SUSTAINABLE DEVELOPMENT GOAL 3

GOOD HEALTH AND WELL-BEING

CONTRIBUTIONS OF EMBRAPA

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Technical Editors

Embrapa

Brazilian Agricultural Research Corporation
Ministry of Agriculture, Livestock and Food Supply

Sustainable Development Goal 3

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Foreword

Launched by the United Nations (UN) in 2015, 2030 Agenda for Sustainable Development is powerful and mobilizing. Its 17 goals and 169 targets seek to identify problems and overcome challenges that affect every country in the world. The Sustainable Development Goals (SDG), for their interdependent and indivisible character, clearly reflect the steps towards sustainability.

Reflecting and acting on this agenda is an obligation and an opportunity for the Brazilian Agricultural Research Corporation (Embrapa). The incessant search for sustainable agriculture is at the core of this institution dedicated to agricultural research and innovation. Moreover, sustainable agriculture is one of the most cross-cutting themes for the 17 goals. This collection of books, one for each SDG, helps society realize the importance of agriculture and food in five priority dimensions – people, planet, prosperity, peace and partnerships –, the so-called 5 Ps of 2030 Agenda.

This collection is part of the effort to disseminate 2030 Agenda at Embrapa while presenting to the global society some contributions by Embrapa and partners with potential to affect the realities expressed in the SDG. Knowledge, practices, technologies, models, processes, and services that are already available can be used and replicated in other contexts to support the achievement of goals and the advancement of 2030 Agenda indicators.

The content presented is a sample of solutions generated by agricultural research at Embrapa, although nothing that has been compiled in these books is the result of the work of a single institution. Many other partners joined in – universities, research institutes, state agricultural research organizations, rural technical and extension assistance agencies, the Legislative Power, the agricultural and industrial productive sector, research promotion agencies, in the federal, state and municipal ranges.

This collection of books is the result of collaborative work within the SDG Embrapa Network, which comprised, for 6 months, around 400 people, among editors, authors, reviewers and support group. The objective of this initial work was to demonstrate, in according to Embrapa, how agriculture research could contribute to achieve SDGs.

It is an example of collective production and a manner of acting that should become increasingly present in the life of organizations, in the relationships

between public, private and civil society. As such, this collection brings a diverse views on the potential contributions to different goals and their interfaces. This vision is not homogeneous; sometimes it can be conflicting, just as is society's vision about its problems and respective solutions, a wealth which is captured and reflected in the construction of 2030 Agenda.

These are only the first steps in the resolute trajectory that Embrapa and partner institutions draw towards the future we want.

Maurício Antônio Lopes
President of Embrapa

Preface

In 2015, the United Nations (UN) together with the signatory countries, including Brazil, agreed to the 2030 Agenda. This agenda has 17 Sustainable Development Goals (SDG), which are translated into 169 targets that must be attained by 2030.

In recent decades, Brazil has made significant progress in reducing poverty and hunger, as well as in promoting the right to food and nutrition safety. Despite this progress, the Country still has a scenario of contrasts regarding income, good health and well-being across its population. Agriculture can contribute in an expressive way to minimize these issues.

Embrapa, given its mission to seek and promote solutions for Brazilian agribusiness, has been contributing to the achievement of these SDGs targets. Accordingly, Embrapa was required to submit its contributions to the Brazilian progress in meeting the targets established in the 2030 Agenda.

Thus, this publication aims to discuss and present the contributions of Embrapa to SDG 3, whose theme is good health, aiming to ensure a healthy life and promote well-being for all, at all ages.

For this SDG, nine targets were defined based on reducing maternal mortality and the end of avoidable infant deaths; in fighting epidemics and diseases transmitted by water and other vehicles; in reducing premature deaths from non-communicable diseases; and others. Among them, RD&I actions of Embrapa have been contributing to the achievement of targets 3.4 and 3.9:

> 3.4. By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being; [... and]
>
> 3.9 by 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination[1]. [...]

This publication consists of five chapters and begins by presenting SDG 3 in the global and Brazilian context and within the scope of Embrapa, making a brief contextualization of the theme Good Health and Well-Being. Chapter 2 addresses the main challenges related to the theme, particularly those related to targets 3.4

[1] Available at: <https://sustainabledevelopment.un.org/sdg3>.

and 3.9. Contributions of Embrapa to reaching these targets have been presented in the next two chapters, Chapter 3, on the availability of quality food and well-being, and Chapter 4, on contributions to reduce contamination of rural area and production. Chapter 5 summarizes the challenges and the conclusions on the topics, considering Embrapa's strategic vision for 2030.

Technical Editors

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Chapter 1

Healthy life and well-being for all

Joanne Régis Costa
Lúcia Helena Piedade Kiill
Diogo Denardi Porto

Introduction

In 2015, the United Nations (UN) and the signatory countries agreed to the 2030 Agenda, which has become an important landmark for the sustainable development of the planet. This agenda is composed of 17 Sustainable Development Goals (SDG), which unfold to 169 targets that must be reached by that year. In addition, the document focuses on planet, people, peace, prosperity and partnerships, and considers aspects such as human needs for good health, education, improvement of the quality of life and justice, preservation and conservation of the environment, consumption of resources and production and waste management in a conscious way as relevant points.

In this Agenda, SDG 3 (Objetivos..., 2016, our translation) focuses on Quality Good health, aiming to "ensure healthy lives and promote well-being for all at all ages." The World Health Organization (WHO) defines good health as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity; while well-being is the measure that an individual or group is capable of, on the one hand, to achieve aspirations and satisfy needs and, on the other hand, to deal with the environment (FAO, 2013). Thus, good health ceased to be seen as an individual value and began to be treated collectively, being considered a fundamental right to be guaranteed for all, regardless of race, religion, socioeconomic status and political ideology.

With this focus, nine targets for SDG 3 were established based on the reduction of maternal mortality; the end of avoidable infant deaths; combat of epidemics and diseases transmitted by water and other vehicles; reduction of premature deaths due to non-communicable diseases; prevention and treatments related to alcohol, tobacco and narcotic use; reduction of deaths in traffic and hazardous chemical situations; and the necessary access to good health systems.

SDG 3 in the global context

Concerns regarding good health and well-being have been under discussion globally. In the 21st century, the occurrence of diseases still relates to nutritional deficiency, especially in low and middle-income countries, and the difficulty of accessing food in regions of extreme poverty. In 2000, in the UN Millennium Declaration, Eight Millennium Development Goals (MDGs), with 22 targets, were proposed, of which 3 focused on good health issues (reducing child mortality; improving the health of pregnant women; combating AIDS, malaria and other diseases), showing which initiatives needed to be taken to reverse this condition.

One of the chronic issues that have been pointed out is nutritional deficiency (Figure 1) and overweight (Figure 2). According to UN data, about 2 billion people have some type of nutritional deficiency and 1.9 billion are overweight (Nações Unidas, 2017). In addition, 25% of all children less than 5 years of age suffer from short stature (Figure 3), and 31% have vitamin A deficiency. The estimated cost of malnutrition impact on the world economy reaches 5% of global Gross Domestic Product (GDP), equivalent to 3.5 trillion dollars per year, or US$ 500 per person per year. The Food and Agriculture Organization of the United Nations (FAO) (FAO, 2013) claims that around 870 million people on the planet are still starving (2010–2012 biennium), and billions suffer from insufficient food intake.

SDG 3 in the Brazilian context

In Brazil, a major event on this theme occurred in 1986, with the *8ª Conferência Nacional de Saúde* (*8th National Good Health Conference*), considered the landmark of the Brazilian sanitary reform. This meeting brought up topics such as the need to expand the concept of good health and of a new national health system and the orientation of health financing policy (Brasil, 1986).

The final report of this conference became an instrument that influenced the responsibilities of the State in assuring the right to good health for the whole population, access conditions and quality of public services, providing subsidies for the elaboration of health related articles in Brazil Constitution (Brasil, 1988). A major objective was the implementation of a health system with attributions and competences for the federal, state and municipal spheres, which culminated in the Unified and Decentralized Health System as an immediate and progressive need for the Sistema Único de Saúde (Unified Health System – SUS) (Souza; Costa, 2010).

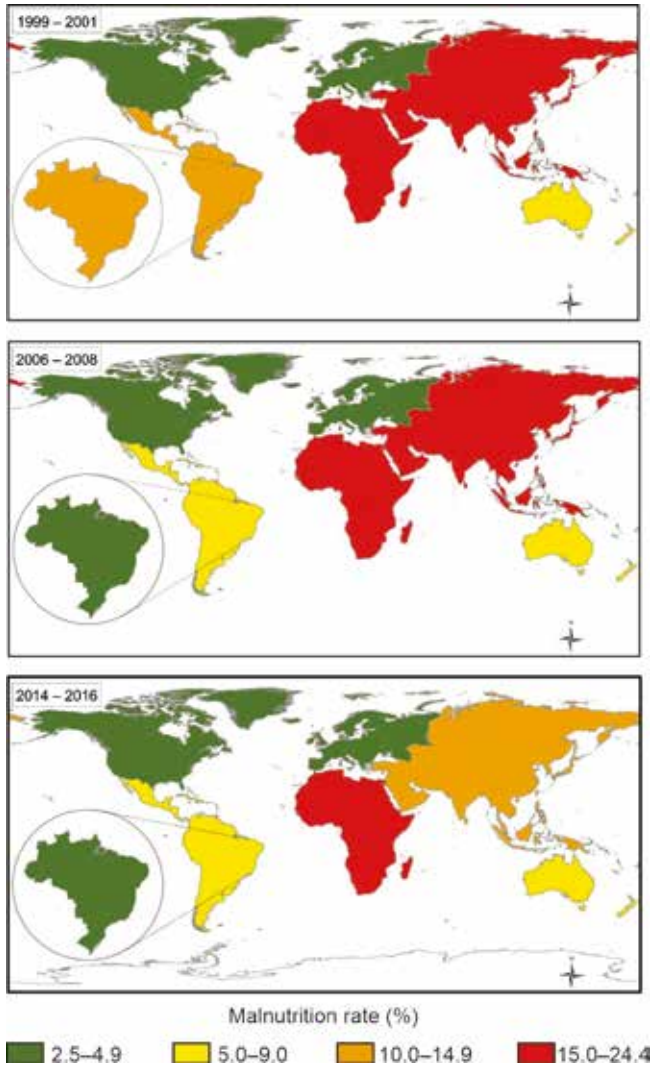

Figure 1. Malnutrition in the world, emphasizing on Brazil, in the periods 1999–2001, 2006–2008 and 2014–2016.

Source: Adapted from FAO (2013).

Subsequently, in 1988, the Brazilian Constitution defined the guidelines for the SUS creation with states and municipalities autonomy, with participatory popular management and establishment of good health as "a right of all and a duty of the State", according to art. 196 of the Constitution (Brasil, 1988).

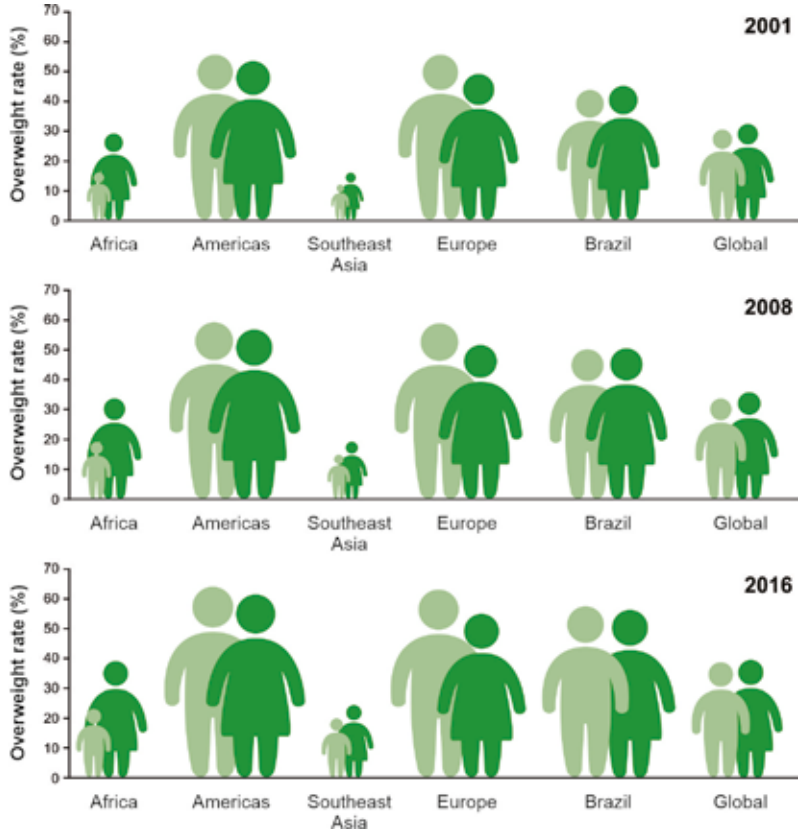

Figure 2. Overweight rate recorded in the continents, in Brazil and in the world, in 2001, 2008 and 2016.

Source: Adapted from FAO (2013).

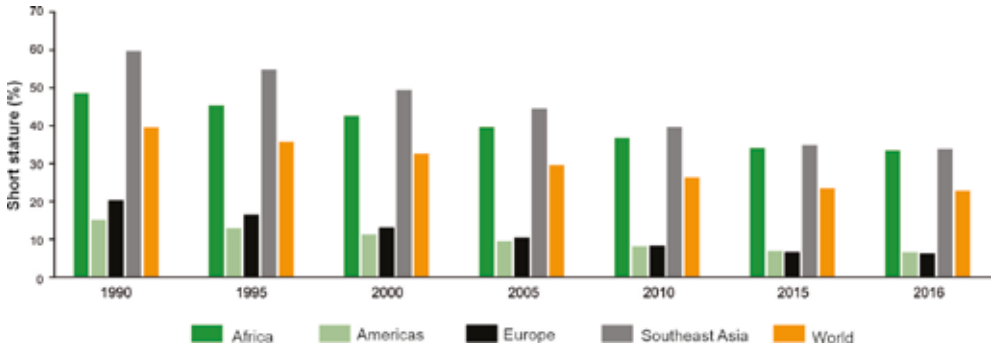

Figure 3. Short stature rates recorded in the continents and in the world, from 1990 to 2016.

Source: Adapted from FAO (2013).

According to data from the Brazilian Institute of Geography and Statistics (IBGE) and the Ministry of Health, the number of children who are underweight and has growth failure has decreased, while the number of overweight children increased significantly. However, Lima (2016), in a comparative study of good health in Brazil and in the countries of the Organisation for Economic Co-operation and Development (OECD), reports that Brazil performs below average when compared to the others.

Thus, Brazilian society shows the need for the development of joint, solid and urgent actions, considering topics such as basic sanitation, nutrition and sustainable agricultural production for the fulfillment of the SDG 3 targets. Thus, to reach the targets proposed for this SDG, Brazilian social policies must be characterized as part of economic and political interests, recognizing social rights and seeking for the design and development of actions that reduce social inequalities, ensure healthy life and promote well-being for all Brazilians.

SDG 3 in Embrapa scope

Science and technology outcomes in the agricultural sector and food science are capable of improving the good health and well-being of the population, helping to reduce diseases related to malnutrition besides meeting growing consumer demand for healthier diets. Advances in research on food, nutrition and good health and their relationships have brought clarity to the diet role in improving the life of human beings.

Aligned with these issues, Embrapa shows its concern in the VI Master Plan 2014–2034. In this document, it states the vision of "Being a world reference in the generation and supply of information, knowledge and technologies, contributing to innovation and sustainability of agriculture and food safety" (Embrapa, 2015, p. 8, our translation).

Among the eight macro-themes proposed as pillars that guide Embrapa RD&I action discussions are Food Safety, Nutrition and Good Health, which, with the broad impact axes and transversal themes, guided the definition of its 12 Strategic Goals (SG) (Embrapa, 2015). Among them, Goal 7 relates the closest to SDG 3, aiming to "Promote the advancement of knowledge and technological solutions focused on expanding the contributions of agricultural research to the integration between food, nutrition and good health" (Embrapa, 2015, p. 13, our translation)

as a way to contribute to the development of healthier and better quality foods (Figure 4).

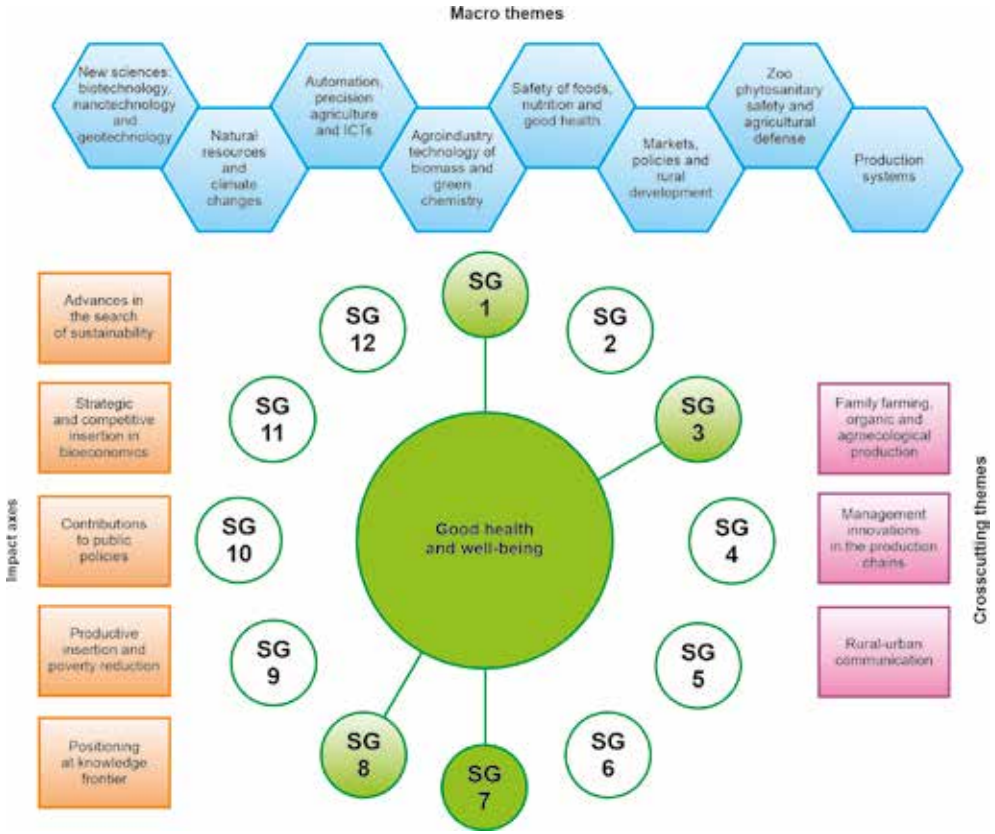

Figure 4. Strategic map of Embrapa and its relationship with SDG 3 and its 12 Strategic Goals (SG).

The alignment of projects that meet the goals of

> Developing knowledge and technologies for the adequate management and sustainable use of Brazilian biomes [(SG 1),] Extending the knowledge base and generating assets that accelerate development and incorporation to agro-food and agro-industrial systems of advanced solutions based on emerging sciences and technologies [(SG 3) and] Generating agricultural innovation assets based on the use of biocomponents, substances and technological routes that contribute to the development of new bio-industries focused on renewable energy, green chemistry and new materials [(SG 8)] (Embrapa, 2015, p. 12-13, our translation).

This alignment shows that Embrapa, through the generation of knowledge, technologies, services and processes, contributes to the improvement of agricultural production and food quality and, consequently, to the achievement of the targets proposed for SDG 3.

Thus, the research has the challenge of developing technologies that are more efficient for agricultural production, seeking to contemplate the needs of food and other products in order to guarantee the population's food safety. Therefore, as part of the research and innovation system, Embrapa has been contributing to meet society's growing demands for the development of a dynamic, complex and, at the same time, more sustainable agriculture.

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Chapter 2

Challenges to ensuring good health and well-being

Diogo Denardi Porto
Lúcia Helena Piedade Kiill

Introduction

Over the past 15 years, international cooperation efforts intermediated by the United Nations (UN) and implemented by governments and non-governmental organizations in several countries have resulted in significant improvements for the quality of life of lower-income populations. The incidence of contagious diseases, premature deaths from non-contagious diseases and infant and neonatal mortality rates are declining (United Nations, 2017). These efforts now need to be expanded so that good health and well-being targets are met.

In 2030 Agenda, SDG 3 is represented by nine targets (Table 1) seeking to "ensure a healthy life and well-being for all, at all ages" (United Nations, 2018). Among them, Embrapa RD&I actions have contributed to reach two targets (3.4 and 3.9), which will be contextualized here.

Premature mortality due to chronic non-communicable diseases

According to the World Health Organization (WHO), chronic non-communicable diseases (NCDs) have become a major health problem in many countries. Diseases such as hypertension, type 2 diabetes, chronic cardiovascular and respiratory problems, as well as certain cancers have been reported as the cause of about 56 million deaths worldwide in 2015. This indicator accounts for 70% of all registered deaths, with more than 90% occurring in low and middle-income countries. In addition, the impact of these diseases also reflects in the high rates of years of life lost, in the reduction of the workforce and daily activities (World Health Organization, 2013, 2017b).

In 2007, in Brazil, NCDs accounted for 72% of deaths; the most prevalent diseases were circulatory system diseases (31.3%), neoplasias (16.3%) and diabetes (5.2%)

Table 1. Sustainable Development Goal 3 targets, with emphasis on those that count on the contributions of Embrapa.

Target	Description
3.1	By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births
3.2	By 2030, end preventable deaths of newborns and children under five years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births
3.3.	By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases
3.4	By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being
3.5	Strengthen the prevention and treatment of substance abuse, including narcotic drug abuse and harmful use of alcohol
3.6	By 2020, halve the number of global deaths and injuries from road traffic accidents
3.7	By 2030, ensure universal access to sexual and reproductive health-care services, including for family planning, information and education, and the integration of reproductive health into national strategies and programmes
3.8	Achieve universal health coverage, including financial risk protection, access to essential, quality good health services and access to essential, safe, effective, quality and affordable medicines and vaccines for all
3.9	By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination
3.A	Strengthen the implementation of the World Health Organization Framework Convention on Tobacco Control in all countries, as appropriate
3.B	Support the research and development of vaccines and medicines for the communicable and non-communicable diseases that primarily affect developing countries, provide access to affordable essential medicines and vaccines, in accordance with the Doha Declaration on the TRIPS Agreement and Public Health, which affirms the right of developing countries to use to the full the provisions in the Agreement on Trade-Related Aspects of Intellectual Property Rights regarding flexibilities to protect public health, and, in particular, provide access to medicines for all
3.C	Substantially increase health financing and the recruitment, development, training, and retention of the health workforce in developing countries, especially in least developed countries and small island developing States
3.D	Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global good health risks

Source: United Nations (2018).

(Schmidt et al., 2011). The loss of labor productivity and the decrease in family income resulting from the presence of some NCDs would probably have led to a loss in the Brazilian economy of US$ 4.18 billion between 2006 and 2015 (Abegunde et al., 2007).

Among the main determinants of NCDs increase are the demographic, epidemiological and nutritional transitions. In this last one, the changes in dietary patterns stands out because of urbanization and industrialization that have led people to adopt high-energy diets based on meat, milk and high fat derivatives with low nutritional values (Pan American Health Organization, 2014).

These changes also related to the increase in obesity of the population in developing countries. In Latin America, around 58% of the adult population (about 360 million) is overweight, which is similar to the Brazilian population tendency, according to the Pan American Health Organization (2014), Brazil (Brasil, 2017) and FAO (2017) research. These changes are even more pronounced when observing the evolution in cases of obesity and NCDs in less privileged ethnic and racial groups, such as the indigenous, Afro-descendants and vulnerable populations suffering from iniquities (Schmidt et al., 2011).

Therefore, in the last decades, there has been an intensification of research on the relationship between food, nutrition and good health. In addition to contributing to NCDs reduction, studies show the importance of diet in improving mental and physical performance, as well as in strengthening the immune system, among other benefits.

Contamination of people and the environment through agricultural activities

A large number of people become ill every year due to the consumption of contaminated food, even in developed countries. In more severe cases, hospitalization and even death may occur. Therefore, there is a significant demand for safe food.

Safe food consists of food free from contamination by biological, physical and chemical agents harmful to human health. This contamination may come from several sources, potentially present from the primary production and along food supply chains. In primary production, food can be contaminated as a result of the use of areas where the environment itself is a threat to food safety, with

the presence of dangerous substances or outbreaks of pathogenic organisms. However, even if produced under suitable premises, food may become unsafe during transport between the facility and the place of supply to the final consumer due to inadequate handling and lack of control measures.

Food safety has received increasing attention from international organizations, which reflects, for example, in barrier clauses as part of trade agreements and periodic inspections of productive facilities such as agro-industries. International control agencies such as the World Trade Organization (WTO) closely monitor food safety standards in order to ensure product quality and safety.

Consumption of contaminated water is another serious problem, affecting millions of people every year. The number of deaths due to diarrhea reaches 1.5 million annually (World Health Organization, 2017a). Approximately half of these deaths may occur due to contamination of water for human consumption. In addition to diarrhea, the consumption of contaminated water can cause illnesses such as cholera, hepatitis, typhoid fever and poliomyelitis.

In addition to biological agents as microorganisms that cause infections and diseases, contaminated water can contain chemical agents, such as medicine residues, poisons and other toxic substances, even radioactive, which can cause serious illnesses such as cancer. Certain harmful substances may remain in the water even after effluent treatment. This is the case of chemical compounds called endocrine interferons, which can cause intoxication even at very low concentrations.

In Brazil, although the supply of water in quantity is not a problem in most of the territory, an increasing number of places has problems with water quality on their sources. There are several causes for water contamination; the most common are the urban and industrial sewage disposal without treatment directly in the environment and the indiscriminate use of toxic chemicals in agricultural activities.

Some agricultural technologies have risks associated to their use and, in this regard, environment and human contamination with synthetic pesticides is a relevant matter, especially in Brazil. The country is one of the world leaders in agricultural production; however, it is the one that most consumes synthetic pesticides. The use of this input has grown rapidly in the last decade, and Brazil is currently responsible for approximately one fifth (20%) of the world consumption of pesticides.

Uncontrolled application of synthetic pesticides in rural areas can cause several problems both to the environment and to human health. Rainwater can carry

chemical residues present in the soil and accumulate them in the water sources, which will then be used in the human supply. In addition to environmental contamination, the exposure of rural workers to synthetic pesticides is another problem associated with the lack of control in the use of these products. The number of intoxication cases among farmers is high and often originates from inadequate handling. Figure 1 shows a map with the distribution of the use of synthetic pesticides in Brazilian municipalities.

Several countries recognized the problems generated by the indiscriminate use of synthetic pesticides and began to adopt policies to discourage their usage. These new policies started to stimulate the search for alternative forms of food production and the establishment of certifications regarding the prohibition or the correct usage of synthetic agrochemicals. One of the greatest challenges of agricultural production is to combine compliance to standards and required certifications along with production yields sufficient to meet all demand for food.

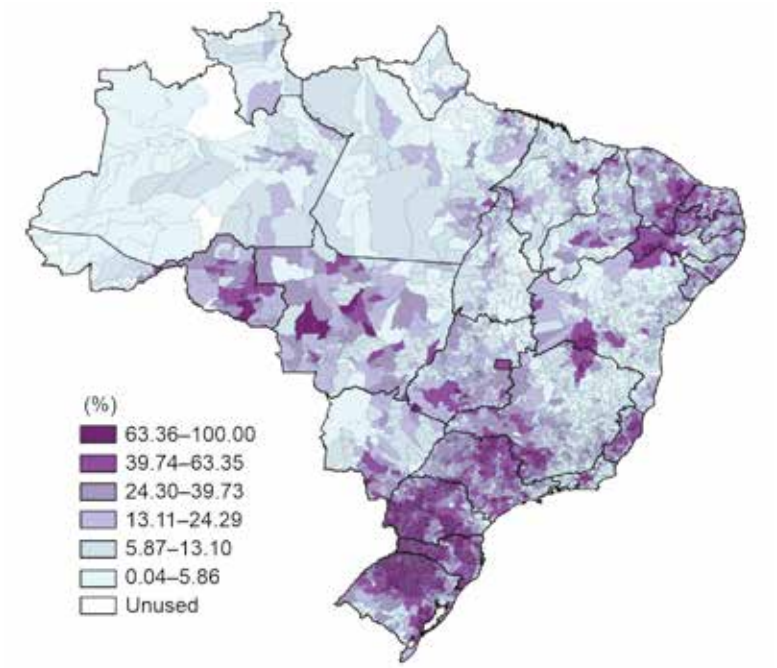

Figure 1. Percentage of establishments that use pesticides in relation to the total of rural establishments in Brazilian municipalities.

Source: Adapted from Bombardi (2017).

Reference standards for food safety

The Joint WHO/FAO Food Standards Program has set out a number of recommendations for safe food production. These standards are compiled in the collection called Codex Alimentarius (from the Latin "food law" or "food code"), which in turn serves as a reference for food safety standards used worldwide.

The Codex is applied to all types of food, including processed, semi-processed and *in natura*. The maximum limit of chemical residues in food is an example of an established standard. For this standard, the presence of a list of substances used for various purposes in food production, such as pesticides, antibiotics and hormones, is evaluated. The concentration of these substances in the food has a maximum threshold, which stands as a safety reference. The rationale behind these thresholds is that the amount of residue found in food should be safe to the final consumer and as little as possible.

In addition to chemical contaminants, Codex establishes standards and norms for controlling the presence of pathogenic microorganisms in food. Measures to ensure food hygiene need to be applied throughout the production chain, including transport, storage and supply to the consumer. Among these measures are the control of sanitary conditions of raw materials and production area, the hygienic elimination of all rejected material in the production process, the maintenance of an adequate hygiene level among the people involved and the quality control of product storage.

Standards that regulate food safety are constantly changing with new milestones in which the use of an increasing variety of toxic products is banned, and progressively lower chemical levels are tolerated in food. Meanwhile, new technological strategies, especially those derived from biotechnology and nanotechnology, are incorporated into productive means; however, even these are subject to regulation and not all are accepted in importing countries.

Increasing food nutritional quality

With the development of the global cargo transport network, the consumption of fresh products from other continents has become a tangible possibility. However, in addition to transport infrastructure, the products had to tolerate long periods in various storage modalities without losing quality and nutritional properties. This is still a challenge for a wide range of products and, considering

the restriction on the use of potentially hazardous chemicals, it may require highly innovative approaches. Not only have the populations that import fresh products for consumption benefited from their greater conservation. Among other advances, the greater product durability can confer less food waste, greater use of production and lower price of these products for all consumers.

Another way of ensuring the preservation of nutrients in food is forms of processing that, while eliminating the presence of pathogenic microorganisms and guaranteeing product preservation for long periods, preserve the substances responsible for their functional properties. One of the most traditional methods of preserving food is the treatment with high temperatures followed by packaging in tightly sealed containers. Although effective and easily incorporated into the industry, this method eliminates several beneficial natural substances, such as vitamins and antioxidants.

Thus, advances in food industry technology have contributed as one of the means for improving the population's quality of life, reducing heath costs with diseases associated with poor nutrition as well as consumers' opportunity for healthy, practical and sensorially attractive foods.

The development of technologies aimed at supplying foods with differentiated nutritional composition capable of contributing not only to the supply of nutritional deficiencies but also the prevention of diseases and maintenance of the population's good health is fundamental. Therefore, functional foods are one of the main world trends in this segment and the fastest growing in the food industry. Such products promote the good health and well-being of consumers through biochemical and physiological effects that go beyond basic nutritional functions, representing a new frontier for the sciences that study the relationship between food, nutrition and good health, and providing an opportunity for technological innovation with potential impact on the population's good health.

In line with this demand, Embrapa has been developing RD&I actions on target compounds with nutritional impact or biologically active compounds with beneficial effects on good health in order to develop more nutritious and healthy foods, as well as strategies or technological tools capable of promoting variations in concentration (increase, reduction or elimination) of the proposed target compounds. These actions aim at contributing to the development of these foods, as well as studies that qualify such products in relation to nutrition and good health aspects. These research actions were gathered in the portfolio of Food, Nutrition and Good Health projects, aiming at promoting the advancement

of knowledge and the development of technologies for expanding the supply of functional and healthy foods, as well as food for groups of the population with specific needs (diabetics, hypertensive people, allergies or food intolerances, among many others), systematically exploring the connections between food, nutrition and good health.

On the other hand, research actions aiming to fill technological gaps and contribute to strengthening of initiatives focused on the production of safe food are part of the Safe Food portfolio. The projects seek to induce the desirable synergy of knowledge and accumulated experiences to trigger an integrated national agenda on the frontier of knowledge, in order to strengthen the Brazilian competence in food safety.

In the line of contamination of production and the environment, the Rationale Management for Agrochemicals portfolio, in turn, aims to offer strategies and technologies to improve use efficiency and avoid or reduce environmental impacts associated with agrochemicals. Thus, it can reflect on the improvement of human and animal well-being, mainly in the rural area. In addition, contamination of water resources can affect rural and urban populations that use this natural resource. Workers and families living in agricultural areas, as well as rural schools, should be exposed to fewer pesticides.

Finally, the Biological Control portfolio has the scope in the research for alternative methods of pest control by the use of living organisms. Thus, the idea is to contribute to the production systems with low environmental impact inputs and safety for producers and consumers' good health.

Embrapa, through RD&I actions, has been contributing for the development of practices and friendly and innovative processes in the quest for sustainable development and safer food production.

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Chapter 3

Food and well-being

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Introduction

The target 3.4 of Sustainable Development Goal 3 (SDG 3) is "By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being" (United Nations, 2017). These issues include food availability as well as their nutritional quality through safer production systems.

Advancements in food, nutrition and health research and their relationships have brought clarity to role diet plays in improving human health. For this reason, investments in research and dissemination of preventive actions are increasing. However, access to adequate food does not depend only on individual choices, but implies the investment of integrated public policies such as pedagogical activities and provision of adequate school meals, as well as incentives for the production, distribution and marketing of healthy foods (Malta et al., 2014).

Thus, adopting healthy and sustainable food practices is multidisciplinary and covers agriculture, food, nutrition and good health. Under its expertise, Embrapa has sought to develop technological solutions aimed at not only increasing the supply of food but also at reducing nutritional deficiencies, preventing diseases and promoting population's good health.

Availability of quality food for at-risk groups

Embrapa is aligned with national policies aimed at supporting intersectoral initiatives to increase the supply of basic and minimally processed foods, at their production, supply, and promotion of conscious and healthy food consumption. Thus, these strategies are consistent with the study of Goodman (2003) in a quality turn perspective, that is, in research topics focused on food quality and alternative production practices.

Technological innovation initiatives, which aimed at improving health, start with ensuring and guaranteeing access to quality food for at-risk groups. An important

contribution of Embrapa is the Integrated System of Food Production, also known as Embrapa-UFU-Fapemig Sisteminha, which consists of the productive integration between fruits, vegetables, poultry, fish and small animals, through the recirculation of nutrients. It is considered a low-cost and easily accessible technology, targeting the population of urban, peri-urban and rural areas, including indigenous villages and family farmers. In Brazil, several units were deployed in the five regions of the country, and were made available to African countries through international technical cooperation projects, such as the Agricultural Innovation MKTPlace.

Fruits and vegetables production using rainwater is another strategy developed by Embrapa and being used in the Brazilian semiarid region in order to meet household consumption needs, allowing the insertion of vitamins and minerals into the family diet. Federal government has being using this technology as food safety in the so-called Uma Terra e Duas Águas Program (One Land and Two Waters Program – P1+2).

Organic and agroecological production has been developed in the Sistema Integrado de Produção Agroecológica (Integrated System of Agricultural Production, Sipa), with numerous indications of vegetable consortia, green manure (rotation or consortium of vegetables with legume), organic compounds, vegetable cultivars adapted to organic handling and biological control by conservation to manage natural enemies of pests, innovations that Chapter 4 will detail. Other technologies with this focus (Figure 1) are, for example, Quintais Produtivos (Productive Backyards) and the alternative system of poultry breeding (Barbosa et al., 2007).

Production of quality and enriched foods

After observing the increase in chronic non-communicable diseases (NCDs) and with the objective of making access to quality food increasingly affordable and universal, Embrapa has developed technologies that are used in agricultural and agro-industrial processes, which result in fortified and enriched products, probiotics and foods with reduced levels of fats, sugars and salts.

Adding fibers for functional purposes is a line that has been developed for different products. For dairy products, the production of cheese and cream cheese enriched with passion fruit fiber stands out, which, in addition to providing higher fiber levels, gives the product its flavor identity. Other technologies with this focus are, for example, fiber-enriched tilapia nuggets, passion fruit peel soup (Cardoso et al., 2009) and fiber-enriched paste (Figure 2).

Photo: Edna Maria Cosme Santos

Figure 1. Alternative system for growing free-range poultry.

Photo: Tomas May

Figure 2. Fresh pasta enriched with passion fruit fibers.

With regard to fortified food products, Embrapa has contributed to the development of products on different lines. By means of genetic improvement techniques, new sweet potato varieties were obtained which have better productive efficiency, adequacy of characteristics for processing purposes (as chip production), presence of resistance genes to diseases and pests, and improvement in their nutritional characteristics. 'BRS Amélia' is an example of biofortification and presents high levels of carotenoids and very sweet flavor. The 'Beauregard' potato has ten times more carotenoids (pro-vitamin A) than its main competitors do.

Soymilk enriched with calcium is another product Embrapa has produced. Chocolate, strawberry and vanilla flavors had 15% of the calcium requirements according to the parameters of the recommended daily intake (RDI) and presented better sensorial and nutritional quality when compared to the product without addition of sodium lactate and flavorings agents. This milk represents an alternative product of better sensorial quality, capable of circumventing a nutritional limitation of conventional soymilk, that is, the low calcium content. Other examples of technologies in this line are wheat flour and corn enriched with iron, rice added with isolate protein, grains enriched with sesame and tilapia sausage enriched with grape bagasse extract.

Embrapa also supports diagnostic actions on eating and consumption habits that aim to guide the strategic planning of government policies for healthy eating habits. In Rio de Janeiro, research and educational activities with youngsters from high schools corroborated sensorial tests of numerous products (grape nectar, bread roll and potato stick) with reduced contents of sugar, sodium (present in salt) and fat. Awareness and publicity actions were also promoted on the benefits of healthy eating by means of lectures, the distribution of a didactic booklet and a cartoon projection for children and adolescents.

This type of social intervention is important because of the growing sugar, fat and salt consumption, especially among young people, who are directly affected by the increase in overweight, hypertension and diabetes cases. According to data from the Pan American Health Organization (2014) and FAO (2017), the calorie value obtained through sugary, butter and oil products is significantly lower than the calorie produced by natural products, generating the so-called "obesogenic environment", which promotes the consumption of products rich in salt, sugars and fats in detriment of fresh and healthy foods such as fruits, vegetables, legumes, dried fruits and whole grains. This abundance of low-cost calories generates significant changes in diets such as those aforementioned.

The presented diagnosis has triggered the need for agricultural research to concentrate efforts on the development of technologies, products, processes or services (TPPS) that minimize the healthy food production costs. In this perspective, Embrapa has focused its efforts on the development of technologies in both agriculture and livestock, not only for products that target these types of reductions, but also for technology and knowledge generation for coping with NCDs. An example is Recombinant Glucagon, a biologically active compound obtained and purified by Embrapa and partners that may be a relevant tool for the treatment of patients with diabetes or hypoglycemia.

In the line of food aimed at this public, Embrapa has in its portfolio of technologies the Light Swine, a lineage of heavy animals, but with lean meat and low backfat thickness; jellies (mixed and passion fruit ones); low-sugar melon juice as an alternative to the juice industry; and flours and cereals for the whole grain and/or functional food industry.

Recently, the development of probiotic-function foods has been a tool in the industry to add functional value to these products. Probiotic bacteria are related to the modulation of intestinal microbiota, and its good health maintenance relates to a better use of foods and reduction in type 2 diabetes, which increases the importance of technology for the production of these types of food (Tonucci et al., 2017). For the food industry, regardless of the production scale, using probiotics is an opportunity to add value to conventional products, differentiation and meeting the demand for food that, in addition to nourishing, provides good health benefits. For this, Embrapa is active in the production of beverages and dairy products with probiotic function, such as probiotic ice cream based on goat milk, probiotic goat curd cheese, pasteurized milk with probiotic and probiotic milk beverage with pineapple juice.

Besides food, other factors are considered when thinking about prevention of NCDs and other diseases that affect mainly the economically active population, such as stress and problems related to work activities, such as repetitive strain injuries, musculoskeletal problems and accidents at work. Therefore, in addition to the research and innovation focused on the awareness and use of healthy foods that influence the quality of life, Embrapa has invested efforts to stimulate the development of agricultural activity in favorable ergonomic characteristics, without losing focus on productivity.

Well-being on agricultural production

In rural areas, the great majority of workers are constantly exposed to potential sources of health problems, either because of the high efforts that make up the field routine, such as long walks; excess of physical effort due to transport of heavy raw materials and utensils; the use of different tools, machines and implements, as well as exposure to chemical and biological risks that follow farmers' lives from childhood to old age (Marques; Silva, 2003; Leite et al., 2007).

Given the importance of the agricultural sector to developing countries, in which the sector is one of the main responsible for economy dynamization, there is a need to increase solutions that minimize the risks to which workers are exposed and receive better performance in their work activities (Martins; Ferreira, 2015). Other technologies developed by Embrapa (Figure 3) to promote well-being of this public in several agricultural branches are: Grafting Bank, harvesting workstation (Lana; Monteiro, 2014), desuckering by rotor-compression (Gasparotto et al., 2014), manual harvester of mango (Pinto; Ramos, 2000), Extraction Equipment of *Baru* Almond, threshing machine of rice (Silva et al., 2002), Spraying Machine by

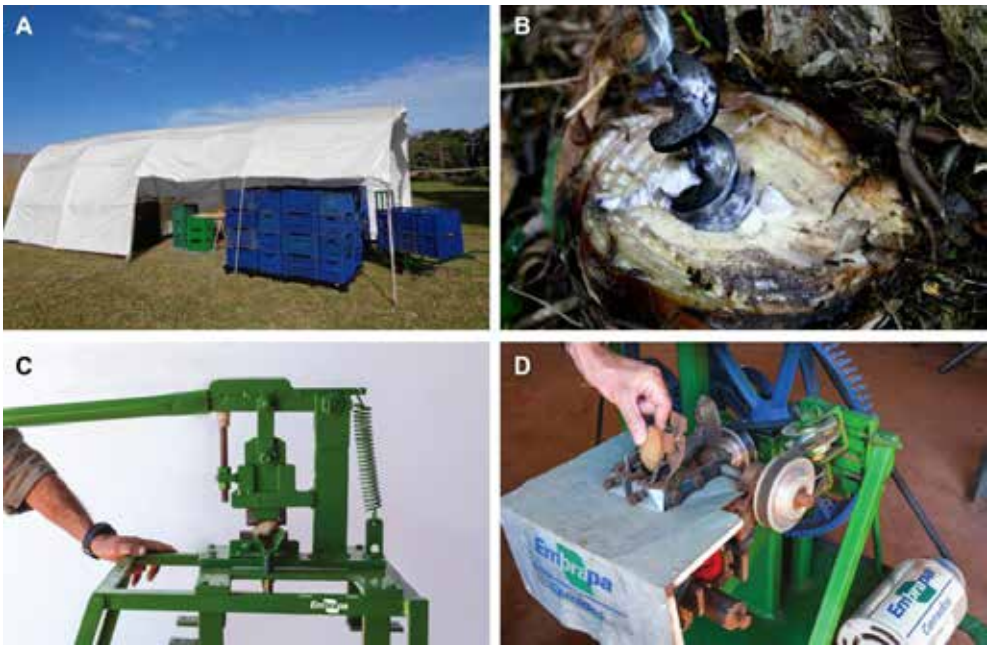

Figure 3. Embrapa technologies for rural well-being. Harvesting workstation (A); desuckering by rotor-compression (B); manual machinery (C) and electric machinery (D) of baru almond extraction.

Human Traction and course of Formation of Swine Transports. Other technologies can be found in the e-book *Sustainable Development Goals 8* (Loiva et al., 2018).

In addition to the technologies, well-being is taken into account throughout the development of other solutions, which are also an evaluation factor of technology impact that is transferred to the society. For this, Embrapa has a software called System for Environmental Impact Assessment of Agricultural Technology (Ambitec-Agro), which is a set of multi-criteria matrices that integrate indicators of technological innovations performance and management of practices adopted in the accomplishment of activities. Seven key aspects of evaluation are considered: use of inputs and resources; environmental quality; respect for the consumer; employment; Income; good health; and management and administration. Chapter 4 shows further details on this technology.

The results of this assessment allow farmers (or property managers) to determine which management practices have the greatest impact on the performance of their activity. To decision makers, managers and organizations, they can define policies and strategic instruments to improve the performance of rural activities, as well as to choose better options of practices, forms of management and technologies to the promotion of sustainable development through rural activities.

By knowing the importance of preventive actions and their impacts, it is fundamental that areas such as food and well-being are always in vogue on the political agenda and strategic institutional planning of research, science and technology agencies. Guaranteeing the workers the conditions to perform their task in a functional and healthy way is one of the goals, giving the population adequate food that actually promotes nutrition, not only satiety, but also encourages the use of technologies (and developing) which contribute to the improvement of a number of socioeconomic and nutritional indicators, especially in developing countries.

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Chapter 4

Contamination of rural environment and production

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Introduction

Target 3.9 of the Sustainable Development Goal 3 (SDG 3) is "By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination." (United Nations, 2018). The contamination of the rural area has been pointed out as one of the serious problems of the present times, since it puts at risk human health, natural resources and biodiversity. In most cases, the contamination of this space is attributed to chemical contamination, a direct result of the use of agricultural inputs, mainly insecticides and herbicides, which pollute the soil and water, and can even reach foods human beings consumed, causing various diseases.

Studies show that pesticides can affect human health during their manufacture, preparation and application and when consuming a contaminated product, and regardless of the form of contact, the effects are extremely dangerous. Surveys have estimated that millions of agricultural workers in poor countries suffer from some form of intoxication caused by pesticide exposure.

Reduction of contamination of rural areas and protection of human health through agricultural activities

The growing concern about the impacts of agricultural activities on natural resources and human health has led to the development of research focused on the rational use of agrochemicals, seeking to mitigate their harmful effects. Embrapa has been generating and/or perfecting technologies, products, processes and services (TPPS) in order to reduce the use of these inputs in crop production.

In this sense, Embrapa has been working on different fronts, such as integrated and organic production, development of biopesticides, nanoproducts and production systems for impact management.

In the Integrated Production (IP) approach, which encompasses alternatives to the conventional production system with the main goal of rationalizing the use of pesticides, stimulating the balance of ecosystem and maintaining the quality and safety of products, Embrapa has been contributing with studies aimed at different crops (mango, grape, citrus, strawberry, among others). Currently, the Ministry of Agriculture, Livestock and Food Supply (Mapa) coordinates the program, called Produção Integrada Agropecuária (Agricultural Integrated Production – IP Brasil), which can be certified by the National Institute of Metrology, Quality and Technology (Inmetro). The program also has the support of a large number of research, teaching and extension institutions for its technical development and training of multiplier agents involved in the process of converting from conventional to sustainable. This technology has contributed decisively to increasing exports, especially to the more demanding markets such as the European and North American.

In São Paulo, Produção Integrada de Morango (Integrated Strawberry Production – PIMo) organizes society segments involved in the culture to develop and implement this production system, which protects the environment, the rural worker and the consumer, generating strawberries of high quality and safety, branded by Brasil Certificado seal.

For several years, strawberry appeared in the media as a product that contains pesticide residues beyond the safety thresholds. In addition to endangering consumers, this information also threatens family farmers with marketing difficulties. As this crop is very susceptible to pests and diseases, some farmers use

pesticides without need, and, consequently, are the first ones to be contaminated. With the aim of disseminating and demonstrating the technologies needed to convert the conventional system to a sustainable integrated strawberry production (PIMo) in the regions of interest, the technology proposes to sensitize and train extension agents, farmers and other actors on the basic themes necessary for PIMo implementation; prepare, publish, validate and update technical standards; take to the field the technologies disseminated in the theoretical-practical trainings performed after the installation of demonstrative units (DUs); conduct training on the main themes, using multiplier agents to carry out evaluations in the DUs (research methods) and expand knowledge to other regions; propose public policies that guarantee the program sustainability in the region and for other interested parties. Thus, the first certification of strawberries in IP Brasil occurred in the state of São Paulo in 2011, and then expanded to Minas Gerais in 2016 and Rio Grande do Sul in 2017.

The integrated crop-livestock-forestry system comprises another technology that has contributed to reduce the use of external inputs and to a potential decrease of the negative environmental impacts of conventional agriculture (Reis et al., 2015). Specifically, in crop rotation with pasture, species of brachiaria break the cycle of pests and diseases, reducing population of fungus species (*Fusarium* spp. and *Rhizoctonia* spp.) causing root rot in soybeans, beans and other crops and diminishing the germination of fungus causing white mold (*Sclerotinia sclerotiorum*). Studies by Embrapa show that a dense straw of brachiaria hampers the incidence of white mold on beans. The control mechanisms are the physical barrier, which reduces the contact of soil fungi spores with the plants and, mainly, the allelochemical, since, from the third year of brachiaria cultivation in one area, the germination of sclerotia that cause mold is greatly reduced. Thus, adopting rotation with brachiaria pasture is a good management practice for an infested area. Other observations relate to the reduced need for post-emergent herbicides such as in maize and bean crops, since, due to the large amount of soil cover, together with the low rate of decomposition of brachiaria straw, there is lower incidence of weeds in rotational areas with pasture-grains (Oliveira et al., 2015).

Organic Agriculture (OA) and Agroecology (AE) are areas of research developed by Embrapa, which have contributed significantly to the reduction of contamination of food and the environment. According to Abreu et al. (2012) these practices represent a new field of knowledge in support of the transition process towards sustainability. In this sense, agriculture can be more or less sustainable when it is able to meet, in an integrated way, the following principles: low dependence

on external inputs and internal recycling; use of renewable natural resources locally; minimum adverse impact on the environment; long-term maintenance of productive capacity; preservation of biological and cultural diversity; use of knowledge and culture of the local population; satisfaction of human needs for food and income (Gliessman, 2009).

In this sense, the Plataforma Digital de Conhecimento Agroecológico (Digital Platform of Agroecological Knowledge –Plataforma Agroecológica) was created to systematize, popularize and make available public domain publications generated by Embrapa on Agroecology knowledge.

The Integrated System of Agricultural Production (Sipa), or *Fazendinha Agroecológica*, is one of Embrapa partner institutions' technologies, which proposes consortia of vegetables, green manure, organic compounds, vegetable cultivars adapted to organic management and biological control by conservation for the use of natural enemies of pests. Among the activities, the actions linked to federal government programs stand out, such as Mais Alimentos e Bancos Comunitários de Sementes de Adubos Verdes (More Food and Community Banks of Green Fertilizer Seeds). Farmers from different regions of Brazil adopted the management techniques developed at Sipa.

Embrapa has been developing another line related to the development of nanoproducts for agriculture. By means of nanotechnology, which consists of a set of techniques used for visualization, characterization, production and manipulation of matter in the scale of atoms and molecules, products have been developed seeking to improve the quality of life. As in any area of technology making intensive use of new materials and substances, it may pose a risk to the environment and human or animal health. Thus, the assessment of the potential biological impact of nanomaterials has become of great importance in recent years, since the rapid pace of development of nanotechnology has not been followed by a thorough investigation of its safety. The same properties that make nanoparticles interesting for applications, such as their small size, large surface and high reactivity, also make them accessible to previously inaccessible sites in living systems with potentially significant consequences for the environment. There is still much discussion about the regulation of these materials as a new area of knowledge. Understanding potentially at-risk situations is complex and challenges evaluators to choose priorities among the multiplicity of factors. In general, indicators and methodologies development for at-risk assessment of nanoproducts is important to support the work of nanotechnology developers. Embrapa AgroNano team and the focus on the development of these evaluations

by Embrapa Environment should support both scientific and regulatory agents to address the most relevant concerns in this area.

Sistema de Avaliação de Impactos Ambientais de Inovações Tecnológicas Agropecuárias (The System of Environmental Impact Assessment of Agricultural Technological Innovations – Ambitec-Agro) is another example of a technological solution developed by Embrapa. This system is a set of multicriteria matrices that integrate indicators of the performance of technological innovations and management practices adopted in rural activities. In it, seven essential aspects of evaluation are considered: use of inputs and resources, environmental quality, respect for the consumer, employment, income, good health, and management and administration.

The criteria and indicators are constructed in weighting matrices in which data obtained in the field are automatically transformed into graphically expressed impact indexes. The evaluation results allow the producer/manager to determine which impacts of technology are dissatisfied with their social well-being goals. To the decision maker, the results allow for the indication of measures to enhance or control the technology adoption, according to sustainable local development plans, and, finally, provide an objective measure of impact, helping in the qualification, selection and transfer of agricultural technologies.

The Ambitec-Agro indicator system aims to provide a simple and practical, expeditious and low cost approach, applicable to the multicriteria evaluation of socio-environmental impacts, for the wide variety of technological innovations and rural activities focused on Embrapa RD&I projects and their partners of the Brazilian Agricultural Research System.

Sistema de Avaliação de Impacto Social da Inovação Tecnológica Agropecuária (Social Impact Assessment System for Agricultural Technological Innovation – Ambitec-Social) consists of a set of electronic spreadsheets that integrate 14 indicators of the contribution of a given agricultural technological innovation to social well-being within a rural establishment. This system aims to assist agricultural RD&I institutions in the evaluation of projects, as well as rural producers and decision makers in the choice of best practices, management forms and technologies aimed at the sustainable development of rural activities.

Another line of action of Embrapa is the agrochemicals application technology, which is an applied science of multidisciplinary nature, involving knowledge of agriculture, biology, chemistry, trade, economics, engineering, medicine, physics,

among others (Matthews, 1982). The exchange of information between those involved in the practical problems of phytosanitary control and researchers in application technology is essential to achieve some progress in this area of knowledge.

Application type, treatment number, pesticide formulation, applied dose, equipment type, characteristics and spatial distribution of spray nozzles, droplet diameter and density, micrometeorological conditions are partially interdependent and should be selected to achieve the best biological effects, according to the application purposes. However, actual agrochemical application does not differ essentially from that practiced in the last century, and is characterized by considerable waste of energy and chemicals (Chaim, 2009).

Volume selection of liquid in which a pesticide is applied is on the user's criterion, in which in practice the same volume is applied against a wide variety of pests and is usually determined by the flow of the sprayer nozzles. Both in Brazil and abroad, there is no definitive information on the wastes that occur during spraying. Some information available in the international literature indicate that pesticide applications are extremely inefficient; however, they base only on theoretical facts, that is, based on theoretical doses of pesticides necessary to control populations of pests that cause economic damage. Chaim et al. (1999b) developed a method to quantify wastes that occur during spraying on creeping crops. The results of the losses verified in low size crops are around 40% to 70%, depending on the stage of plant development. Studies on shrub-like crops also point to similar results (Chaim et al., 1999a). Currently, Embrapa is proposing solutions to some problems of pesticide application technology through suggestions on methodology for deposition calibration and development of more efficient spraying technologies.

A system for droplet electrification produced by hydraulic nozzles was invented after the discovery of hydrophobic material to serve as a support for induction electrodes with specific geometries for conical jet nozzles or fans. The system consists of a high voltage source, powered by two AA batteries, which are connected by a high voltage cable to the induction electrode attached to the head of hydrophobic material. When the electrode is energized by positive energy, it attracts electrons in the droplet-forming zone of the hydraulic nozzle. The droplets acquire loads of polarity opposite to the induction electrode at the time of their ejections, and some are retro attracted, causing head wetting. For this reason, the head needs to be hydrophobic; otherwise, it would form a trail of liquid that would bind the electrode to the nozzle, and the system would collapse. The system can be coupled to any sprayer that uses hydraulic nozzles,

transforming a common spraying into an electrostatic. It promotes a significant increase in the efficiency of droplet deposition in biological targets and in the broth economy. Its use has a positive impact on the environment and preserves the applicator's health by reducing spray drift. The technology is protected by patent and promotes good health and well-being to consumers.

Producing quality foods

Products of animal or vegetable origin go through various intermediates until reaching the final consumer. Monitoring of food safety conditions at each stage of the process is essential, and one of the most efficient ways to do this is by tracking agricultural products. A traceability system is a set of measures that make it possible to control and monitor the steps between the production and food supply. Therefore, any harmful changes in the production, storage and transport stages can be quickly detected, thus ensuring greater food safety.

Embrapa provides traceability solutions for animal (meat from goat and sheep, beef, milk, among others) and vegetable (pineapple production, planting, grape processing, among others) production chains. The purpose of these solutions is to ensure the obtaining of safe and quality food, as well as the preservation of these characteristics in the product supply to the final consumer.

Milk is a good example of food that is often produced in an inadequate way, and sometimes can cause risks to consumers' health. Embrapa makes available several solutions for correct production and storage of bovine and goat milk, such as milking kits (Figure 1), storage quality monitoring training for workers involved in production. In addition, the standardization of milk processing, such as in cheese production, is a way of contributing to maintain the sanity and quality of its derivatives. These solutions involve the implementation of good production practices that avoid food contamination.

For plant products, several good practice courses are offered in various productive activities, including the extractivism of native products such as Brazil nuts, *cupuaçu* (Figure 2), *pequi* and acai, besides the processing of crops such as cashew, grape, cassava, pineapple, sesame, among others.

The availability of machinery and the adoption of adequate procedures are of great importance to maintain hygiene during the production process. In this sense, solutions such as the standardization of dryers developed for the production of

Photo: Alcides Okubo Filho

Figure 1. Training in operation and maintenance of mechanical milking machines.

Photo: Felipe Santos da Rosa

Figure 2. Thermal pasteurization process of cupuaçu pulp for freezing.

raisins and *Capsicum baccatum*, besides the use of specific boxes for vegetable and fruit packaging, promote the hygiene and the efficiency of the processes.

Another type of approach is the development of methods of analysis to detect the chemical and biological contamination in foods, especially meat products. These methods detect, by chemical, bacteriological or DNA analysis, residues with the potential to cause disease. In addition, Embrapa offers consulting services for disease prevention and control during the production process.

In the future, innovative technological solutions should emerge from the progress of research in new fields of knowledge, such as biotechnology and nanotechnology. Biotechnology involves the in-depth knowledge of biological processes and the use of these processes as a transformative component, be it in industry, agriculture, medicine, and many other fields. Nanotechnology can be defined as matter manipulation at the atomic and molecular level, giving rise, among other innovative products, to new materials with unprecedented

properties. The application of these new sciences to agricultural production can give rise to safer inputs and processes with a more positive impact on the consumers' good health and well-being.

Some examples of solutions that have already emerged through these surveys are flexible films, biocomposites and coatings, which can be used in the food preservation industry. As these materials come from harmless substances such as starch and other natural polymers, they can substitute chemical preservatives as significant advancement in the sanity and safety of food products.

Post-harvest fruit treatments that combine the use of clean technologies are other examples of alternatives that can have a positive impact on food safety. In these technologies, combinations of time and water temperatures are used along with doses of ultraviolet radiation according to the characteristics of each fruit or pathogen. In addition to not using fungicides in the process, providing fruits free from residues and chemical contaminants, these processes preserve the qualitative aspects and increase the shelf life of the treated fruits. Therefore, clean technologies are considered an economically viable and technologically safe option for food sanity control, which can benefit farmers, exporters and the final consumer.

In addition to contaminations of chemical origin, food may also present biological contaminations. Agricultural products of vegetable origin are highly consumed throughout the world, mostly fresh, with no treatment by means of heat that eliminates possible microbiological contaminants. Among the possible pathogen sources in crops of agricultural products are the use of irrigation water or for pesticide preparation; use of fresh or improperly composted animal manure; presence of domestic animals close to the plantations, among others. Considering that these foods are part of Brazilian diet, as salads or fruits, there is a potential risk of pathogens presence such as *Salmonella* spp., *Listeria monocytogenes*, *Escherichia coli*, *Shigella* spp., *Aeromonas hydrophila*, *Clostridium botulinum*, parasites, and viruses. At Embrapa Environment, microbiological analyzes are being applied to test extracts/vegetable oils as well as to prove the efficiency of alternative physical methods of controlling microorganisms in foods, such as UV combined with hot water treatment. This approach results in the guarantee of the absence of pathogenic microorganisms, resulting in good health and well-being of the consumer population.

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Chapter 5

Future challenges for good health and well-being

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Diogo Denardi Porto

Introduction

For a long time, good health and absence of diseases were considered as synonyms. Today, it is believed that good health goes far beyond disease absence, encompassing good physical and mental availability and social well-being, in addition to the normal organism functioning. Thus, an individual's good health relates not only to human physiology itself but also to its interaction with the physical, social, and economic environment associated with its eating habits and other behaviors that may be beneficial or harmful.

From this perspective, the challenges to promote the population's good health and well-being are enormous and depend on several aspects. By 2030, factors such as the population's growth and aging will require more and more intensification in the actions aimed at this aspect.

Challenges and solutions

In order to minimize current problems, it is necessary to face these challenges working in a preventive way. In this sense, the sustainable agriculture will play a fundamental role, given its direct connection with good health, poverty and food production, as well as its relation with natural resources, clean power generation and climate changes.

Scenarios still predict the prevalence of low-quality diets associated with malnutrition and micronutrient deficiencies. However, the demand for healthy, enriched and innovative foods will increase with reduced substance content, such as sugars, salts and fats, considered harmful to good health if ingested in excess.

Thus, technologies aimed at the development of these products will be fundamental. The consumer market will be more demanding and more conscious and will have strong influence on quality food production. In addition, these

consumers will be more attentive to environmental issues, especially those focused on production with less impact on the environment and human health.

Research aimed at the improvement of sustainable production systems will be necessary, as well as those aimed at expanding efforts for the development of agrochemicals with lower environmental impact, and also biological control for pest and disease handling.

Another demand that is growing is for foods targeted at specific publics, such as those free from sugar, gluten or lactose, as well as those produced in alternative systems, with lower level of processing and that are concerned with animal well-being. The native biodiversity of the Brazilian biomes is another field to be explored as a source of exclusive, authentic, and singular products that will allow adding value to the agricultural production.

Contributions of Embrapa

With the growing concern with nutritional values and food quality, Embrapa has been developing more nutritious and biofortified varieties, seeking to provide solutions to health problems associated with nutritional deficiencies. Thus, cultivars of rice, sweet potato and cowpea bean have already been launched on the market, while others are in the final stages.

Concerning this theme, research aimed at target compounds to be added/increased, such as vitamins, minerals, proteins and unsaturated fatty acids, have been carried out and will contribute to the generation of unique products that can serve as alternatives for the industry. The identification of compounds to be added (bioactives, proteins, fibers) or to be reduced (salt, sugars, saturated fats) in food continues to be investigated by Embrapa, thus impacting the quality of products and, consequently, human good health.

Chapter 3 presented some of these technologies although a significantly larger number represents the Embrapa's collection. Related to the theme, around 90 cultivars, 110 agricultural practices, 60 agroindustrial processes, 40 methodologies, 80 solutions from other categories, and 90 services were generated, including analyzes, training, qualifications and consultancy.

Regarding sustainable production systems, the search for more resilient alternatives with reduced greenhouse gases (GHG) emissions stand out in Embrapa programming. Chapter 4 presented some of these systems, such as the

integrated crop-livestock-forestry system; organic and agroecological agriculture (OA and EA). Others, such as no-tillage systems, biological nitrogen fixation, biological control of pests and diseases, planted forests, recovery of degraded areas, treatment of animal waste, recovery, restoration and environmental adequacy of rural properties are also among research priorities.

In accordance with the new trends in the food industry, Embrapa has focused its research activities on the advancement of knowledge and innovative technologies in the search for solutions to these issues. Nanotechnology, through the manipulation and optimization of nanometric-scale properties of matter, has demonstrated enormous potential for improving the performance of various products and processes as well as facilitating traceability processes. In addition, it can also be applied in the industry of inputs, veterinary medicine, as well as in the sectors related to food processing and conservation.

Biotechnologies are another field that has been emerging, highlighting the prospection of new products through genomic, proteomic, metabolomic and metagenomic technologies. Among the main contributions are the development of superior genotypes, the dominance of metabolic routes of plants, animals and microorganisms, as well as the development of materials and substances of high value, which will allow an increase in productivity in agricultural production systems.

In recent years, Embrapa has its strategic vision focused on anticipating trends, seeking to adjust its performance to offer solutions that meet future demands. The food-nutrition-health integration and sustainable production have become a reality for quality of life improvement. Thus, research actions will effectively contribute to improving the population's health and well-being. In this respect, through the generation of knowledge, technologies, services, and processes aimed at improving agricultural production and food quality, Embrapa will continue to contribute to this theme and, consequently, will be collaborating to reach the goals proposed for SDG 3.

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