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Inter-American Institute for Cooperation on Agriculture

New realities, new paradigms:

the new agricultural revolution

Economic models and development patterns in Latin America | Assessment of the economic impact of Huanglongbing disease on Mexico's citrus chain | Climate change and food security: cross-cutting axes of agricultural policies | Agro-biotechnologies: bio-logical tools at the service of agriculture | Project "The new face of rural poverty in Brazil: transformations, profile and public policy challenges"

IICA

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IICA is the institution of the Inter-American System that provides technical cooperation, innovation and specialized knowledge to contribute to the competitive and sustainable development of agriculture in the Americas and to improve the lives of rural dwellers in the member countries.

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Coordination

Federico Sancho

Editing

Olga Patricia Arce

Desing and layout

Carlos Umaña

Translation

Language Services Unit

Authors in the current issue

Diego Montenegro, Arturo Barrera, Pedro Rocha, Diznarda Salcedo, Gustavo Mora, Ignacio Covarrubias, Carlos Cíntora, Raúl Hinojosa, Fernando DePaolis, Saturnino Mora, Alejandro Barahona, Carlos Miranda, Breno Tiburcio.

Editorial Board

James French, Arturo Barrera, Gustavo Cárdenas, Miguel García, Ricardo Molins.

Pictures

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FOREWORD

In the face of the challenges posed by the crisis of the three Fs (food, fuel and finance), the Inter-American Institute for Cooperation on Agriculture (IICA) remains firmly committed to proposing news ways in which stakeholders in the agricultural sector can learn about novel ideas and successful experiences. The agrifood chains and territories of the countries must be able to shield themselves from the effects of the crisis and have access to tools and strategies that allow them to innovate and take advantage of the opportunities to enhance their capabilities, embark upon the road to recovery and attain high levels of development.

As the agency of the Inter-American System specializing in agriculture and rural well-being, IICA envisions a new paradigm for agriculture that would not only mitigate the impact of the crisis of the three Fs, but also help to improve the competitiveness of chains, the well-being of rural communities, and food security, and mitigate the effects of climate change.

With the emergence of this new paradigm in agriculture, it is even more important that we furnish the Member States with proactive, up-to-date information, so that agricultural policymakers in the Americas can translate this more productive, more inclusive and more sustainable form of agriculture into concrete actions. With this vision, the current issue of COMUNIICA marks a new departure and addresses new issues related to the challenges facing agriculture:

- As this emerging paradigm takes shape, it is necessary to clarify the development models and approaches used in Latin America, where agriculture plays a key, visible role not only in supplying food but also in creating a more diversified base of production and employment, and of rural initiatives based on knowledge, innovation, technology and cultural identity.

- One important aspect of the new paradigm is the transformation that agriculture is undergoing as a result of the use of information and communication technologies (ICTs) and biotechnology to meet the new

demands of society, markets and agrifood chains. As biotechnology is one of the main components of the transformation, there is growing interest in providing objective, impartial, up-to-date and scientifically validated technical information on the progress, benefits and risks of agro-biotechnology, which offers an effective array of techniques for enhancing the productivity and competitiveness of the agricultural sector and making better, sustainable use of genetic resources for agriculture and food security.

• The new paradigm in agriculture also calls for efforts to tackle climatic phenomena, with positive solutions based on far-reaching political decisions, changes in individual and collective consumption patterns, programs and strategies that promote technological contributions, innovation and modern institutional arrangements.

• To complement the topics addressed, the magazine also presents the initiative implemented in Mexico to assess the economic impact of huanglongbing (HLB) disease on the country's citrus fruit chain, which includes a comparison of the preventive and control actions taken to date.

• Finally, the progress of the rural development initiatives that IICA is spearheading with Brazilian institutions is highlighted in a brief description of the project, "The new face of rural poverty in Brazil: challenges for public policies, profile and transformations," which invites reflection on the urgent need to understand and define the phenomenon of poverty in a new and different way.

In this way, COMUNIICA seeks to contribute to the efforts of many institutions and countries in the region keen to provide a proactive response to the effects of the crisis of the three Fs by furnishing accessible, up-to-date and clear information. The contents of this and previous issues of the magazine are available on the Web page (www.iica.int).

Economic models and development patterns in Latin America

DIEGO MONTENEGRO[1]

Summary

In this article, the author suggests that it is time for the countries to return to the drawing board to construct new paradigms with multidimensional approaches and the economic, political, social, educational and environmental practices required to ensure economic growth, especially in the developing nations. He points to the disconnect between the economic models currently employed in the hemisphere and the dominant development patterns in the Latin American countries, which in many cases are incongruous. He argues that the governments of the region and their institutions, specialized agencies and universities should continue to facilitate opportunities for the study and discussion of the need for the gradual transformation of the countries' development patterns, adopting a creative and systematic approach. Agriculture has a key role to play in this process, not only by supplying more and better food, but also by generating a broader, more diversified base of production and employment and innovative rural initiatives, based on knowledge, technology and value-added.

[1] *IICA Representative in Costa Rica, diego.montenegro@iica.int*

Key words: economic development, models, economic growth, Latin America

The current global economic crisis has led to the collapse of paradigms, the discussion of alternative road maps and the implementation of new proposals. For some, the global crisis is not only deep but also multidimensional, with economic, political, social and environmental facets. For others it is merely a temporary state of affairs and the world will soon return to the path of globalization and economic growth.

Whatever the truth of the matter, the dilemma in which we find ourselves is the subject of heated debate: should developing countries promote economic growth first and then focus on poverty reduction, or should they devise public policies to combat poverty first and then create the conditions for economic growth.

The answers to these questions may seem obvious to those of us involved in the development of agriculture and the well-being of rural families, but the important thing is that issues that deserve greater analysis and discussion are being raised.

The debate becomes even more complex and challenging when it focuses on the benevolence or perverseness of the economic models currently employed in the hemisphere, and whether they are consistent or inconsistent with the dominant development patterns in the Latin American countries.

We have become bogged down in endless debates about the currency or obsolescence of the present economic models, which in practice are little more than differences of opinion about minimalist approaches: do we want more (or less) state influence or should we depend more (or less) on the invisible hand of the market? Should we invest more (or fewer) public resources in social programs or should we seek more (or less) integration into the world economy? However, no one attempts to answer a key question: do we, or do we not, need to change the development patterns currently employed?

We find ourselves in a heated debate: should developing countries promote economic growth first and then focus on poverty reduction, or should they devise public policies to combat poverty first and then create the conditions for economic growth.

The fact is that a number of Latin American nations, despite implementing sweeping reforms aimed at achieving macroeconomic stability and economic growth, have failed to match the achievements of other countries with similar characteristics. A simple illustration will suffice. At the end of the 1960s, the per capita gross domestic product (GDP) of the Andean nations was similar to that of the East Asian countries. Four decades later, despite the recent upturns, the per capita income of the Andean countries is, on average, less than half that of their Asian counterparts.

We are gradually realizing that economic growth alone has failed to solve the problems of extreme poverty and inequity. In many cases, it has actually helped make them worse. We have also seen how the incidence of rural poverty and the reproduction of inequality have become more accentuated in recent decades, despite the high economic growth rates recorded in many Latin American countries, with only a few exceptions.

Progress has been slow using the traditional approaches to economic development, based primarily on the utilization of nonrenewable natural resources. Nor have development patterns based exclusively on natural resources enabled many of our countries to achieve diversified, sustainable, broad-based economic development, led by micro, small and medium enterprises (MSMEs) and incorporating value-added and know-how.

Consequently, many Latin American countries still face major challenges in formulating and implementing policies and strategies designed to achieve a significant leap in that direction.

The Economic Commission for Latin America and the Caribbean (ECLAC) is on the right track when it suggests in its report "Latin America and the Caribbean in the World Economy 2008-2009" that Latin America's pattern of international integration needs to be rethought, but it then goes on to recommend that countries fully exploit their natural resources and once again place emphasis on exports of raw materials.

While the high price of primary products and commodities can generate short-term economic growth in many countries, it should go hand in hand with programs to diversify production and efforts to incorporate broad new productive sectors.

Progress has been slow using the traditional approaches to economic development, based primarily on the utilization of nonrenewable natural resources.

We agree that an economic model is simply the way in which a development pattern is administered. The development pattern is the "what" and the economic model is the "how."

It is interesting to note that several Latin American countries are beginning to construct new economic models: some designed to consolidate the free market and private enterprise; and others leaving less to the invisible rules of supply and demand, and assigning organized communities and the State a leading role in the development of strategic economic sectors.

However, it remains to be seen whether these or other economic models (or variants and combinations thereof) will be able to transform the present economic development patterns, rooted in the use of non-renewable natural wealth, into others that will lead to diversified economies with broad social, participatory and sustainable bases.

The United Nations Development Programme (UNDP) defines a development pattern as the way in which the factors of production of an economy are linked, function and cooperate in or impede economic activity, in a context of competitive advantages and disadvantages that energize or undermine the productive framework (UNDP 2005:269).

Therefore, a development pattern describes both the endowment of factors of production (capital, labor, technology and natural resources) and the mode of international integration.

If we accept this line of analysis, it is clearly essential that the governments of the region and their institutions, specialized agencies and universities continue to facilitate opportunities for the study and discussion of the need to find a creative, systematic approach to the gradual transformation of the countries' development patterns, and to integrate, in addition to traditional economic agents, new work forces and rural family units and micro-enterprises into productive dynamics that will generate income and employment, particularly based on the agricultural, forestry and manufacturing sector.

It is time for the countries to rethink their approach to development and combine economic and productive considerations and the need to export with environmental, political, institutional and educational factors and social inclusion. In this context, we need to abandon the production-based, minimalist approaches of traditional economic models and adopt multidimensional development patterns, in which agriculture can and should play a leading and visible role, not only in supplying more and better food, but also in generating a broader, more diversified base of production and employment and innovative rural initiatives, based on knowledge, technology and value-added.

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New realities, new paradigms: the new agricultural revolution

ARTURO BARRERA[1]

Summary

World agriculture is undergoing a transition to a new technological paradigm very different from that of the green revolution. The development of this new paradigm is being driven by the ongoing “bio”, “info” and “nano” revolutions, and the new demands of society and the markets. The agricultural revolution of the 21st century is deeper and more far-reaching than previous ones: it is an organizational revolution of knowledge management and of convergences between technologies. One of the effects of this new agricultural revolution is a notable increase in the sector’s potential to create wealth. This article is intended to contribute to the characterization of the new paradigm of agricultural technological development and the type of agriculture that is taking shape.

[1] *Manager of IICA’s Innovation for Productivity and Competitiveness Program, arturo.barrera@iica.int*

Key words: agricultural development, biotechnology, modernization, technological change, innovation, nanotechnology, information and communication technologies (ICTs)

Introduction

We are witnessing the emergence of "post-green revolution agriculture." The paradigm of the green revolution has run its course and has been obsolete for some time, its effectiveness called into question by climate change and the new techno-economic and organizational paradigm based on the advances in information and communication technologies (ICTs) and modern biotechnology.

The green revolution led to a particular way of conceiving and "doing" agriculture, understanding agricultural modernization and measuring sectoral performance, accompanied by a specific sectoral institutional framework.

While this development signals the end of an era and its paradigm, the term "post-green revolution agriculture" is insufficient to describe or characterize the new era that is beginning to unfold. For the purposes of this article, a paradigm is a set of values, concepts and definitions that makes it possible to address a problem or issue and shapes specific ways of understanding the world and intervening in it. More specifically, a technological paradigm is the "creation of innovation opportunities measurable by changes in the basic technical characteristics of the "artifact(s)" concerned" (ECLAC 2008:149)[2]. From a broader perspective, a paradigm has to do with the way we conceive and "do" agriculture, promote agricultural modernization and measure sectoral performance.

The paradigm of the green revolution

The technological paradigm of the green revolution was the product of the industrial society and "food Fordism." The revolution was linked to a specific way of understanding modernity and promoting modernization, since it developed in an intellectual climate in which a model of modernity was held up as the ideal and a single path was proposed for achieving it. The green revolution occurred at a time when humankind was creating new risks, but was not aware of them and so failed to address them.

This paradigm led to a particular way of conceiving and "doing" agriculture, understanding agricultural modernization and measuring sectoral performance, accompanied by a specific sectoral institutional framework. The key technological challenge of the green revolution was to increase yields per hectare (mainly yields of wheat, rice and corn) in order to combat hunger, especially in the Asian countries.

Although the increases in production achieved in the 1960s, 1970s and 1980s were mainly due to higher yields, the agricultural frontier and water were not limiting factors, as the growth of production in Latin America in those decades demonstrates. The negative environmental externalities generated by the intensive use of fertilizers and agro-chemicals to control pests and diseases were not constraints either.

The technological challenge was met by an institutional framework based on public research, with the Consultative Group on International Agricultural Research (CGIAR) facilitating a great deal of technology and germplasm transfer worldwide. As FAO (2004:32) has observed, "the international flow of germplasm has had a large impact on the speed and the cost of crop development programmes of national agricultural research systems."

The green revolution led to the development of a form of agriculture heavily dependent on technological advances such as high-yielding varieties, obtained through conventional genetic improvement, the intensive use of technological inputs like fertilizers and agro-chemicals that made it possible to tap the genetic potential of new varieties, and greater utilization of the modern

[2] In the case of the digital paradigm, for example, the "artifacts" include semi-conductors, microprocessors and data storage systems. In the case of the biotechnological paradigm, they are the analysis and modification of genetic material, high-speed sequencers, molecular markers, genes and DNA (ECLAC 2008).

A number of models and trajectories to modernity are on offer and we no longer have absolute faith in science and technology's capacity to control the world and make it more predictable. It is also a time of systemic risks.

economic rationality of cost-benefit analysis through the increased use of management technologies. The green revolution championed these concepts as the keys to agricultural modernization.

The green revolution's impact on higher yields and production was evident, as was its contribution to reducing world hunger, mainly in Asia. According to FAO, between 1963 and 1983 total production of rice, wheat and corn in the developing countries increased by 3.1%, 5.1% and 3.8% per year, respectively. Over the next decade, the annual increases in the production of the same crops were 1.8%, 2.5% and 3.4%, respectively (FAO 1996).

The environmental and social debates on the costs of the revolution were intense, especially in the 1980s and 1990s. Different authors point to environmental degradation, genetic erosion, the exclusion of women and increased inequality as some of the costs. The most obvious cost – on which there is consensus – was the damage done to the environment.

During the 1990s, basically as a result of the 1992 United Nations Conference on Environment and Development, the idea of a "new green revolution" or a "second green revolution" was put forward, based on the principles of sustainable development. One example of this attempt to reduce the environmental costs of the green revolution was the development of the concept of integrated crop management, which is achieved through the integrated management of pests and soil nutrients.

It soon became clear, however, that these solutions – based, as they were, on the paradigm of the green revolution – were insufficient and that the new digital and biotechnological revolutions and the emergence of the issue of intellectual property for plant genetic materials were beginning to effect far-reaching changes that would have a major impact on the technological paradigms of different production activities.

It is worth remembering that the 1990s saw the first commercial releases of transgenic crops, the emergence of functional foods, the first report of the Intergovernmental Panel on Climate Change and the development of the concept of the risk society. The same decade also witnessed the emergence of the concepts of expanded agriculture, knowledge management and knowledge and learning-based economies. It was a time when new questions were asked: what is agriculture and how can agricultural technological development be achieved? At the sectoral level, it marked the start of the transition to a new technological paradigm.

The new paradigm: an info-biotechnological agricultural revolution[3]

Today we are witnessing a transition toward the consolidation of

The new technological revolutions underway – digital and biotechnological – as well as the emergence of the topic of intellectual property for phytogenetic materials, were beginning to cause major and far-reaching transformations that would significantly impact the technological paradigms of the different productive activities.

[3] *In the case of the digital paradigm, for example, the "artifacts" include semi-conductors, microprocessors and data storage systems. In the case of the biotechnological paradigm, they are the analysis and modification of genetic material, high-speed sequencers, molecular markers, genes and DNA (ECLAC 2008).*

The new paradigm is substantially altering some of the basic characteristics of the green revolution. Some cases in point are:

a. The uniform farm management model, which is increasingly being replaced by precision agriculture.

b. The high use of chemical inputs, challenged because of its effects on the concentration of greenhouse gases.

c. The focus on a single type of agriculture, which is being replaced by a variety of ways of "doing" agriculture: traditional, transgenic, organic, etc.

a new agricultural technological paradigm. Since this post-green revolution technological paradigm is developing in the context of late modernity, it is drawing on the knowledge accumulated in recent decades and beginning to address the risks created during the same period and the new demands of society and consumers with regard to environmental issues. A number of models and trajectories to modernity are on offer and we no longer have absolute faith in science and technology's capacity to control the world and make it more predictable. It is also a time of systemic risks.

This new paradigm is developing at a time when science and technology are beginning to seek new areas of convergence, and systemic approaches are gaining ground. The new agricultural technological paradigm is part of this new global intellectual and technological climate.

The new agricultural technological paradigm is framed within the techno-economic paradigm created by the large-scale utilization of ICTs and biotechnology. It is also framed within the new demands of society, the markets and agrifood chains, including the differentiation of products, quality and safety, biosafety, animal well-being and the sustainable use of biodiversity and natural resources.

As ECLAC (2008:149) has stated, the generation of techno-economic paradigms is based on innovations that are capable of redefining "the trajectory not only of the technological and economic spheres but also of the social sphere." Furthermore, this new paradigm is developing at a time when science and technology are beginning to seek new areas of convergence, and systemic approaches are gaining ground. The new agricultural technological paradigm is part of this new global intellectual and technological climate.

The key agricultural technological challenge of the 21st century is to produce more, better and more diverse food and non-food agricultural products by means of productive processes that:

- Generate smaller amounts of greenhouse gases
- Make more efficient use of water
- Use basically the same amount of land
- Respond to new biotic and abiotic stresses caused by climate change
- Permit greater monitoring by society of the technologies used.

All these are new production constraints and requirements that were practically non-existent at the time of the green revolution (Table 1).

Table 1. Change in the paradigm of agricultural technological development.

Aspect	Green revolution	New agricultural revolution
Core concept	**Research**	**Innovation**
Main objective of research/innovation	Higher yields and greater resistance to pests and diseases.	Higher yields, more stable production systems, improvement of product quality and sustainable use of natural resources.
Approach	Focus on supply and primary production. Research prioritizes only some crops.	Focus on the demand from businesses and innovations throughout the chain. Innovation incorporates a wide range of products.
Principal technology	Conventional genetic improvement.	Biotechnology, ICTs and nanotechnology.
Type of inputs	Increasingly chemical.	Increasingly biological. Importance of biodiversity.
Main protagonists of research – innovation	Public institutions.	Private enterprises and public institutions.
Goods produced by research/ innovation	Public goods.	Increasingly, private goods and club goods.
Intellectual property	Not important.	Increasingly a key factor.
Type of knowledge that is important	Explicit.	Explicit and tacit. Growing importance of knowledge management.
Characteristics of agricultural modernization	Increased use of the cost-benefit approach and chemical inputs.	Various trajectories and models. Continuous improvement and good agricultural practices.
Performance measurement	Yield per hectare.	Multiple. Yield per unit of water, active/hectare component, carbon and water footprint.
Institutional framework	National agricultural research systems.	National agrifood innovation systems.

In this context, the objectives of "sectoral" technological development are to increase productivity, improve the industrial, nutritional and organoleptic quality of products and ensure the sustainable use of natural resources. Another goal is "the stability and resilience of production systems" (World Bank 2008).

As a result, there is no single option and trajectory for agricultural modernization. Modernization no longer means the use of specific inputs and a single approach.

The key aspect of the agricultural technological challenge of the 21st century is fully consistent with the new technological paradigm of ICTs and biotechnology, whose core objective is to use less raw materials and energy through the intensive use of information, knowledge, services and gray matter (Pérez 1998).

From this perspective, bio-technology and its application to agriculture and the food industry is a good example of a technology that makes intensive use of processing and information (in this case, genetic information) and saves energy when used in agro-industrial bioprocessing. Similarly, the utilization of ICTs in precision agriculture is a demonstration of the intensified use of on-farm (and off-farm) information and how it improves the way in which the different factors of production are used, including water, fertilizers and pesticides. Moreover, since one of the potential uses of nanotechnology is precision agriculture, its contributions will strengthen the benefits and chief characteristics of this type of agriculture.

If biotechnology, ICTs and nanotechnology have increasingly broad and unanticipated applications in the technological development of agriculture, the convergences between them will simply multiply those applications. One only has to look at what is happening with bioinformatics and the incipient uses of nanotechnology in the development of precision agriculture. Other technological convergences are bound to emerge, since we are only just beginning to see the development of this trend[4].

In the era of knowledge-based agriculture and the new food revolution, the method used to measure sectoral performance is beginning to incorporate new indicators such as the yield by unit of water and the carbon footprint (Barrera 2010). Another performance indicator that is likely to be used increasingly is that of active components of agricultural products by unit of land or water. "Site-specific" and "precision" technologies are beginning to play a key role, as are differentiation and quality management and assurance (see Text Box 1).

A key aspect of the change in the technological paradigm of agriculture has to do with the predominant concepts that have sustained agricultural technological development and are responsible for the chief characteristics of the national institutional frameworks that promote it: the concepts of research and innovation and the national systems devoted to these areas.

[4] *The European Commission (2004) believes that the next big wave of innovations will come from the convergence of four technologies: nanotechnology, biotechnology, information and the advances in neuroscience. The first three clearly relate to the agricultural area, the fourth less so, but it is important to bear in mind that the research centers and global food companies are investing more resources in efforts to gain a better understanding of the relationship between the brain and nourishment.*

The way in which the institutional framework took up the gauntlet and addressed the technological challenges of the green revolution already mentioned was very different from the approach adopted for the new agricultural revolution. In the first case, the task fell to the national agricultural research systems; today it is the responsibility of the national agrifood innovation systems.

There are major differences between the institutional arrangements in each case, including the following:

a. The national agricultural research systems were simple and linear, with a small number of protagonists; the current national agricultural innovation systems, on the other hand, are interactive and complex, with a multiplicity of stakeholders and subsystems.

b. In the past, research was the only source of innovation; in today's systems, that is no longer the case.

c. The systems of the green revolution were focused on the supply of research. Today, the innovation systems respond increasingly to the demand from businesses, where the application of knowledge is fundamental.

d. In the national research systems, the emphasis was on explicit knowledge; in the national innovation systems, tacit and explicit knowledge are equally important.

e. Today, the governance of the system is becoming an important issue, which was not the case with the research systems.

Another important aspect of the institutional framework (understood in a broad sense) has to do with the types of goods generated by research and innovation processes. In the paradigm of the green revolution, agricultural research mostly generated public goods. In the present technological and institutional paradigm, on the other hand, national innovation systems increasingly generate private and club goods. As a result, intellectual property management has become a crucial issue.

The new revolution may be bio-technological, but it is not only bio-technological; it is digital, but not only digital; it is nanotechnological, but not only nanotechnological. This revolution is more than bio-technological, more than digital and more than nano-technological. It is a revolution of knowledge management and technological convergences.

At the heart of the new agricultural technological paradigm, in addition to the current technological revolutions and the new demands of society and the markets, is a new way of "doing" science and technology. As Trigo (2010) points out, the production function used to "produce" knowledge and technology has changed. Biotechnology and ICTs have played an important role in those changes. In fact, biotechnology and ICTs have changed not only the production function of agricultural and food activities, but also the one used to generate science, technology and innovation. Furthermore, due to the complexity of 21st century societies and the problems that have to be addressed, the scientific and technological approaches are more systemic and multidisciplinary. ICTs have transformed the ways of accessing and managing the research centers' data and information. Internet and its logic of networks has fostered and multiplied collaboration on a global scale. All this has had an impact on productivity and the costs of generating new knowledge.

The agriculture of the 21st century

Based on the new technological paradigm described above, the agriculture of the 21st century is beginning to experience a new revolution.

The new info-biotechnological agricultural revolution is a direct consequence of the information society and the knowledge economy. It marks a reconceptualization and reinvention of what humankind understands by agriculture and how it is carried out. The revolution is generating new potential to create wealth and new opportunities for innovation. Like all technological revolutions, it is generating new products, such as transgenic crops, functional ingredients and high-value inputs for different industries.

The new revolution may be bio-technological, but it is not only bio-technological; it is digital, but not only digital; it is nano-technological, but not only nano-technological. This revolution is more than bio-technological, more than digital and more than nano-technological. It is a revolution of knowledge management and technological convergences. The agriculture that is taking shape as a result of this new revolution is more about networks and interactivity, DNA and software, site-specific and precision technologies, and terroirs and clusters (Table 2).

We are on the cusp of a new era whose changes are affecting the most diverse areas of human activity, including agriculture and food production. The principal technological dynamics of agriculture come from the dynamics of cross-cutting technological revolutions, such as ICTs and the biotechnology, and not the largely internal technological dynamics of agriculture, as occurred with the green revolution. The same is beginning to happen with nano-technology.

The agriculture of the 21st century is also based on new types of businesses and work, mainly in a more empathic relationship with natural resources and nature. Agriculture is increasingly viewed as a pillar of the bio-economy and a key activity for tackling climate change.

Table 2. Changes in the conceptual framework and way of "doing" agriculture.

Aspect	Green revolution	New agricultural revolution
Definition as an economic activity	Primary activity	Expanded agriculture, agrifood chains
Principal objective of agriculture	To supply food	To supply food and functional ingredients, produce environmental services and generate non-food agricultural products
Type of business	Fordist – Taylorist	Responsible, adaptive and flexible
Obsession of the chain	Quantity and yield	Quality, innovation and reputation
Type of products	Commodities	Increasingly differentiated
Principal characteristic of the work	Manual and repetitive	Increasingly sophisticated and creative
Relationship with nature	Indolent	Empathic and responsible
Carbon content	High in carbon	Low in carbon
Management logic of agriculture	Uniform	Use of site-specific and precision technologies
Type of agriculture	Homogeneous	Varied. More about networks and interconnections. More about terroirs
Type of economy	Industrial economy	Knowledge economy. Bio-economics

Final considerations

The green revolution was one of the major revolutions of the 20th century and one of humankind's success stories.

We are embarking upon a new agricultural revolution that is deeper than the green revolution and whose consequences will be more far-reaching. This is due to the scope of the digital, biotechnology and nano-technology revolutions and the convergences between them. The ways in which these technologies are applied in the agricultural and food sector will undoubtedly continue to surprise us in the coming decades.

The green revolution was a major process of "artificializing" agricultural production, reflected basically in a sharp increase in the use of, and dependence on, chemical inputs. The new agricultural revolution is, in some sense, a process of "naturalizing" production, reflected in the growing use of biological inputs, although it does include aspects of "artificialization" – genetic engineering, for example.

Every era and society has its own fears and bogeymen to deal with, and each of the revolutions analyzed in this article came about in response to a global concern. In the case of the green revolution, it was the Malthusian fear of hunger. In the case of the new agricultural revolution, it is the fear of global warming, that Gaia will pass the point of no return.

The green revolution was a great advance for humankind, especially for the developing countries. Similarly, the new technological and agricultural development paradigms of the 21st century allow us to feel moderately optimistic that we will be able to produce sufficient good-quality food to feed the planet's nine billion inhabitants in 2050. However, this will undoubtedly depend on how different countries and social groups access food, which has to do with how globalization is organized.

Text Box 1. Precision technologies: one of the most notable features of the new agricultural revolution.

One of the principal features of post-green revolution agriculture is the site-specific management techniques that are beginning to be used for different production resources and the greater precision employed in agrifood research processes.

Precision agriculture is gaining ground the world over. This growth is being driven by the increased, intensified use of the many more sophisticated tools provided by information and communication technologies. Increasingly, the applications and potential of this type of agriculture are being reinforced by the advances of another technological revolution: nano-technology.

Precision technologies are also making their presence felt in other areas besides what is now referred to as "precision agriculture." Biotechnology, for example, is making it possible to extend the logic and dynamics of precision to the other end of food chains, to consumption by individuals who are increasingly demanding and obsessed with their health. Thanks to the progress being made in the area of nutrigenomics, in the near future it will be possible to tailor the dietary intake of individuals to their nutritional needs.

Biotechnology has also fostered precision practices in an area that is important for agriculture – genetic improvement. The genetic improvement of trees, crops and animals is now more "precise" and rapid because it is "targeted," based on high-speed sequencers and molecular markers.

However, nanotechnology is the technology that will expand and deepen the logic of precision in the future. And it will do so in the different links and areas of food chains. For example: a) it will strengthen precision agriculture; b) it will make it possible to create intelligent food, with nutrients located in nano-capsules that the organisms of humans and animals will utilize better; c) it will permit better safety management through the use of interactive containers and in other ways; and, d) it will strengthen the prevention and control of plant and animal diseases.

In short, precision technologies are one of the main features of the new agricultural and food revolution, and their impact will become even more pronounced in the years ahead.

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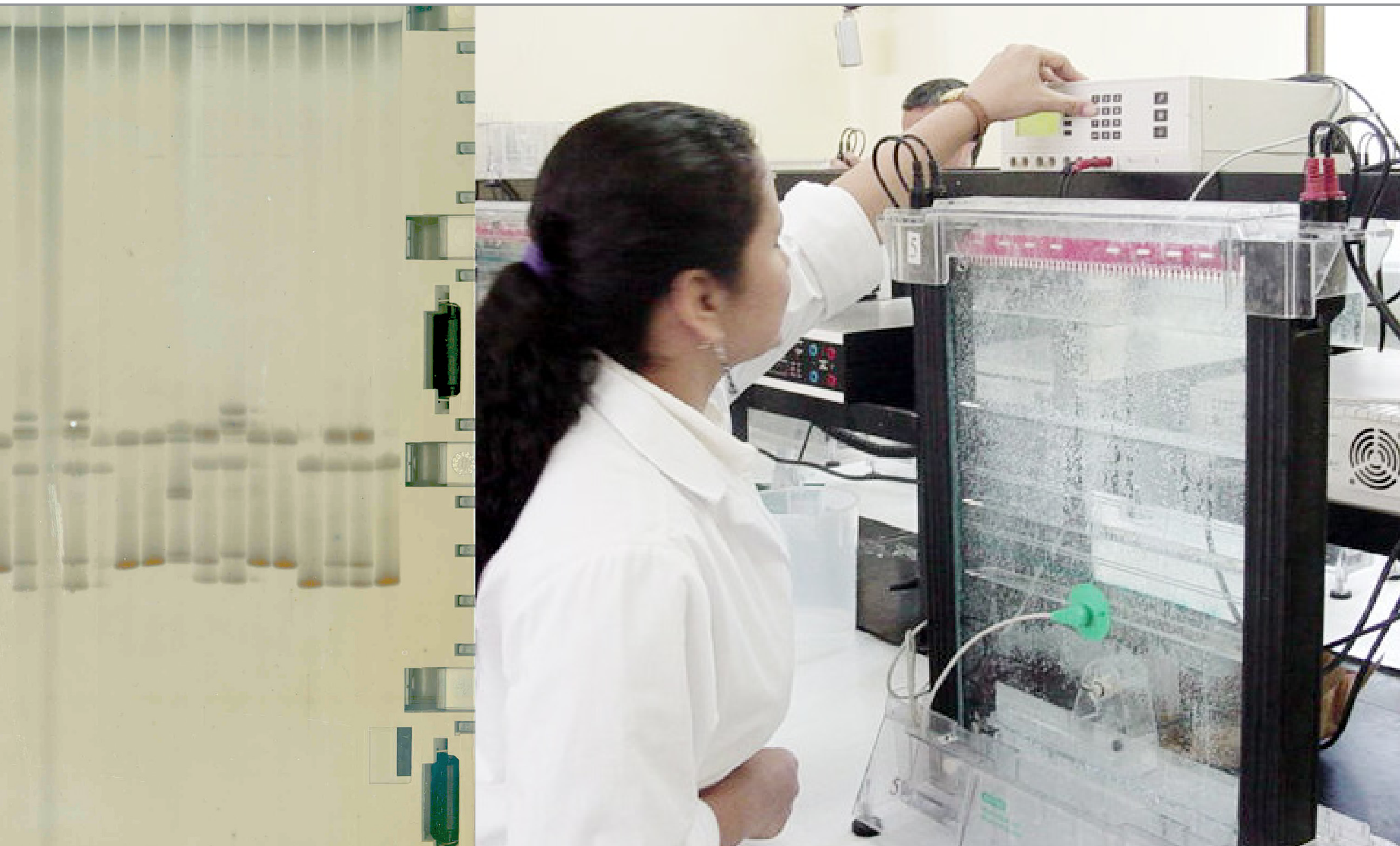
Agro-biotechnologies: bio-logical tools at the service of agriculture

PEDRO J. ROCHA[1]

Summary

Agro-biotechnology is an effective technology in which numerous and varied techniques such as hybridization, in vitro cell and tissue cultivation, fermentation, biological control through microorganisms, and some other techniques that do not make use of living organisms are used. In this article, these techniques are described concisely and some concepts are presented to clarify the relationship between transgenesis, one of the multiple techniques, and agro-biotechnology. In addition, the position of the Inter-American Institute for Cooperation on Agriculture (IICA) on biotechnology and its interrelationship with other areas is briefly explained.

[1] *Coordinator of the Biotechnology and Biosafety Area of the Innovation for Productivity and Competitiveness Program of IICA, pedro.rocha@iica.int*



KEY WORDS: *IN VITRO* CULTIVATION, BIOPROCESSES, HYBRIDIZATION, BIOLOGICAL CONTROL, FERMENTATION, GENOMICS, BIOINFORMATICS, TRANSGENESIS.

INTRODUCTION

Technology, defined by the Diccionario de la Real Academia Española (DRAE) as the "collection of theories and techniques that allows the practical use of scientific knowledge" and its interaction with politics, economics and culture, among other areas, are essential to making agriculture competitive and ensuring its desired economic, social and environmental sustainability.

Since the early stages of humanity, some of the biological technologies[2], referred to as biotechnology, have been used with the aim of providing solutions in different spheres including the pharmaceutical, food, industrial and agricultural sectors. Due to their growing importance for the agricultural sector, it is necessary to have available factual concepts and information that allow decision making and objective valuation of the actual impact caused by these technologies.

Some of the multiple agro-biotechnology techniques will be outlined in this article. In addition, due to its relevance, reference will be made to IICA's position on biotechnology and its interaction with other areas, in order to introduce technical knowledge and contribute to making agriculture competitive, sustainable and environmentally friendly.

AGRO-BIOTECHNOLOGY

Among the technologies used in agriculture –conventional, organic, etc.-, those based on the activity or presence of living organisms or their by-products are considered important. Biological technologies used in agriculture are known as "agricultural biotechnology" or "agro-biotechnology." These terms make reference to a collection of different techniques (a set of procedures and resources) that can be used to help solve some agricultural problems.

The diverse techniques of agro-biotechnology are based on biological sciences such as ge-

[2] *The Convention on Biological Diversity (CBD, 1992) defines biotechnology as "any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use."*

netics, physiology, microbiology, biochemistry, and molecular and cell biology. Furthermore, they relate to other disciplines such as chemical and bioprocess engineering, computer science, statistics and economics, *inter alia.* Although some biotechnological techniques have been used for thousands of years for different purposes (such as food and beverage production), about four decades ago, techniques characterized by their specificity, precision, speed and versatility have been introduced into agriculture and have clearly surpassed or strengthened some of the natural processes relating to living organisms. Some of these techniques are briefly described below.

1 ***Hybridization*** is a process that consists in cross-mating different parents of plant varieties (or animal breeds) to take advantage of their parental characteristics, in order to generate a crop with new or improved characteristics that satisfies the condition of distinction, homogeneity and stability required to produce a new plant variety. During the early decades of the twentieth century, the use of this technique in agriculture resulted in noticeable increased crop productivity (mainly corn) and still has significant impact today.

2 ***In vitro cell and tissue cultivation***, which includes numerous techniques and procedures, is carried out based on the fact that a plant fragment (cell, tissue or organ) can be cultured under

About four decades ago, techniques characterized by their specificity, precision, speed and versatility have been introduced into agriculture and have clearly surpassed or strengthened some of the natural processes relating to living organisms.

aseptic conditions in a solid or liquid artificial medium (substratum) that possesses a particular chemical composition and is kept under controlled environmental conditions. In practice, all crops of commercial interest have undergone study with respect to *in vitro* cultivation, most of them with the aim of multiplication or massive propagation of elite plants, pathogen elimination in planting material, haploid generation or conservation (i.e. embryo rescue and cryopreservation). This biotechnology is used routinely and, as a result of its application, large extensions of banana, sugar cane, oil palm, fruits, flowers, and forest species, among other "biotechnological crops", have been produced for decades.

3 ***Fermentation*** is a biological process in which sugars, in the presence of microorganisms or isolated enzymes originating from them, are converted into energy and diverse metabolic products such as alcohol or acids. The fermentation technology is one of the oldest biological technologies known and has been widely used in the production of different types of food, beverages, medicines, and biofuels (ethanol). Additionally, fermentation is an important stage of composting processes (essential for biofertilizers production in the agricultural sector) and of different industrial activities generally associated with the use of bioreactors.

Although the use of this bioprocess is evidently advantageous, it can also be harmful for plants affected by bacterial or fungal diseases (rotting). As a consequence, vast research has been done in connection with this technology to determine how to avoid damage in crops and make use of microorganisms in other activities.

4 ***The biological control through microorganisms*** is another biotechnological technique used in agriculture. Its purpose is to cause diseases naturally in insects through several microorganisms (bacteria and fungi).

The *Bacillus thuringiensis* is the most commonly used bacterium for the biological control of coleopterans (beetles), lepidopterous pests (butterflies and moths) and dipterans (flies). It produces a protein crystal that works as a toxin when in contact with the intestines of such insects' larvae. Through the development of bioreactors, the bacterium can be cultured to extract the crystal, which can then be sprayed on a crop to protect it against pests that are susceptible to the toxin. Some fungi (such as vg. *Trichoderma sp., Beauveria bassiana, Paecilomyces sp., Metarhizium sp., Lecanicillium sp., and Cordyceps sp., inter alia*) can be used to achieve biological control of different pests (whiteflies, trips, aphids, weevils and mites).

Techniques of isolation, study and culture of these biocontrol micro-organisms, along with the design of methods for their growth (in bioreactors) and use (inoculation) in crops, are agro-biotechnology techniques as well. A crop treated by this kind of control could be considered also a biotechnological crop. Similarly, the insect control that reduces the reproduction of a determined bug in a particular place through the release of sterilized males by means of radiation can be considered a biotechnological control method (IAEA, 2011a).

5 Direct ***genetic modification*** (also known as transgenesis) is a technique that overcame the biological obstacles imposed by nature and allowed the generation of organisms that express other organisms' genes (viruses, bacteria, animals, human beings or other plants). In 2010, genetically modified crops (mainly corn, soy, cotton and colza) occupied an area of 148 million hectares in 29 countries, cultivated by 15.4 million farmers, 90% of whom own land smaller than 0.6 ha (James, 2010).

Widely discussed in different fora, transgenic technology has fostered regulation in the countries measures, for example, with respect to biosecurity (Cartagena Protocol, 2000)[3] and has been quickly adopted by the agricultural sector (James, 2010). In addition, it is considered an essential tool to satisfy, in a timely manner, the current challenges of agriculture (for example, adaptation to climate change, increase in crop yields, decrease in certain inputs, water and soil resource optimization, etc.).

However, in order to produce new materials, transgenic technology requires genes, in vitro regeneration systems and gene introduction systems, for which molecular marker, cloning and tissue culture techniques are indispensable.

[3]*Information on biosecurity current status in the countries can be found in http://www.bch.cdb.int*

The potential of transgenic technology applied to agriculture is so remarkable that it was considered the representative tool for agro-biotechnology and, as a result, the term "biotechcrops" was used to refer to "genetically modified crops (GM)". Nonetheless, as mentioned before, GM crops are biotechnological cultures too, but not all biotechnological cultures are transgenic.

In terms of genetic modification, it is worth mentioning that there are other techniques that can be included in the biotechnology toolbox. For instance, through the use of radioactivity, it is possible to induce mutations (changes). The results of such mutations are currently applied (IAEA, 2011b). However, transgenics is recognized as a method that implies greater precision and control.

6 ***"Biotechnological" techniques that do not use living organisms.*** Strictly-speaking, a practice is considered biotechnological if it includes the use of living organisms (as was shown in the cases of *in vitro* cell and tissue cultivation, fermentation, bioinput generation and transgenesis). Nevertheless, even if there are techniques (molecular markers, DNA sequencing, "omics" –genomics, transcriptomics and proteomics–, bioinformatics, etc.) that do not make use of living beings, some of them have been used as essential tools for agro-biotechnological development and serve to analyze organisms at an unprecedented level of resolution. Moreover, within the inputs required, biotechnological products are used almost mandatorily and routinely.

Among the biotechnological techniques, molecular markers are important for the genetic characterization of germplasm, the creation of genetic and molecular maps, the identification of genes associated with characteristics of agronomic relevance, as support for improvement in breeding programs and for diagnostic, follow-up and control activities.

The DNA sequencing of multiple species and the procurement of a huge amount of information have opened up new areas of study ("omics") and possibilities for analysis (bioinformatics), which offers obvious opportunities relating to detailed knowledge and the subsequent use, in the agriculture and livestock sectors, of each gene identified. To date, the sequences of 1,749 complete genomes

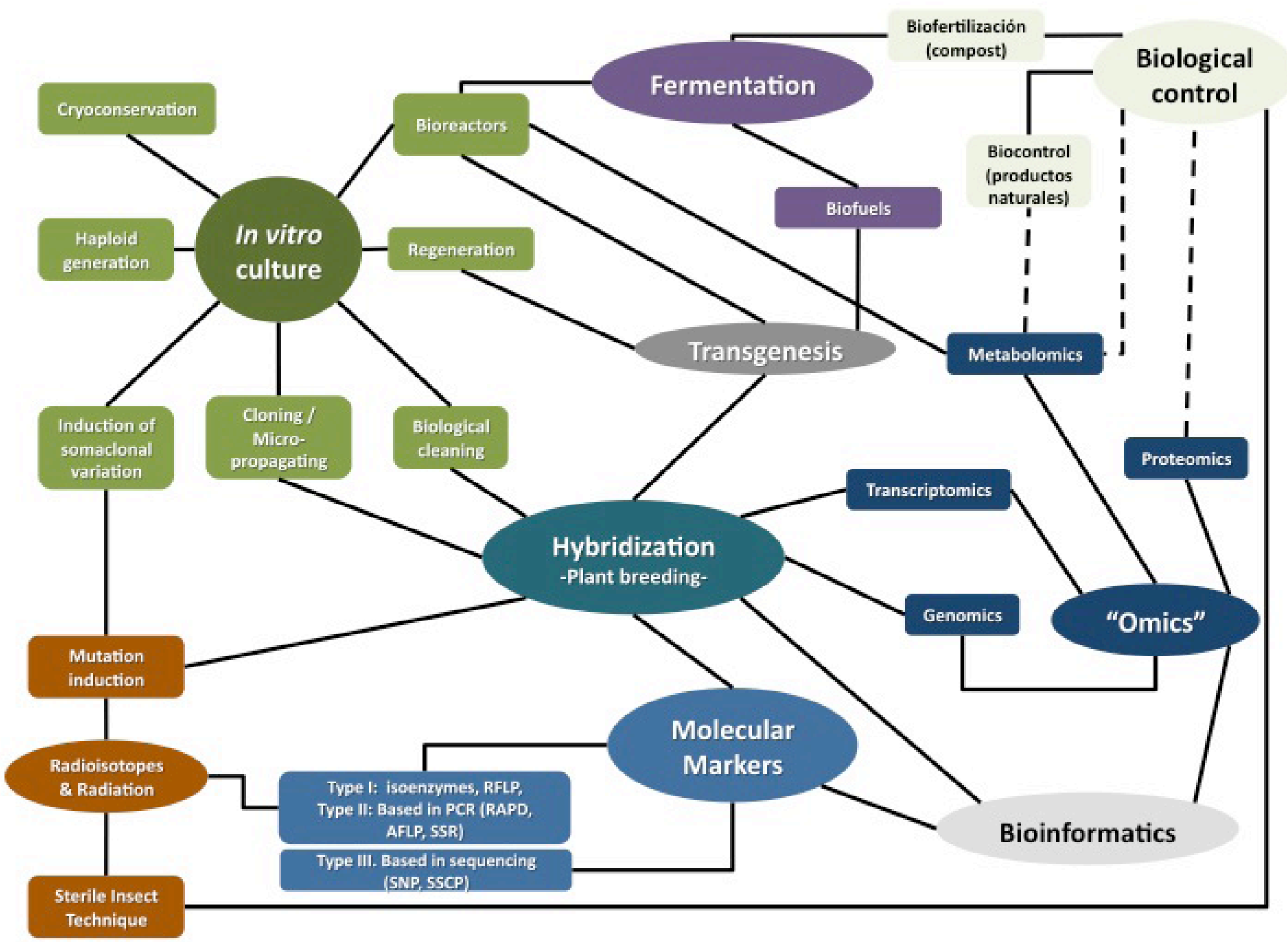


FIGURE 1. SOME TECHNIQUES USED BY AGRO-BIOTECHNOLOGY AND ITS INTERACTIONS.

of diverse organisms have been reported and 10,337 sequencing projects have been carried out (GOLD, 2011). Similarly, sequencing tools have opened up the possibility of sequencing communities (metagenome) of complete organisms with no need to isolate them, which will have a huge impact on agriculture. At the present time, 249 metagenomes of 323 reported projects have been analyzed (GOLD, 2011).

IICA's position on agro-biotechnology

With the aim of "strengthening the development and safe use of agro-biotechnologies as a key tool for improving the productivity and competitiveness of the agricultural sector and the sustainable use of genetic resources for agriculture and food security" (IICA, 2010), the Biotechnology and Biosafety Area of IICA has committed to providing technical, impartial, updated and scientifically validated information on the progress, benefits and risks of biotechnology. In this way, it is hoped to provide support to the governments of IICA Member States through information that allows the creation or the strengthening of institutional frameworks and the formulation of biotechnology and biosafety policies and strategies and consequently, contribute to the support for decision making processes relating to the responsible and efficient use of the different agro-biotechnology tools.

Based on this line of thought, it is IICA's responsibility to provide the public with technical knowledge, in order to make concepts clear and indicate the technological advances with the potential to contribute to making agriculture efficient, sustainable and environmentally friendly. Consequently, at the request of the governments of its Member States, IICA is seeking to strengthen institutions that carry out activities related to biotechnology and is interested in supporting technical-scientific, capacity-building processes in agro-biotechnology (in a broad sense, as shown in this document). Furthermore, the Institute wishes to demonstrate that most agro-biotechnology tools are compatible with different types of agriculture and therefore, farmers (small and medium size) are called upon to explore the potential of agro-biotechnology and make it a reality for their own and their families' advantage.

With respect to IICA's position regarding the use of modified living organisms (MLOs) obtained through transgenesis, IICA presents information, but neither takes sides nor participates in the sovereign decision of the countries to adopt or not such technology (CBD, 1992). However, in terms of transgenesis technology, IICA is in favor of the implementation of regulatory frameworks on biosafety by the countries (Cartagena Protocol, 2000), regardless of their position in support of or against MLOs, since these represent tools that guarantee the sovereign decisions of the States.

Final considerations

The rapid growth in the world population (UN, 2008) and the increasing food and industrial requirements (fuels, medicines, fibers, etc.) resulting from it, the alteration of arable lands (FAO,

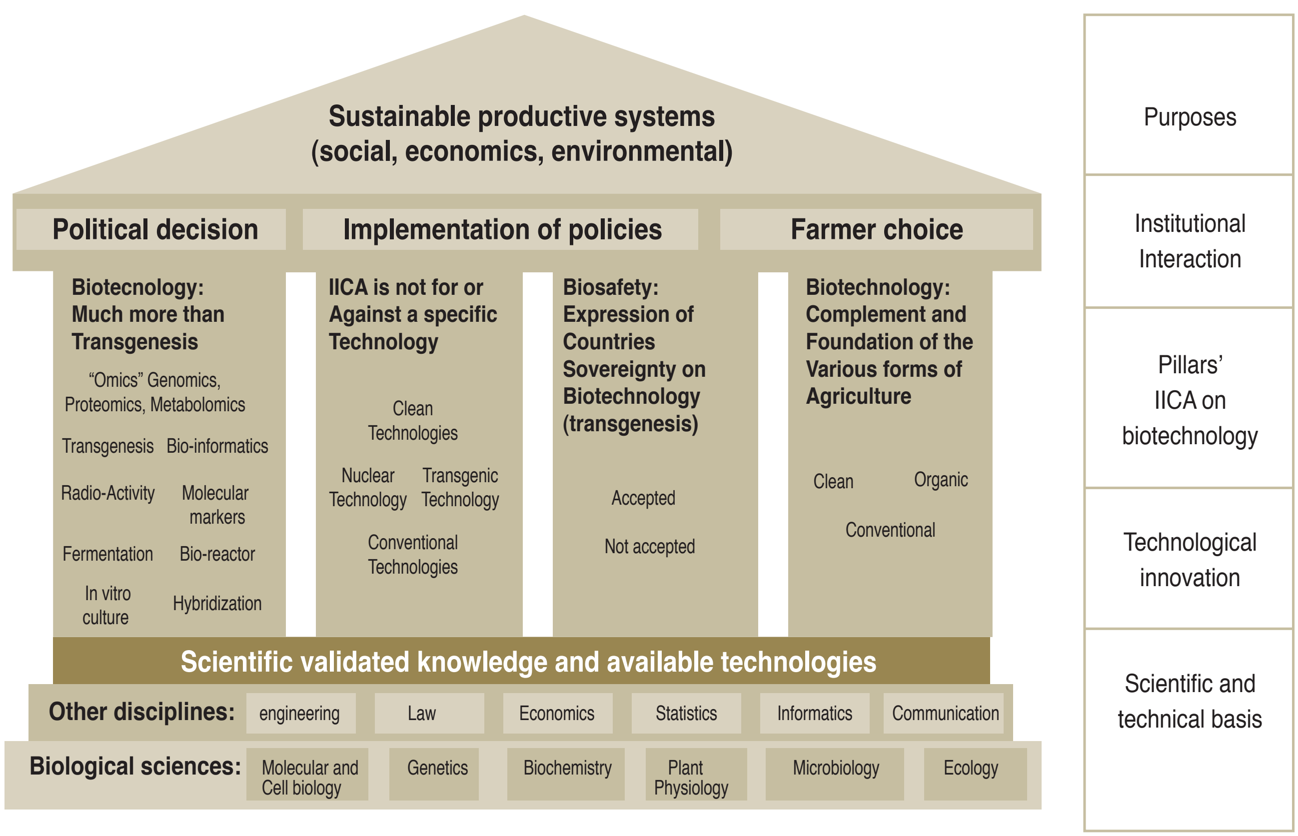


Figure 2. Statements that sustain IICA's actions and position on biotechnology

2011), the pressure caused by water availability, and the multiple current and potential effects of climate change (IPCC, 2001) make it necessary to adjust agriculture rapidly and efficiently to these and other forthcoming challenges.

In the previous paragraphs, agro-biotechnology was described as a box of solid tools (or techniques) that do not belong exclusively to any science, discipline or sector, but can interact with each other and contribute to facing the challenges mentioned before.

It is worth mentioning that, even if numerous and varied biotechnology techniques have been available for several years, some people associate agro-biotechnology only with MLOs or transgenic organism production, which has misinformed users and polarized agriculture into two main types: organic agriculture and MLOs-based agriculture. In keeping with the regulations governing organic production in the countries, organic agriculture does not allow the use of the transgenesis and ionizing radiation biotechnology tools[4]. However, organic agriculture, agroecology and the other forms of agriculture have always used and will continue to make routine and efficient use of all biotechnology techniques available (hybridization, in vitro cultivation, fermentation, compost, biological control, etc.).

In conclusion, agro-biotechnology has generated significant changes in production methods and supply of new products. As a result, there are more opportunities for technology to contribute to solving not only agricultural problems in particular, but also humanity's in general. Nevertheles, technology in and of itself is not good enough. As a matter of fact, in order to create a meaningful impact and achieve the development of rural communities, science, research and technology, along with timely and correct political decision-making, as well as implementation of such decisions, should be the mainstays of sustainable productive systems at the social, economic and environmental levels. However, we will need to act rationally, maturely and in a timely manner. IICA, as the House of Agriculture in the Americas, is willing to support all the different processes required to achieve this goal.

[4] *Further information can be found on the Inter-American Commission on Organic Agriculture (ICOA) web site http://www.agriculturaorganicaamericas.net*

Table 1. Description, achievements and status of some agro-biotechnology techniques in LAC

Technique	Date of introduction	Description	Achievements	Status in LAC
In vitro cultivation	1968	Allows cell and tissue cultivation in culture media. Important for basic (physiology, phytopathology, etc.) and applied research. Works as a germ-plasm conservation tool. Useful in productive processes such as: elite material cloning, plants massive propagation and material cleaning. Essential for transgenesis.	*In vitro* techniques have been applied in almost all plants of agronomic interest.	Routine use, with corporate outlook for plant species.
Bioreactors	70's	Organisms or metabolite production in closed crops. Technology associated with engineering and productive processes.	Bioinput production (fertilizers, biocides, etc.). Used in food, beverages and biofuel industries.	Routine and industrial use by most biotechnology-based enterprises.
Molecular markers	1977	Allows the indirect analysis of DNA. Used to carry out genetic diversity analysis, the creation of genetic maps, gene identification, assisted selection and diagnostic systems.	Numerous studies on genetic diversity. Marketable varieties issued. Diagnostic kits available.	Frequently used for academic purposes.
Transgenesis	1980	Allows gene insertion and expression from one organism to another. Transcends natural reproductive barriers. Requires genes, transformation, regeneration and regulation systems. Is the basis of metabolic engineering.	Technique standardized practically in all crops of trade interest, although only few of them are marketed (soy, cotton, rape and corn). Not approved by organic agriculture.	Up to 2010, ten LAC countries possessed marketable cultivations of genetically modified crops.
Genomics	1976 (beginning)- 2000	Groups high efficiency techniques (reduction in the number of analyses and in time and cost). Requires expensive infrastructure and highly qualified staff. Simultaneous detailed study of genomes or multiple gene sequences. Based on DNA sequencing.	10,337 sequenced genes and 323 metagenomes developing.	Incipient development, although Brazil becomes the global leader of this application in agriculture.
Proteomics	2000	Sequences proteins and carries out functional trials.	Developing.	Poor development.
Metabolomics	2000	Metabolite identification and isolation.	Remarkable experience in molecular characterization and isolation.	Incipient development.
Bioinformatics	1962 (beginning)	Devoted to the management (compilation, analysis and use) of a great deal of biological information. Includes the management of databases, annotation, DNA sequencies and aminoacid analysis, biological systems modeling, and image analysis.	World databases including several billions of genes and protein sequences.	Growing development.

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Climate change and food security: cross-cutting axes of agricultural policies

ALEJANDRO BARAHONA[1]

Summary
The present article examines the impact of climate change on food security, particularly from the point of view of agriculture, a relationship that must be borne in mind when public policies are being defined to improve food security. This implies promoting productive innovations that allow countries to face adverse climatic conditions in their effort to satisfy the demand for food of a growing population.

[1] Former IICA staff, iicahq@iica.int

KEY WORDS: CLIMATE CHANGE, FOOD SECURITY, AGRICULTURAL POLICIES, OUTLOOK FOR CLIMATE CHANGE.

INTRODUCTION

Climate change is without doubt the main challenge affecting all areas of human activity and its inter-connectivity, ranging from global political decisions to individual actions that can make the difference between the quality of life of one generation and another.

In order to deal with the consequences of climate change and find solutions that could prevent a worsening of the situation, far-reaching political decisions must be taken, changes must be made to individual and collective consumer patterns, programs and strategies that promote technological inputs, innovation and institutional arrangements that make it easy to attend to this multi-causal and multi-dimensional challenge.

The consequences of this phenomenon, which are evidenced by climatic conditions such as droughts, floods and sudden changes in temperatures, have affected and will continue to affect the lives of millions of persons around the world. The populations that are vulnerable to this phenomenon also seem to be those who are the most vulnerable. This has put in jeopardy the achievement of the Millennium Development Goals and some specialists are convinced that climate change could seriously affect the achievement and sustainability of any successes gained from the globally-defined objectives of the Millennium Summit.

New development paradigms have begun to emerge and with them, the challenges facing our countries and governments to understand the situation and issue coherent and consistent policies and legislation in a novel and sustainable way that does not compromise future resources.

This has led to a search for creative solutions that guarantee economic growth and social equity in a context of sustainable development. New development paradigms have begun to emerge and with them, the challenges facing our countries and governments to understand the situation and issue coherent and consistent policies and legislation in a novel and sustainable way that does not compromise future resources.

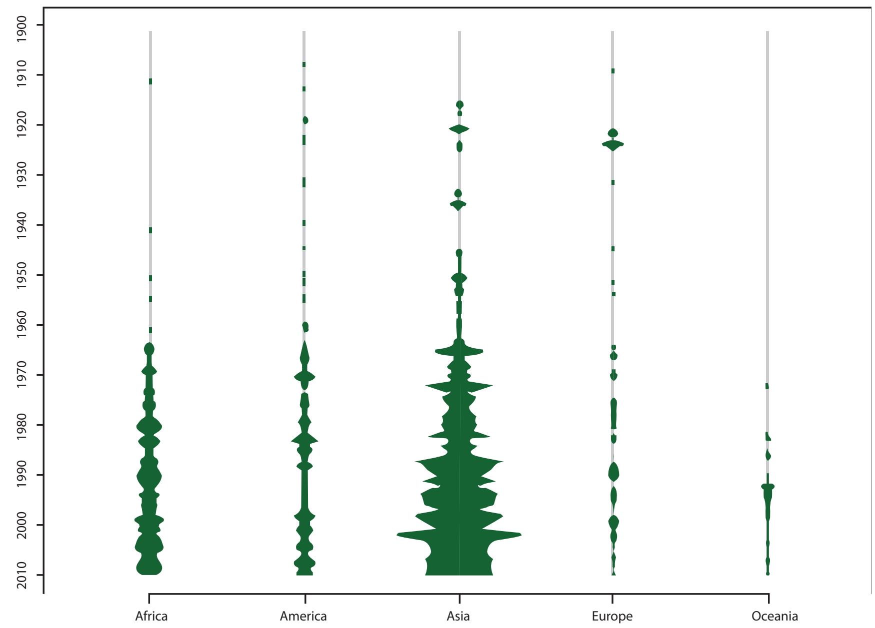
TRENDS AND CONSEQUENCES OF CLIMATE CHANGE

According to 2010 data published by the World Bank, over the last millennium, the average temperature shift of the Earth remained at below 0.7° C. However, greenhouse gas emissions of human origin over the past 150 years (industrial period) have caused an increase in the world temperature of nearly 1° C, a trend that is rising, according to projections by the World Bank, which predicts a period of possible world temperatures for this century. These estimates reveal that even the most ambitious mitigation efforts can cause a 2° C temperature rise (a level that is still considered as dangerous) and that most forecasts determine that reduced mitigation would cause a 3° C to 5° C warming (although this is less certain with respect to these higher levels of global warming).

This level of global warming has never been experienced in the history of mankind and the physical results would seriously limit sustainable human development, especially in the ag-

ricultural sectors (agriculture, livestock, fishing, aquaculture, and forestry) which are some of the most seriously affected by this type of extreme phenomenon).

One example of the above was the damage and losses in agriculture and livestock caused by Hurricane Mitch in Central America, representing 21% of total losses in Costa Rica, 39% in El Salvador, 51% in Nicaragua and 68% in Guatemala. These countries, like all other developing countries in the tropical and sub-tropical regions, continue to be highly impacted as a result of their vulnerability. For these reasons, the priority is adaption and change to new and productive paradigms. Nevertheless, these countries are generally less prepared to confront these changes.



Source: CRED 2010.

Figure 1
Number of persons affected by natural disasters by region and decade (1990-2010).

According to data provided by the International Database on Disasters (EM-DAT) of the Centre for Research into Epidemiological Disasters (CRED), since the decade of the sixties, the number of natural disasters has continued to grow steadily, along with an increase in the average temperature (1˚ C) over the past 50 years, as a result increases in the emission of greenhouse gases (GHG).

Figure 1 shows that the continents with the greatest increase in number of persons affected by natural disasters are Asia, followed way behind by Africa and America.

According to World Bank estimates, climate change threatens the entire world, but developing countries are more vulnerable, since they will have to bear between 75% and 80% of the cost of the damage caused by climate variation (World Bank 2010).

Populations and authorities in Latin America and the Caribbean (LAC) are quite aware of the devastation caused by flooding, hurricanes, land slippage and drought. Over the past ten years, natural disasters have accounted for more than 45,000 deaths, have left 40 million persons homeless and have caused more than US$32,000 million in damage (IDB, 2002).

For those countries, climate change represents an increase in vulnerability, erasing progress made with much effort and seriously jeopardizing development forecasts. It would be even more difficult to achieve the Millennium Development Goals and guarantee a safe and sustainable future beyond 2015 (World Bank 2010).

Climate change and food security

This climatic phenomenon presents paradigmatic challenges in all productive sectors; however, it is urgent for the agricultural sector to achieve not only productive sustainability, but also food security, which is considered to exist when all people, all the time, have physical and economic access to enough safe and nutritious food (FAO 2008). This approach is shared by IICA, who defines it as "… the existence of conditions that make it possible for human beings to access, in a socially acceptable way and in agreement with their cultural preferences, a physical and economic safe and nutritious diet to meet their dietary needs for a productive and healthy lifestyle." Such conditions are: food availability, access to food for all people, food utilization, and access stability (Chavarría and Salazar 2008).

This approach and its four conditions for food security depend necessarily on two aspects being affected by climate change:

a. Physical food availability, limited by the consequences of climate change in crops, such as flooding, drought, hailstorms, fire, and, in the best-case scenario, abrupt temperature changes impacting agricultural productivity, which decreases food quality and safety.

b. Economic capacity to acquire food, due to important losses resulting from climate change, especially when considering the costs incurred by families and enterprises to reduce or face the effects of natural phenomena associated with climate change, which not only limits production possibilities (infrastructure and technology), but also consumption, due to the resulting rise in food prices.

Climate change and agriculture

According to Thomas Schelling, Nobel Prize winner in Economic Sciences (2005), "Climate change is real, and its most devastating effects will occur in agriculture, and it will impact food supply and distribution" (quoted in IICA Nicaragua 2008).

According to Greenpeace estimates, agriculture is responsible for 25% of the emissions of greenhouse gases (GHGs), mainly as a result of the use of agrochemicals, pesticides, machinery, changes in soil, and the development of water resources (Greenpeace 2008).

On the one hand, this implies that agriculture is responsible for contributing with the GHG emissions that accelerate climate change; but, on the other hand, this sector is the most affected by the phenomenon. This is why there is huge interest not only in adapting, but also in developing the potential of agriculture (unlike other productive sectors) as a natural carbon sink, in order to reduce the effects of the emissions through modern practices, technologies and policies.

Another valuable aspect to analyze is the uncertainty caused by climate change in agricultural activities, as a consequence of the risks that long-term rainfall and temperature trends imply, as well as the greater impact of extreme climatic conditions.

Today, more than ever, agriculture remains one of the most important sectors in the entire region, not only as a result of the high level employment it generates, but also due to its productive linkages. In fact, according to recent estimates, the agricultural sector recovered more quickly from international financial crises than any other sector (IICA 2010), which contributes to improving general macroeconomic conditions, taking into ac-

count the important increase in food prices that began in August 2010.

In recent years, political awareness of climate change has increased; however, public policies for adaptation to the new scenario are still limited. Farmers can adapt to climate change locally, for instance, by changing crops or varieties, using more efficient irrigation systems, advancing or delaying sowing periods, or by simply varying the location of its activities. Therefore, national and international public investments aimed at improving the adaptation capacity of agriculture represent an innovative and completely necessary perspective for the agricultural and rural sectors of the region.

> It is necessary to increase significantly the number of projects and amount of resources aimed at linking an environmental and social approach to adapting to and reducing the impacts agriculture and climate change have on each other, with agricultural and rural investment for the sustainable and inclusive development of agriculture.

Moreover, the genetic improvement of traditional varieties and the development and diffusion of new varieties better adapted to the foreseen changes in the climate, the provision of infrastructure to manage water scarcity and excess (e.g. irrigation and drainage) and the development of insurance schemes for small-scale producers with coverage for climate risks and early warning systems, inter alia, represent potential areas of investment that, besides improving the adaptation capacity of agriculture before climate change, contribute to strengthening its competitiveness. Therefore, it is necessary to increase significantly the number of projects and amount of resources aimed at linking an environmental and social approach to adapting to and reducing the impacts agriculture and climate change have on each other, with agricultural and rural investment for the sustainable and inclusive development of agriculture.

Outlook for climate change

Climate change constitutes a challenge for the entire humanity, particularly at a time when increasingly stronger pressure is exerted upon the Conference of the Parties (COP) to reach global and binding agreements that supersede the Kyoto Protocol, determine differentiated limits for developed and developing countries and foster certified environmental services as an alternative for environmental compensation.

This forces us to think that climate change transcends national borders and that it is irreversible; nevertheless, its impact can be reduced if we succeed in decreasing the GHG emissions that threaten us with warming up the world more than 2°C, with dangerous consequences. Governments, enterprises and joint and consensual efforts by civil society, as well as technical assistance provided by institutions such as IICA, will be necessary to achieve such a reduction by:

a. Establishing participation agreements with the stakeholders involved, in which goals are set for each actor.

b. Defining innovative strategies, systems and public policies that will contribute to the fulfillment of the goals.

c. Promoting sustainable institutional mechanisms for the implementation of the strategies and policies.

d. Designing a monitoring mechanism that allows for follow-up to the goals and commitments acquired by each sector and country.

Agricultural policies and climate change

In order to cope with climate change, a new development paradigm with agricultural policies that take into account human development in the transition towards low carbon emission economies, and make the effects of this change adaptable, is required. In this context, the governments of the region will have to support the formulation of public policies for promoting long-term innovative national programs and strategies, as well as decentralized strategies for climate change mitigation and adaptation.

> Governments, enterprises and civl society require joint and consensual efforts, as well as technical assistance provided by institutions such as IICA.

Without a doubt, modern agriculture needs to be integrally sustainable in the future. It is therefore essential to promote sustainable productive models that supply safe food and contribute to improving the lives of farmers and local communities.

To achieve this purpose, some policies should be adopted:

- Replacing the productive development model based only on economic growth with one based on sustainable human development. To this effect, it will be necessary to:

  - Design public policies for institutional modernization in a global environment to facilitate the shift in productive paradigm, which will support institutional modernization and strengthening, and organize and integrate the productive systems, especially with respect to agriculture and the rural milieu.

  - Promote, through more public and private investments, the implementation of an agenda for institutional innovation, in order to strengthen national institutions.

- Carrying out actions that allow acceleration of the recovery in the agricultural sector from the international impact of the food crisis and the international economic crisis. This is particularly important in view of the questioning of the sustainability of the incentive policies used to tackle the international economic crisis.

- Promoting the appropriate use of methods and technologies for sustainable agricultural production and, by comparing existing experiences (benchmarking), boosting their use in the countries. For instance, the efficient use of water and fertilizers allowed an increase in rice production. At the present time,

this practice has been adopted worldwide.

- Using fertilizers rationally and sustainably. By using the precise levels of fertilizers at the right time, a great quantity of GEI emissions can be avoided.

- Protecting the soil. Most of the current problems in agriculture originate in the soil, with consequences not only for climate change, but also on food production. Very frequently, intensive chemical agriculture produces a spiral of soil and water degradation and causes a reduction in crop yields, environmental destruction, poverty and hunger.

- Reducing the use of fossil fuels, not only in agricultural activities, but also worldwide, through the utilization of biofuels. This implies an increase in agricultural production to avoid limiting food availability and threatening food security.

It is therefore essential to promote sustainable productive models that supply safe food and contribute to improving the lives of farmers and local communities.

- Improving conditions for forestry services to contribute to climate change mitigation.

- Developing "green" production, industrialization and marketing systems, as well as the corresponding certification, to achieve better prices and responsible agricultural models (Corporate Social Responsibility, CSR).

Agriculture and rural development policies, as well as institutional frameworks, are in a constant process of change. In some countries of the region, it has been a deliberate and planned process, but in most of the others, it has been specific for of the aspects and conditioned by an international context that continuously puts pressure on governments to assume tangible international commitments in the Summits on Climate Change.

In any event, there are enough reasons to be concerned, and even more motives to cope with climate change through sustainable efforts aimed at reducing GEI emissions. This implies an analysis with a comprehensive view and a work agenda drawn up by decision makers. Here is where IICA plays a fundamental role in endorsing these concrete actions.

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Assessment of the economic impact of Huanglongbing (HLB) disease on Mexico's citrus chain

DIZNARDA SALCEDO, GUSTAVO MORA, IGNACIO COVARRUBIAS
CARLOS CÍNTORA, RAÚL HINOJOSA, FERNANDO DEPAOLIS, SATURNINO MORA[1]

Summary

In this article, the authors assess the economic impact that HLB could have on Mexico's citrus chain, and compare the preventive and control measures that different countries have adopted. The assessment of economic impact was carried out at three levels: primary fruit production, agro-industrial operations and the economy as a whole. The results suggest that the volume and value of the production of citrus fruits and their byproducts would be affected, as would employment (on farms and in agro-industrial operations and related businesses) and the foreign exchange earned by exports of fresh and processed citrus fruits. Other factors highlighted by the study are the high risk of an epidemic and the potential economic impact in the states of Veracruz, Colima and Michoacán, in the Pacific coastal region and in the Yucatan Peninsula, as well as less serious effects on quality, the amount of raw material available and the turnover of packing and processing plants. The study indicates that the primary sector would be the hardest hit by direct losses, with a decline in the value of production, employment, wages, food products, beverages and tobacco. Mexico responded immediately to the outbreaks of HLB that occurred in July 2009 in the Yucatan Peninsula, instituting an emergency plan to mitigate the risk of the entry and spread of the disease.

[1] *Consultants specializing in the economics and finance of plant health programs. Their e-mail addresses are: salcedo@cef-profit.com, morag@colpos.mx, icovag@gmail.com, carlos.cintora@gmail.com, raulahinojosa@gmail.com, depaolis.fernando@gmail.com, and saturnf@colpos.mx*

Key words: impact assessment, *citrus*, epidemiology, plant diseases, pathogenesis, agro-industry, Mexico.

Background

When the bacterium *Candidatus Liberibacter asiaticus* – the cause of Huanglongbing (HLB) disease – was detected in July 2009 in the community of El Cuyo, in the municipality of Tizimín, Yucatán, the General Directorate of Plant Health (DGSV), the National Service for Agrifood Health, Safety and Quality (SENASICA) and the Inter-American Institute for Cooperation on Agriculture (IICA) decided to carry out a study on the implications for Mexico's citrus industry if the disease – the most destructive for citrus fruits – were to become established in the country.

The general objective of the assessment was to quantify the possible economic impact of HLB on Mexico's citrus chain. The specific goal was to compare the preventive and control measures that Mexico has adopted with the actions implemented by other countries faced with the same threat. To achieve the main objective, the assessment set out to quantify the effects at the following three levels:

a. **Primary production.** Part of the analysis of the epidemiological effects of the disease and its impact on production involved simulating two loss scenarios. A model was designed especially for the purpose, based on the application of factorial analysis and cluster analysis as statistical techniques.

b. **Agro-industrial operations.** The study quantified technical indicators, with 2008 used as the baseline year. The risk scenarios developed for primary citrus production served as the point of reference. In estimating the indicators, the study drew on both published general information and specific information obtained by means of a survey of companies and processing plants, statistically selected using a stratified sampling procedure.

The estimated losses for the Mexican citrus chain and the economy as a whole were quantified at different points in time and in three risk scenarios (low, moderate and high impact), once the disease had become established in the country.

c. The **economy as a whole.** The study estimated the impact on both the citrus fruit sector and other activities related to the national citrus industry, using the IMPLAN input-output model that Texas A&M University employed previously for the same purpose. The model generated employment multipliers and estimated the direct effects (on the agricultural sector), the indirect effects (on the industries that supply inputs to the agricultural sector), and the induced effects (on the economy as a whole, due to the loss of income in the sectors affected directly and indirectly) one, three and five years after HLB had become established.

The analysis of the epidemiological effects and the impact on production was used to identify and analyze the characteristics of the citrus production sector, the main production areas with the species and varieties grown, production typologies to stratify the existing technological levels, the agro-climatological conditions of the crops, and epidemiological aspects that would make it possible to understand the incidence and spatial distribution of the disease. The authors also conducted a review of the literature to determine what other countries have done with respect to the estimation of risk scenarios.

The authors analyzed the way in which the agro-industry is organized and the relationships among the companies and plants that brush, wax, pack, process and market citrus fruits. The cost structure of the products and their commercial use were included, as were the costs of the following elements:

- Prices of raw materials (fresh citrus fruits such as oranges, lemons and limes, grapefruit and tangerines)
- Inputs and amount used

- Services used and (operating and administrative) personnel involved in the processing stage
- Canning, packaging and packing materials
- Volumes and values of processed products
- Exports of fresh products with value added (e.g., brushed Persian limes) and processed products like juices and concentrates, essential oils, dried peel and pectins
- Installed capacity of agro-processing companies and capacity utilized
- Transportation (of both raw materials and finished products) and energy

The estimated losses for the Mexican citrus chain and the economy as a whole were quantified at different points in time and in three risk scenarios (low, moderate and high impact), once the disease had become established in the country. Based on the scope and assumptions of the economic analysis, the assessment yielded the following results as potential loss scenarios for primary citrus production:

Scenario 1

This estimated potential citrus production losses in the event of a severe, widespread and simultaneous epidemic in all of the country's production areas. The results indicated:

• That the potential impact of HLB depends on the acreage and yields in the different states around the country: in Veracruz, losses of oranges, grapefruit and Persian limes would be high; in Colima and Michoacán, key lime losses would be high to moderate; and in Tamaulipas, orange losses would be moderate and grapefruit losses low. Oranges accounted for 43% of the total value of citrus production in 2008, key limes for 33%, Persian limes for 16%, grapefruit for 5%, tangerines for 2% and lemons for around 1%.

• The impact on orange production in Sonora, Tamaulipas, Morelos and Jalisco would be moderate. In Nuevo León and San Luis Potosí, the impact would be low because, although citrus fruits are grown on more than 25,000 hectares of land, yields are low; the same applies to the other states where oranges are produced. Some 1.8 million tons of the nation's orange production would be lost, 47% (846,543 tons) in Veracruz, 18% (329,354 tons) in the group of states where the impact would be moderate (Jalisco, Morelos, Sonora and Tamaulipas), and 35% (644,743 tons of combined output) in the other states where the impact would be low.

• In the case of national grapefruit production, 63% of the losses (111,949 tons) would occur in Veracruz, 20% (36,077 tons) in eight other states and the remaining 17% (30,195 tons) in a further 10 states.

• The country would lose 183,168 tons of its key lime production, with Colima suffering 48% of the losses (87,765 tons), as the impact of HLB would be high. Michoacán, where the impact would be moderate, would account for 32% of lost production (59,071 tons), and another 20 states, where the impact would be low, for the remaining 20% (36,332 tons). With respect to Persian lime production, Veracruz would lose 75,987 tons of its production (64% of the country's total losses); five other states (Tabasco, Puebla, Colima, Jalisco and Sinaloa), where the impact would be moderate, would account for 19% (22,882 tons) of total losses; and 14 states, where the impact would be low, for the remaining 16% (19,380 tons).

• If the impact of HLB were low, 1.84 million tons, or 25% of the nation's total citrus production, would be lost. Oranges and grapefruit would account for the biggest losses (33%), followed by tangerines (17%) and, lastly, lemons and the different varieties of limes (10%). If the impact were moderate, 2.35 million tons would be lost (32% of national production), with oranges and grapefruit once again the fruits hardest hit (42%). If the disease were to have a high impact, the losses would rise to 3 million tons, equivalent to 41% of the country's production. Oranges and grapefruit would be the fruits worst affected, accounting for 53% of the losses, followed by tangerines (26%) and limes (18%).

• A low impact outbreak of the disease would result in the loss of 4 million days' work. The figure would rise to 12.6 million in the event of a moderate impact outbreak, and 19.3 million in the case of a high impact outbreak.

Scenario 2

The biological conditions that influence the temporal and spatial dimensions of the epidemic process were taken into account. In other words, the factors that would affect the seriousness of an HLB outlook in the country and the speed with which it would spread. The results were as follows:

• In the event of an HLB epidemic in Mexico, the scenario would differ from region to region, due to variables such as climate and the structure of citrus host plants in relation to susceptibility to the pathogen and the acreage involved. Veracruz, Colima and Michoacán are regarded as areas where the risk of an epidemic is high and commercial operations would be affected. The Yucatán Peninsula and the Pacific coastal region are other regions that would be at risk but the impact on the local economy would be relatively low.

• In the event of simultaneous epidemics of varying intensity (high, moderate and low impact) in different states, the maximum combined percentage of losses to

national production for all types of citrus fruits would be 14%, or 1 million tons, in the first year in which the pathogen became established; 24% (1.7 million tons) in the third year; and 38% (2.7 million tons) in the fifth year.

• Three years after the HLB became established in a high-risk scenario, 1.7 million tons of citrus fruits and 12.2 million days' work would be lost nationwide. Orange production would be hit the hardest (1.4 million tons and 9.6 million days' work), followed by grapefruit (196,000 tons and 1.2 million days' work), Persian limes, key limes and lemons (153,000 tons and 1.3 million days' work) and tangerines (22,000 tons and 201,000 days' work).

• Once the disease has been established for five years in a high risk scenario, 2.7 million tons of citrus production and 19.3 million days' work would be lost, with orange production again the hardest hit (nearly two million tons and 13.7 million days' work), followed by grapefruit (260,000 tons and 1.6 million days' work), limes and lemons (415,000 tons and 3.5 million days' work) and, lastly, tangerines (60,000 tons and 543,000 days' work).

Potential losses for the citrus agro-industry

The authors of the study estimated the technical indicators of the structure of production costs for sweet and sour citrus fruits for 2008, both for companies that pack, brush and wax fruit and processors that produce juice, essential oils, dried peel and pectin. The indicators were established based on the inputs and products generated, referenced to the cost and availability of the raw material, to provide a means of estimating the potential losses for the agro-industry. An indicator was also calculated for direct labor and the underutilization of industrial facilities based on the tons of citrus fruit processed. The indicators are described below:

• The impact on primary citrus production was estimated for low, moderate and high-risk scenarios five years after HLB had become established. Under these scenarios, the sour citrus fruit packing and processing plants would be faced with a reduction in raw material of 4% (low impact), 9% (moderate impact) and 19% (high impact). In the last case, the amount of fruit processed would drop from 2.41 million tons

in 2008 to 1.97 million tons. In the case of sweet citrus fruits, under the same scenarios the figures would be 11%, 33% and 48%, respectively. In the event of a high impact epidemic, the packing plants would have 366,000 fewer tons of raw material available, and the processing plants 76,000 fewer tons.

• The quantity of sweet citrus fruits (oranges, tangerines and grapefruit) handled by the agro-industrial operations would fall from 5.95 to 3.18 million tons, following a high impact epidemic and five years after the disease had become established. The packing companies would receive 2.24 million fewer tons of fruit; in the case of the processing plants, the figure would be 524,000 fewer tons.

• The abovementioned reduction in the raw material available to the citrus agro-industry would increase the level of under-utilization of industrial facilities, which would rise from a weighted total of 55% in 2008, to 62% after three years and 71% after five years.

• The number of direct jobs lost in the citrus agro-industry as a consequence of the reduction in the volumes of raw material available would be 3774 per year, 87% in the companies that process sweet citrus fruits and the remaining 13% in those that process sour citrus fruits. As many as 3289 direct jobs would be lost in the sweet citrus industry (the number would fall from 7072 in 2008 to just 3783 five years after HLB had become established), while in the case of sour citrus fruits the number would be 485 (falling from 2652 to 2167).

• Three years after HLB had become established, the citrus industries' loss of income would be $507, $1632 and $2517 million in 2008 pesos in a low, moderate and high impact scenario, respectively; and the fall in exports would mean losses of US$130 million, US$404 million and US$645 million in foreign exchange earnings. The number of jobs lost would be 282, 929 and 1396, respectively (in low, moderate and high impact scenarios).

• After five years of infestation, the financial loss to Mexico's sour citrus industry would be $1385 million in 2008 pesos in the case of a high impact epidemic, $676 million in the event of a moderate impact epidemic and $283 million in the case of a low impact epidemic. Packing companies would be hit harder than processors. Packing companies would be faced with a drop of $1218 million in gross income (down from $6658 to $5440 million in 2008 pesos) and processors with a fall of $131 million (from $720 to $589 million).

• The value of sweet citrus production would be hardest hit, because those fruits are more susceptible to HLB. The size of the loss would vary according to the risk scenario involved, from $1131 million (low impact) to $3751 million (moderate impact) and $5419 million (high impact). Under a high risk scenario, five years after the disease had become established the packing companies would be faced with a drop in income of $3932 million in 2008 pesos (down from $8456 million to $4524 million) and the processors with a drop of $1369 million (down from $2944 million to $1575 million).

• HLB would have a serious impact on Mexico's exports of fresh and processed citrus fruits. In a high risk scenario, five years after infestation the country would earn US$157 million less in foreign exchange than in 2008 (down from US$505 million to US$348 million), which is a drop of 30%. In the case of sweet citrus fruits, US$106 million in foreign exchange earnings would be lost in the event of a high impact epidemic, US$73 million in the face of a moderate impact epidemic and US$22 million in the case of a low impact epidemic, while the figures for sour citrus fruits would be US$51 million, US$25 million and US$10 million, respectively.

Potential losses for the Mexican economy as a whole

Based on the employment multipliers generated by the model, the estimated direct, indirect and induced effects, one, three and five years after HLB had become established, would be:

• After one year of infestation, the total number of full-time jobs lost in the national citrus industry under the three risk scenarios would be 4105 (low impact), 17,988 (moderate impact) and 27,463 (high impact). After three years, the numbers would rise to 9434, 30,628 and 80,691, respectively. After five years, the total number of jobs lost, by scenario, would be 26,311, 82,815 and 126,439. These figures, again by scenario, are made up of 16,000, 50,000 and 77,000 direct jobs, 8000, 25,000 and 38,000 indirect (inter-industry) jobs, and 2000, 7000 and 11,000 induced jobs (for the other sectors of the economy). The activities related to the production of oranges and their byproducts would be hit the hardest.

• Ten main sectors would be affected by a potential infestation of HLB. In terms of the value of national production, the primary sector (which includes agriculture, livestock activities, forestry, fisheries and hunting) would be the hardest hit. That would be the case for all three of the risk scenarios established, and would apply to direct, indirect and induced effects.

• After five years of infestation in a high-risk scenario, the direct loss in the value of primary sector production would be $3800 million in 2008 pesos. The indirect and induced losses would be $479 million and $65 million, respectively, making a total of $4343 million. In descending order of importance, the next sectors that would be hardest hit are "trade and repairs," "food, beverages and tobacco" and "other business activities." For the economy as a whole (48 sectors in total), the figures for the high-risk scenario are $2003 million (indirect losses), $1183 million induced losses) and $6965 million (total losses).

• In all three risk scenarios, the "agriculture, livestock activities, forestry, fisheries and hunting" sector would also suffer the biggest job losses, although the induced and total losses of the "food, beverages and tobacco" sector would be greater in all three cases. For the economy as a whole, in a high-risk scenario 9534 jobs would lost as an indirect effect and 4341 as an induced effect, with total job losses put at 55,249.

• The biggest direct and total effect on wages would be felt by the "food, beverages and tobacco" sector under all three risk scenarios (low, moderate and high impact), possibly because people in that sector tend to be paid more than those in the primary sector, which is next in importance. Therefore, were jobs to be lost in the agricultural sector, the indirect effect on wages would be greatest in the food, beverages and tobacco sector.

Comparison of preventive and control measures adopted to combat HLB in Mexico and other countries

• When *Candidatus Liberibacter asiaticus* was detected in Tizimín, Yucatán in July 2009, Mexico responded immediately by establishing a protocol for dealing with the emergency triggered by the detection of HLB, to mitigate the risk of the introduction and spread of the disease, set forth in NOM-EM-047-FITO-2009, which entered into force.

• The epidemiological surveillance system that Mexico uses for HLB has certain advantages over the one adopted by other countries, as the standards introduced apply to the whole country (the current system is centralized, based on the guidelines of the DGSV of SENASICA, and is designed to eradicate *Candidatus Liberibacter spp.* and prevent it from reentering the country). However, the operational infrastructure of the surveillance system at the state level is insufficient to deal with the enormous threat that the disease poses to the nation's citrus industry.

• The results in Brazil, and now in Mexico, suggest that the spread of the pathogen can be reduced but not avoided, due to the aerial mobility of the vector and the propagative material, making it imperative that action be taken to combat the vector.

• Although the vector was detected in Florida, USA, as long ago as 1998, the government took almost no action until the pathogen appeared in 2005. The actions currently being implemented involve protection through chemical control and, to a lesser extent, biological control of the vector.

• In Brazil, the government's role in coordinating, planning and implementing actions to combat the disease is unclear. Management of the problems that call for the regulation of citrus fruits varies greatly from state to state. São Paulo is the state where the private sector and the government have invested most heavily in plant health management for citrus crops. In that state, the effects of HLB are monitored and inspected periodically and plants exhibiting symptoms of the disease are destroyed. The pathogen was detected in almost every municipal district of São Paulo in 2009.

• In the province of Guangdong, China, the bacterium *(C. Liberibacter Spp.)* was eradicated in the laboratory by means of in vitro cryoconservation (Ding *et al*. 2008), with an effectiveness of 90%.

Based on the results of this study, 22 recommendations were presented at the workshop organized by IICA. Eight of them entail actions that would be implemented by the Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA) and state governments. Five involve all the stakeholders in the national citrus chain, and nine concern studies and specific research that the interdisciplinary teams should carry out for decision-making purposes and the realignment of strategies.

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Project "The new face of rural poverty in Brazil: transformations, profile and public policy challenges"

CARLOS MIRANDA, BRENO TIBURCIO[1]

Summary

The objective of the project was to formulate proposed policies for combating rural poverty in Brazil, taking into consideration the structural changes that have taken place in the economy and society of Brazil, and their impact on the most vulnerable sectors of the rural population. As a basis for formulating the proposals, studies were conducted in nine thematic areas, in two stages. The first was concluded in December 2010 with the Fifth International Forum: territorial development strategies aimed at combating poverty, and the second in June 2011.

[1] *Rural development specialists, IICA Brazil, carlos.miranda@iica.int and breno.tiburcio@iica.int*

KEYWORDS: RURAL DEVELOPMENT, POVERTY, POLICIES, MANAGEMENT, BRAZIL.

INTRODUCTION

This project was implemented by the IICA Office in Brazil, together with the Ministries of Agricultural Development, Social Development and Education, the Institute for Applied Economic Research and the National Council on Sustainable Rural Development, and received academic support from the Economics Institute of the Campinas State University, the Federal University of Uberlandia and the Federal Rural University of Rio de Janeiro. This project was aimed at formulating proposed policies for combating rural poverty in Brazil which take into account the specific nature and the potential of different segments of the rural population who are poor, adopting an approach more suited to actions intended to involve more people in production activities.

THE CURRENT CONTEXT OF RURAL POVERTY IN BRAZIL

The economy and society of Brazil have undergone important structural transformations over the last two decades, which include changes in institutions in general, in the production structure, in the way technology is organized and in demographics, as well as in the definition and redefinition of spaces and territories, as defined naturally and socially. In this process, the nature and meaning of rural life have changed as a result of increased economic, geographic and cultural interaction between rural and urban areas. In addition, the expansion of transportation infrastructure has furthered these transformations and has been conducive to population movements and the increased flow of information throughout Brazil.

The economy and society of Brazil have undergone important structural transformations over the last two decades.

Public social policies aimed at generating income have enabled millions of people from rural areas to join the domestic market, which for long had been the role of the urban sector. Policies on health, electrification and education have also had an important impact on the living conditions of the rural population.

The growth of small cities with large rural populations has been one result of the closer interaction between rural and urban areas, as well as the relations established between them, which have had important impacts on the living and working conditions and way of life of the rural population.

These transformations and their consequences in rural areas point to the need to gain a greater understanding of the magnitude and nature of the changes related to rural poverty, considering that in Brazil a large proportion of the rural population is poor. Therefore, the project called for a number of studies to be conducted and policies proposed, based on the following explicit hypotheses:

- Recent analyses reveal a decline in both poverty levels and in economic inequality in the countryside. In addition to this reduction, everything seems to indicate that the face of rural poverty is changing, as is the way in which it spreads. Given the social importance of these changes, more information is needed on the transformation processes underway in rural areas, which are essential to consolidating existing policies and formulating new ones capable of reinforcing the recent positive trend in social transformation in the countryside.

- The regional and socio-cultural diversity of the rural milieu, specifically traditional communities (indigenous, afro-descendents, forest tribes, fisherfolk, artisans, etc.) must be considered. In this context of diversity, the families of salaried rural workers who fall below the poverty line must be taken into account. It is also important to study the socioeconomic impacts on the populations that surround the territories, following the imple-

mentation of large-scale governmental and private initiatives.

- Historically, the rural milieu has been home to the greatest number and percentage of poor persons. This situation changed in the 1990s when the number of poor living in cities, especially the large ones, began to outnumber the poor in rural areas. The most recent studies reveal a significant reduction in poverty overall; however, poverty in rural areas has not been measured. The availability of statistics would be helpful in determining whether or not it will be possible to overcome extreme poverty in the not too distant future, but this will depend on the continuation and sound management of social policies.

The project vis-à-vis public policies

Regardless of the controversy surrounding the methodologies used to define urban and rural areas and the criteria used to measure poverty in Brazil, the analysis of the "new rural poverty in Brazil" is justified because:

a. the reduction in poverty varies from urban to rural to peri-urban areas;

b. the profile of poverty has also undergone profound changes in recent decades, and varies between spaces and territories;

c. the very meaning of poverty has changed radically, which

There is a need to gain a greater understanding of the magnitude and nature of the changes related to rural poverty.

has important consequences for public policies;

d. the spread of rural poverty had also undergone profound changes that have affected policies and the development of rural and urban areas;

e. the uprooting of poverty will depend even more on sustained growth, resulting from the strengthening of the rural labor market and the continuation of the income distribution processes; and

f. the continuation of the process will depend not only on the formulation and sound management of specific public policies aimed at combating poverty, but also of other social and economic policies.

Until recently, environment and rural poverty were closely associated with agriculture. People associated the rural poor mostly with landless, underemployed and underpaid rural workers, and with small-scale rural farmers with no access to the factors of production required to generate the income needed to provide their families with an acceptable standard of living. Poverty was identified, measured and analyzed in terms of the lack of sufficient income. Nonetheless, poverty is a multidimensional phenomenon that encompasses more than one specific need. In this regard, in defining poverty it is necessary to consider many factors that affect not only the present living conditions of a people, but also their future.

According to Sen (2011): "Poverty is the inability to pursue personal goals and or, simply, to develop as a human being while having the same opportunities available to others in the same society, and goes beyond the lack of material goods or human capacity…"

The evolution of information systems in Brazil has made it possible to analyze more thoroughly the many dimensions of poverty, as it relates to income or living conditions. Even though many studies have been conducted on the subject, reflection on the nature, dynamics and sense of rural poverty is still deficient. This has important implications for public policies, which in large part still reflect the "agrarian vision" of rural poverty and are implemented with little coordination between sectors. An example is the disconnect between the phenomenon of economic policies and education, which has yet to be incorporated or accepted fully as a means of eradicating the "hereditary poverty" (or vicious cycle of poverty) in Brazil and Latin America in general. This connection could become an instrument for intervening actively in the process of reducing poverty.

In sum, this possible lack of reflection on contemporary rural poverty is due, in part, to the increased interest in topics related to the urban environment, which are of greater concern to society and receive more coverage in the media. Even though there is often some point of convergence between urban problems and the situation of the population in rural areas, such as security or unemployment in the big cities, this has not been translated into lines of research and permanent policies aimed at understanding the effective relations between urban and rural areas, the factors that lead to the duplication of rural problems in the urban milieu and, much less, policies intended to stop negative flows of resources and intervene in their causes and forces.

Dimensions of the project

The project focused on three principal dimensions:

- Methodological dimension. The principal methodologies used to conceptualize and measure rural poverty in Brazil were analyzed. This analysis of methodologies focused on: a) the conceptualization of rural poverty and the parameters used to qualify and quantify it; and b) the definition of what is rural in the current context, taking into account both the availability of information and socio-economic dynamics, which determine and re-define social life in territories.

- Empirical dimension. Studies were conducted to analyze the different dimen-

The possible lack of reflection on contemporary rural poverty is due, in part, to the increased interest in topics related to the urban environment, which are of greater concern to society and receive more coverage in the media.

sions of rural poverty in Brazil. The basic questions were: How has poverty changed? Has the nature of rural poverty changed in such a way recently that it could be considered a "new" or "different" poverty? What are the faces of poverty today? How do these faces manifest themselves in the different regions?

- Political dimension. This dimension is intended to: a) determine whether current public policies aimed at the rural poor are adequate and sufficient; and b) determine the political and institutional implications of efforts to adjust and add policies; in other words, to what extent is it necessary to establish differentiated policies for the rural poor and what institutional framework is required? How to coordinate the actions of the different institutions involved in combating all aspects of poverty?

Thematic focuses of the proposed policies for combating rural poverty in Brazil:

a. Thoughts on the nature and limits of what is rural in contemporary Brazilian society, with a view to developing methodologies for identifying and measuring rural poverty.

b. Theoretical and conceptual analysis of the dynamics of rural poverty in Brazil.

c. Critical look at the principal methodologies used to measure poverty in Brazil and Latin America.

d. Reviews of the latest developments in rural poverty in Brazil.

e. Analysis of the regional dimensions of rural poverty, based on specific characteristics of the rural milieu in the regions, and sociocultural and working relations in each region.

f. Theoretical-conceptual analysis of the meaning and content of poverty in contemporary Brazilian society.

g. Analysis of the determining factors of rural poverty in Brazil.

h. Analysis of current social development and poverty alleviation policies, their dynamic and how they relate to the sectoral policies.

i. Studies to evaluate socio-economic impacts on populations surrounding the territories when large projects are implemented by the government and the private sector.

Historically, the rural milieu has been home to the greatest number and percentage of poor persons. This situation changed in the 1990s when the number of poor living in cities, especially the large ones, began to outnumber the poor in rural areas.

Current state of implementation of the project

The project was designed to be carried out in two stages:

- The first stage concluded in December 2010 with the Fifth International Forum: territorial development strategies aimed at combating poverty, the objective of which was to analyze the evolution and the current state of rural poverty and to gather technical and institutional information with a view to developing public policies for addressing the problem in Brazil. The agenda of the forum addressed: a) strategies for linking policies aimed at combating poverty and social inequality; b) mechanisms and instruments to support poverty alleviation policies; and c) requirements for the creation of capacities and institutional arrangements for the participation and development of rural families and their organizations.

- The second stage concluded during the second half of 2011, and focused on the policy instruments for combating poverty proposed in the different discussions and social management models.

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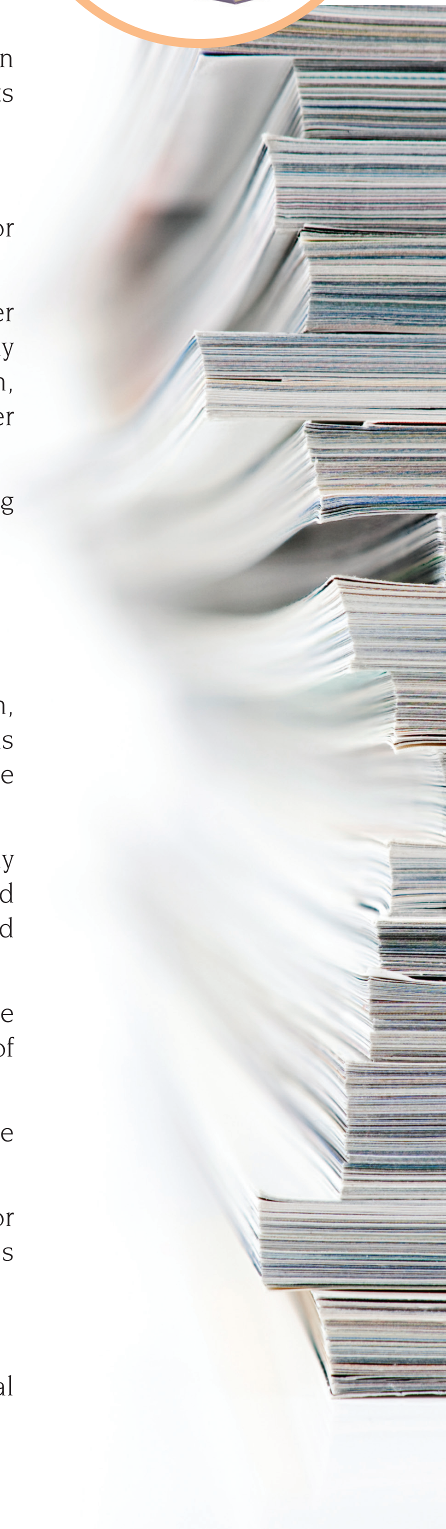
Guidelines for contributing to COMUNIICA ONLINE

COMUNIICA, the technical magazine of the Inter-American Institute for Cooperation on Agriculture (IICA), publishes original works on agriculture and rural life to serve as inputs for decision makers and to help others form opinions on issues related to these fields.

Contributions to COMUNIICA may be:

- **Articles:** texts containing analyses, deliberations and conclusions on academic or professional topics; written in simple style and clear language.
- **Experiences:** descriptions of activities carried out by IICA units or by a Member State that has received cooperation from the Institute, which, if disseminated, may contribute to a clearer understanding of the innovative work under way in the region, to the solution of problems or to the tapping of opportunities for action in other regions or countries.
- **Briefs:** short articles on results of ongoing research which are relevant and deserving of dissemination to a broader audience.



General Guidelines

a. The magazine is published quarterly in English and Spanish.

b. Manuscripts, with their respective abstract and keywords, may be written in Spanish, English, French or Portuguese. The publishers will have the abstract and keywords translated into all the official languages of the Institute, for inclusion in the magazine published in Spanish and English.

c. The original works will be evaluated by specialists in the corresponding fields. Any suggestions they make will be reviewed by the publishers and the contributors and every attempt will be made to ensure objectivity. The identity of the specialists and contributors will not be revealed.

d. Preferably, contributors to COMUNIICA will be IICA staff members. Works by outside contributors may be submitted, however, subject to prior approval by the Director of the respective thematic area.

e. Inasmuch as manuscripts undergo a rigorous review process, contributors often are asked to provide additional information or calcification.

f. Manuscripts published in the magazine may be full or partial reprints, subject to prior approval by the publishers and provided the original source of the publication is cited.

g. The views expressed in the manuscripts are those of the contributors.

h. Our readership comprises decision makers in the fields of agricultural and rural development, as well as specialists and researchers in both fields.

i. ComunIICA and the Editorial Board reserve the right to decline those manuscripts that do not comply with the established guidelines.

j. Once a work is accepted for publication, it may not be published in any other communications media without prior authorization from IICA.

Requirements for submitting manuscripts

- **Format:** Articles are to be submitted in electronic format, using a recognized word processing program; 2-inch upper, lower, left and right margins; Times New Roman 12 font size; single space between lines and double space between paragraphs, no indents.
- **Length:** Considering our readership, it is recommended that manuscripts not exceed five pages. Briefs may be shorter.
- **Figures, diagrams and tables:** They must fit in the margins mentioned above and be legible. All figures, diagrams and tables must be properly numbered and the source of each identified (author, year and page, for example: IICA 2009:23). This information must be included and filled out in the bibliography. All text included in figures, diagrams and or tables must be in a format that may be edited, preferably using the word processing program in which they were prepared.
- **Photographs:** If a contributor wishes to include a photograph, he/she must obtain permission to use same, and it must have a resolution of at least 300 dpi.
- **Information on author:** full name, place of employment, and e-mail address.
- **Keywords:** from five to seven using controlled vocabulary.
- **Abstract:** not to exceed 500 words.
- **Notes:** use footnotes rather than endnotes.
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We recommend that you look over one or two ComunIICA articles to get an idea of the style to use. The magazine is available at: www.iica.int/comuniica.

IICA publications recently obtained by IICA's Venezuela Library

The following are the most recent publications added to the Venezuela Library's collection at the Institute's Headquarters, which are available in printed or digital format. Visit IICA's Digital Library at http://orton.catie.ac.cr/bibliotecadigital.

Agriculture - Leadership

Formando líderes: metodología para el fortalecimiento del liderazgo en el sector agropecuario

IICA supports the development of agricultural leaders in the Americas imbued with an overarching vision for the creation of sustainable and modern agriculture, food security and rural prosperity at the hemispheric, regional, national and territorial levels. Through a participatory process, the Institute has developed a methodology designed to enhance the capacity to exert a positive influence over decision makers, so they understand the need to strengthen the agricultural sector and thereby make an effective contribution to poverty reduction and development efforts.

The methodology is designed to be used to reinforce values, develop confidence, improve negotiating skills and promote commitment, empathic listening and effective communication, among other factors. The methodology proposed is divided into ten modules, each of which provides tools for enhancing leadership skills in relation to a specific issue.

http://webiica.iica.ac.cr/bibliotecas/RepIICA/B2104e/B2104e.pdf

Biotechnology

LOTASSA: *Bridging genomics and pastures in the XXI century*

This publication presents a working methodology of great scientific value, designed to solve problems and fill important gaps in knowledge about large marginal areas of Latin America's Southern Cone countries. This project involved technical and scientific cooperation between European and Latin American institutions, under the auspices of the Sixth Framework Programme of the European Union. It took advantage of the close relationship between forage Lotus species and the model legume Lotus japonicus for genetic and genomic research. The document describes LOTASSA's most important results, which are presented in chapters for ease of comprehension, and includes a list of all those who took part.

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Climate change

Huella de carbono, ambiente y agricultura en el Cono Sur de Sudamérica

This work addresses the emerging issue of carbon footprints, warns of the threats to the growth of production in the region and identifies those responsible, and looks at the region's integration into international trade. It contains an important synthesis of information on the subject that agricultural leaders in the region will find indispensable. The book is very easy to read and understand; the carbon footprint and its implications are explained in simple, non-technical language.

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Rural development

Pobreza rural: concepções, determinantes e proposições para a construção de uma agenda de políticas públicas V Fórum Internacional de Desenvolvimento Territorial

IICA, through the SRD Forum, presents as a special edition, the publication "Pobreza rural: concepções, determinantes e proposições para a construção de uma agenda de políticas públicas V Fórum Internacional de Desenvolvimento Territorial." Produced under the project "The new face of rural poverty in Brazil: transformations, profile and challenges for public policies," it is based on the results of the Fifth International Forum on Territorial Development: Strategies to combat rural poverty.
The book is divided into two parts. In the first, the authors comment on and discuss the main issues addressed by the five panels that took place during the Fifth Forum, including changes in Brazil's rural areas, the determinants of rural poverty, ideas for public policies designed to reduce rural poverty and, lastly, the elements that should be considered when drawing up a public policy agenda. The second part includes the proceedings and the report on the Fifth Forum.

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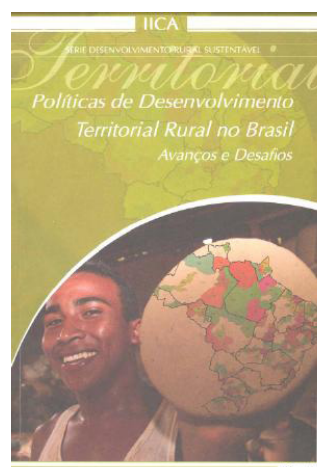
Rural development

Políticas de desenvolvimento territorial rural no Brasil*: avanços e desafios*



This book is the twelfth volume in the Sustainable Rural Development Series, produced and published by IICA and the SRD Forum. It analyzes Brazil's experience with the implementation of territorial development policies in areas where agriculture is practiced mainly on family farms and agrarian reform settlements, and in traditional rural and agricultural communities. The Ministry of Territorial Development, with strong support from IICA, has promoted the debate on territorial development in Brazil by means of seminars, research and the systematization of experiences on the subject.
The publication consists of five chapters:

1. Trends in studies on territorial development policy
2. Background to and evolution of territorial planning in Brazil
3. Evolution of the "Program for the sustainable development of rural territories and territories of the citizenry"
4. Territorial dynamics in Brazil: an analysis of four case studies
5. Future of territorial development policies in Brazil.

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Rural development - electrification

Universalização de Acesso e Uso da Energia Elétrica no Meio Rural Brasileiro: Lições do Programa Luz para Todos

One of the areas on which IICA has focused its work is sustainable rural development, contributing to the implementation of public policies related to the issue. This study argues that access to, and the use of, electricity in rural areas is a key factor for people's work. The joint action of the Ministry of Mines and Energy and the Electricity for Everyone Program has paved the way for a debate on national priorities and the dissemination of practices that can be applied throughout the Americas.

This publication is also intended to be used as an instrument for promoting the mobilization of resources among IICA Member States for joint efforts to meet the universal challenge of providing access to electricity in rural areas.

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Sustainable rural development - Venezuela

Promoviendo el desarrollo rural sostenible en Venezuela. La experiencia del Proyecto Yacambú-Quíbor en el Estado Lara

This publication was produced to disseminate the lessons learned in formulating the Project for the Integrated Management of Water Resources, part of the Yacambú-Quíbor Project (GIRH-YQ Project) implemented in Lara State, Venezuela. The lessons included in the document constitute a theoretical framework of reference and a proposal for action that could be used for future efforts to formulate projects designed to promote the sustainable rural development of other territories, both in Venezuela and in other Latin American and Caribbean countries.

http://webiica.iica.ac.cr/bibliotecas/repiica/b2071e/b2071e.pdf

Irrigation

El riego en los países del Cono Sur

This publication contains important information about issues of key importance for the development of irrigation in the region. It deals with water resources, irrigation policies and the institutional framework, research and development, available technologies, and new, emerging technological advances in the different production systems that make use of irrigation in the Southern Cone.

This information is especially valuable for regional cooperation on an issue that is important not only for agriculture but also for integrated territorial development. Irrigation's impact on development will increase in the years ahead for a number of reasons, including the need to raise productivity to contribute to food security, mitigate the effects of climate change (especially in terms of precipitation variability), and help reduce the water footprint in more efficient production systems. The intensification of agriculture in irrigation areas also generates new jobs, agroindustries and numerous associated services, and drives the development and application of new technologies.

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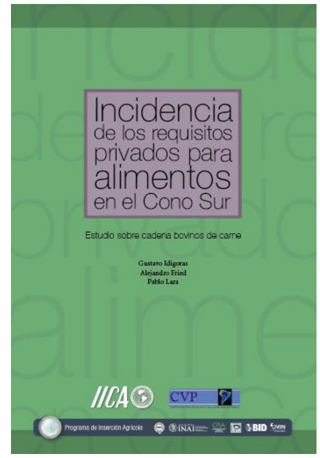
Food safety

Incidencia de los requisitos privados para alimentos en el Cono Sur



The impact of private standards was discussed within the framework of the technical cooperation of IICA and the Standing Veterinary Committee (CVP) of the Southern Cone, and it was decided that a study was needed to identify the financial and legal effects of such standards on beef production and trade in the southern region. A profile for a regional activity was designed in collaboration with the Programa de Inserción Agrícola and the parties involved carefully monitored the progress of the study.

This publication presents the study carried out and the results obtained, and is intended as a contribution to the analysis and discussion of this important issue by public and private sector stakeholders.

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Agrifood systems

Guía metodológica para la activación de Sistemas Agroalimentarios *Localizados* (SIAL)

This publication is targeted at technical personnel, advisers, managers, trainers, coordinators and leaders of both rural organizations and producers' associations, and governmental and civil society development agencies. It is designed to be used to support the development of small production and rural services units in specific regions. The instrument is based on the Local Agrifood Systems (LAS) model. It provides a permanent source of reference for individuals responsible for supporting the development of organizations that articulate rural agricultural production units, known as "development promoters."

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