in small and medium-scale farms, aiming at the sowing of crops such as maize, bean and soybean, which provides increases in the productive process, soil protection and work quality; and the stationary cotton mini power plant, technology developed to ginning cotton (Silva et al., 2000).

The advances in the use of Information Technology (IT) and in the development of new technologies and tools represent an important tool for improving working

Photo: Letícia Longo

Figure 1. Upright compact classifier.

Photo: Lana Milza Moreira

Figure 2. Table for vegetable selection.

conditions in rural areas, since they ease access to new technologies that improve rural workers and their families' conditions. Besides the developed applications (programs), such as Códex and Agritempo GIS, both developed by Embrapa (Embrapa Informática Agropecuária, 2017).

The technologies associated with precision agriculture can be aid tools in the planning and execution of productive activities of rural producers of different scales, reducing risks and providing the well-being of their families. An example that applies to all farmers, regardless of the productive scale, is the Automatic Field Weighing System with remote data transmission (Figure 3), developed in partnership with the Federal University of Mato Grosso do Sul and with Comércio e Indústria de Madeiras e Metalúrgica São Cristóvão Ltda. (Coimma). Such technology allows the replacement of collection of animals for weighing, as well as labor reduction for the weighing of animals and, consequently, of the risks inherent to the activity (Embrapa Gado de Corte, 2017).

Some rural activities involve risk, such as green coconut water extraction and peeling Brazil plum process. With the intention of reducing risk in these activities, Embrapa developed the mechanical extractor of green coconut water (Abreu, 1999) and the Brazil plum fruit peeler (Anjos; Cavalcanti, 2001). The latter is

Photo: Coimma Collection – unidentified photographer

Figure 3. Automatic Field Weighing System.

equipment that aims to take advantage of the bark with the minimum hand contact of the handler with the raw material.

Embrapa also participates actively in regional development programs that contribute in an effective way to the socioeconomic and environmental development of the Brazilian agricultural sector. Examples are the delimitation of the geo-economic region of Matopiba (acronym of the initials of the states of Maranhão, Tocantins, Piauí and Bahia); geographical indications, which organize production, promote development and add value to products; the Rota do Cordeiro Program and the Estradas das Araucárias Project, developed in the states of Paraná and Santa Catarina. In the latter, the producer receives US$ 307.13 per year until Brazilian pine begins the production of pine nuts, as a way of increasing the income of smallholders, as well as stimulating rural tourism and preserving the environment.

Final considerations

Embrapa contributes significantly to sustainable development by increasing the productivity of Brazilian agriculture, providing technological innovations that reduce labor pain and promote better working conditions for the rural population.

The same technology addresses, directly or indirectly, several dimensions of sustainable development, in the economic, social or environmental spheres. Thus, the same technology can contribute to the achievement of several targets of several sustainable development goals. This chapter considered the impacts of technologies on economic growth and rural work issues, clearly showing some Embrapa contributions.

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