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Water, Innovation and Productivity Series

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ACRONYMS

ACH	Administrative Contracting Services
AHFS	Agricultural Health and Food Safety
AMS	Aggregate Measures of Support
AsA	Agreement on Agriculture
CAC	Central American Agricultural Council
CAN	Andean Community
CARDI	Caribbean Agricultural Research and Development Institute
CARICOM	Caribbean Community
CARIFORUM	Caribbean Forum
CATIE	Tropical Agricultural Research and Higher Education Center
CECI	Center for International Studies and Cooperation
CEDEPAS Norte	Ecumenical Center for Promotion and Social Action
CEPALSTAT	ECLAC Databases and Statistical Publications
CGIAR	Consultative Group on International Agricultural Research
CIMMYT	International Maize and Wheat Improvement Center
CIRAD	Center for International Cooperation in Agricultural Research for Development
CITA	National Center for Food Science and Technology
CLIITA	Local research and technological innovation consortia
COMEX	Ministry of Foreign Trade
COMISCA	Central American Health Ministers Council and the Dominican Republic
CONARROZ	National Rice Corporation
CONIAF	National Agricultural and Forestry Research Council

COOPANORTE	Norte Chico Agricultural Cooperative
COSAVE	Southern Cone Plant Protection Committee
CTA	Technical Center for Agricultural and Rural Cooperation
DID	Développement International Desjardins
DIGEGRA	General Agricultural Directorate
DR	Dominican Republic
ECLAC	Economic Commission for Latin America and the Caribbean
EEP	Energy and Environment Partnership Program with the Andean Region
ELFS	Food Safety Leadership Program
ERVIA	Virtual Regional Food Inspection School
ESA	European Space Agency
EU	European Union
FONTAGRO	Regional Agricultural Technology Fund
FADQDI	Financière agricole du Québec - Développement international
FAO	United Nations Food and Agriculture Organization
FAST	Financial Alliance for Partnership for Sustainable Trade
FDI	Foreign direct investment
FF	Family Farming
FLAMA	Latin American Federation of Supply Markets
FSMA	Food Safety Modernization Act
GDP	Gross domestic product
GEF	Global Environment Facility
GHGs	Greenhouse gas emissions
GIZ	German Agency for International Cooperation
ICCO	International Cocoa Organization
ICT	Information and Communication Technology
IDB	Inter-American Development Bank
IDB	Inter-American Development Bank
IDIAF	Dominican Agricultural and Forestry Research Institute
IICA	Inter-American Institute for Cooperation on Agriculture
INIA	National Agricultural Research Institute
IP	Intellectual property
IPPC	International Plant Protection Convention
IRRI	International Rice Research Institute
LAC	Latin America and the Caribbean
M&E	Monitoring and Evaluation
MARNDR	Ministry of Agriculture, Natural Resources and Rural Development
MECA	Methodology for the Evaluation of Agrifood Chains for Identification of Problems and Projects
MEIC	Ministry of the Economy, Industry and Trade
MERCOSUR	Southern Common Market
MGAP	Ministry of Livestock, Agriculture and Fisheries
MINAGRI	Ministry of Agriculture and Irrigation
MIOA	Market Information Organization of the Americas

NGO	Non-governmental organization
NOM	Official Mexican Standard
OECD	Organisation for Economic Co-operation and Development
OIE	World Organization for Animal Health
PAT	Programa Andes Tropicales
PIDEL	Comprehensive Dairy Development Program
PMU	Project Management Unit
PRESICA	Productivity and Competitiveness of Production Chains in Central America and the Dominican Republic
PRIICA	Regional Program for Research and Innovation for Agricultural Value Chains
PROARROZ	Program for the Promotion of Competitiveness of the Rice Chain
PROCAL	Argentine Food Quality Program
PROMECAFÉ	Regional Cooperative Program for Technology Development and Modernization of the Coffee Industry
PVS	Performance, Vision and Strategy
R+D	Research and Development
REDSIAL	Scientific Network on Localized Agrifood Systems
SAGARPA	Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food
SECAC	Central American Agricultural Council
SENASICA	National Agricultural Health, Safety and Food Service
SICTA	Central American Integration Agricultural Technology System
SIDS	Small Island Developing States
SIECA	Secretariat of Central American Economic Integration
SIMAS	Agricultural Market Information Systems
SIRDI	Sugar Industry Research and Development Institute
SMSFs	Small and medium-scale farmers
SOGESOL	Société Générale Haïtienne de Solidarité
SPS	Sanitary and phytosanitary measures
SRI	System of Rice Intensification
STDF	Standards and Trade Development Promotion Fund
SVC	Standing Veterinary Committee
SYFAAH	Financing and agricultural insurance system in Haiti
TFP	Total factor productivity
TIE	Sterile insect technique
UCLA	University of California in Los Angeles
UCOOPANE	Union of Small-scale Fishing Cooperatives in the North of Emeraldas
UNCCD	United Nations Convention to Combat Desertification
UNCTAD	United Nations Conference on Trade and Development
USAID	U.S. Agency for International Development
WTO	World Trade Organization
WUSC	World University Service of Canada

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This book is dedicated to all agricultural researchers and scientists in the Americas who are conscious of the need to produce more food for the growing human population.

This formidable challenge cannot be addressed without the participation of researchers, whose knowledge continuously contributes to the creation and adaptation of methodologies geared toward making agricultural production more efficient, sustainable and inclusive.

FOREWORD

Increasing productivity in agriculture is one of the greatest challenges currently facing humankind. Agricultural productivity is defined as the relationship between products generated and the inputs used to produce them; it is calculated by dividing the value of products by the value of inputs. Therefore, one of the greatest challenges for agriculture in the 21st century is to produce more and better food using land, water, labor and available technological innovations in order to generate a productive, sustainable and inclusive agriculture.

Since the second half of the 20th century, global agriculture has shown a steady increase in productivity. Between 1960 and 2010, agricultural productivity tripled. In 1961, 1.37 billion hectares were cultivated around the world, which made it possible to feed a population of 3.5 billion inhabitants. Fifty years later, the cultivated surface area increased by just 12%, while the world's population doubled. Crop yields for staple grains such as wheat, corn, rice and barley, doubled and, in some cases, tripled over that fifty-year period. This increase in productivity resulted from a growing use of mechanization and improved seeds, the green revolution, the expansion of irrigated farming and the adoption of more efficient agricultural systems.

However, these achievements have been insufficient, due to the fact that the majority of rural producers, particularly in developing countries, lack access to mechanization and innovative technological products. A large number of them still utilize traditional farming systems characterized by low productivity and profitability.

Over the past few decades, the strategies and guidelines of international organizations have focused on increasing agricultural productivity. For this reason, Heads of State and high-level representatives participating at the Rio+20 Conference reached a decision to sustainably increase agricultural productivity in developing countries in particular, by increasing public and private investment, improving land management and fostering rural development.

Agriculture in the Americas has tremendous potential to decisively contribute to global food security; to do so, however, it must consolidate a more productive and sustainable agricultural system. The Latin American and Caribbean region possesses one third of the world's fresh water resources and more than one fourth of land with medium to high farming potential. In addition to boasting remarkable biodiversity, LAC is the region with the second-largest potential for rain-fed agriculture.

In light of the above, one of IICA's main priorities is to increase agricultural productivity on the American continent, with the aim of improving living conditions for rural families, reducing poverty and preserving natural resources. During the Meeting of Ministers of Agriculture of the Americas, held in Cancun, Mexico, in 2015, the ministers adopted a declaration that includes eight commitments geared toward improving agricultural productivity. The document entitled Competitive, Inclusive and Sustainable Productivity served as a primary reference document for the meeting, particularly for the technical forums that were held within the framework of the meeting.

Having the support of ministers and maintaining a technical dialogue on productivity with national and international counterparts is a priority for the Institute. Increasing the productivity of agriculture and rural territories will only yield benefits for the thousands of farmers who are dedicated to food production.

This document provides a detailed account of the actions that IICA has undertaken to fulfill the abovementioned objective. The document presents the strategies and guidelines that the Institute has defined to increase productivity, the main projects it has implemented for that purpose, as well as some of the main success cases resulting from its technical cooperation. I trust that the document will be useful to member countries, producers, agricultural authorities, consumers and researchers related to agriculture on our continent.

Dr. Víctor M. Villalobos
Director General
IICA

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THE IMPORTANCE OF AGRICULTURAL PRODUCTIVITY

Agricultural productivity is defined as the measurement of the output obtained from a series of inputs. The latter may include land, labor, livestock, machinery and equipment, fertilizer and all other items necessary for production. Productivity is generally measured using an index, such as that obtained by dividing the value of output generated by the value of inputs employed.

Productivity is also measured in terms of labor multiplied by time, expressed as volume or value. It serves as an individual indicator by unit of production, sector, branch or country.

Regardless of which measurement is used, empirical studies support the idea that improvements in agricultural productivity are important for poverty reduction (Schneider and Kay, 2011:56).

> The term “productivity” has been defined in many different ways and has given rise to many conflicting interpretations. It is sometimes defined as the overall efficiency of a production system; it has also been described

as the relationship between production and the resources employed, individually or collectively. It has been confused with production, which actually refers to volume, whereas productivity is defined as production in relation to the resources employed to achieve it. Production can be increased by using more resources, without increasing productivity, while productivity per unit can be improved without increasing production and employing fewer inputs to achieve the same level of production. Productivity is generally agreed to mean the ability of a production system to generate output in a more cost-effective and efficient manner. Agricultural productivity may thus be defined as a measure of efficiency in an agricultural production system that employs land, labor, capital and other related resources.

Innovation, structural change, access to natural resources and the impact of climate change are key factors in the growth of productivity and sustainability. Policy can affect these factors in four main areas:

1. Economic stability and trust in institutions (justice, public safety, property rights) essential to attracting long-term investment.
2. Private investment, through a regulatory framework that allows competition, ensures that resources are used sustainably, facilitates adoption of new technologies, encourages trade for the dynamic exchange of goods, capital and knowledge and allows access to financing.
3. Development of capabilities – including essential public services – that facilitate access to markets and knowledge and build the skills necessary to innovate and use resources more efficiently.
4. Specific sectoral incentives to innovation, structural change and sustainable use of resources in the food sector and the agricultural system, by means of:
   a. Agricultural policy: domestic measures, including price and income support, investment support, input subsidies, risk management, adjustment and agri-environmental measures and agriculture-specific trade measures.
   b. Agricultural innovation policy, i.e., government role in providing governance, funds for innovation activities and incentives for private investment in and adoption of innovation (OECD 2015:4).

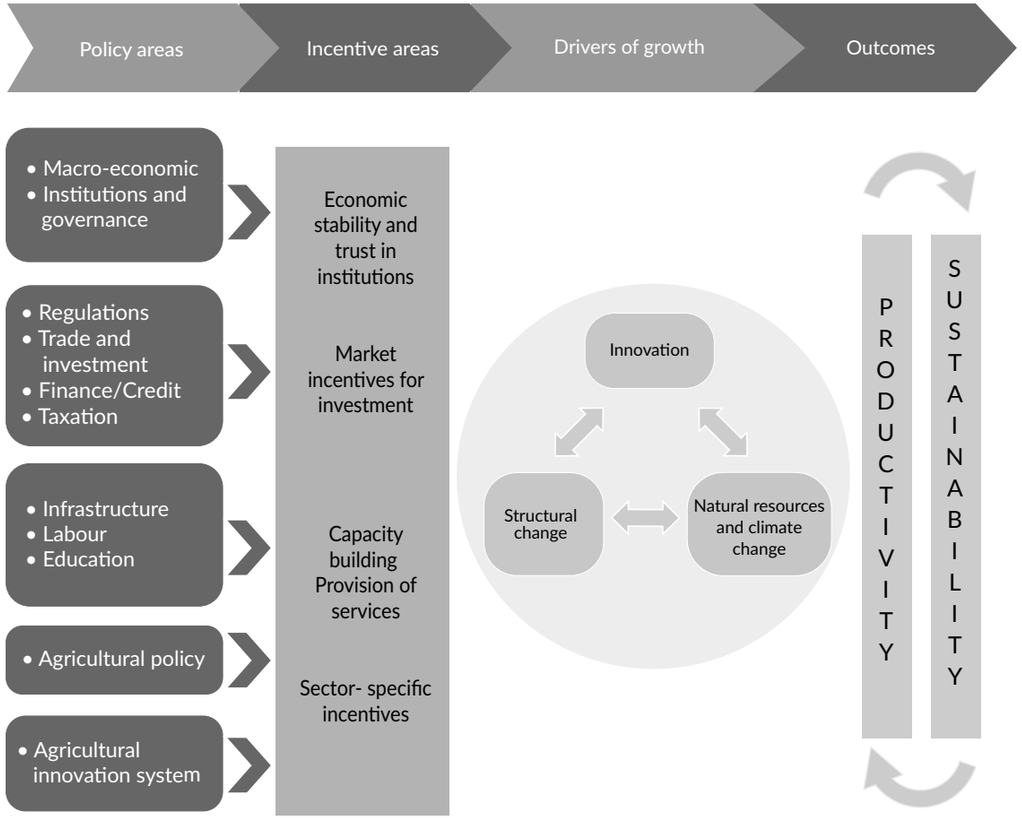

FIGURE 1. Policy drivers of innovation, productivity and sustainability in the agriculture and agri-food sector.

Source: OECD 2015:5.

Figure 2 illustrates the relationship between innovation, economies of scale and productivity. The growth of agricultural productivity is made possible by technological progress reflecting early adoption and improved technical efficiency of innovations adopted by best performers. Improved technical efficiency reflects wider diffusion of innovation and economies of scale. Structural change also affects the capacity to adopt scale-dependent innovations.

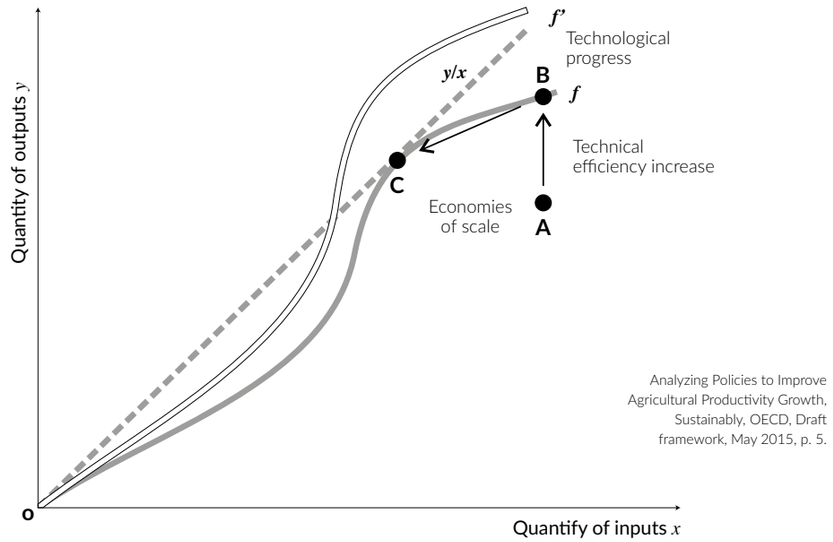

FIGURE 2. Pathway of Productivity Growth.

Source: OECD 2015:6.

TABLE 1. Example of investment support.

POLICY AREA	DOMESTIC AGRICULTURAL POLICY
Policy measure	Support to farm investment
Incentive area	Reduces the cost of investment and thus facilitates
DRIVERS	
Innovation	The introduction of new technologies, allowing for innovation in production methods, products, marketing and organization.
Structural change	The purchase additional inpust (land, buildings), allowing for adjustment and economies of scale.
Sustainable resource use and climate change	The introduction of technologies for a more sustainable use of resources, if there are market and policy incentives to improve sustainable resource use.
Outcomes	Will also depend on market and other policy incentives. Impact will be stronger if support is targeted to specific investments.
Productivity	Innovation and economies of scale contribute productivity growth but the extent depends on the type of innovation (e.g. labour saving technologies may improve labour productivity but not total factor productivity).
Sustainability	Some innovations can improve sustainability and climate change adaptation and mitigation. More likely to happen if support is conditional on the adoption of environmentally, climate friendly technologies and practices.

Source: OECD 2015:7.

Trends in agricultural productivity up to the year 2000

In 1961, agriculture provided food for the global population of 3.5 billion inhabitants with a cultivated area of 1.3 billion ha. Fifty years later, the global population had doubled to 7 billion, although the area of arable land had only increased by 12 % to 1.53 billion has. In other words, agricultural production had tripled thanks to improvements in productivity (Fuglie and Nin-Pratt 2012:15).

Between 1950 and 2000, the growth of agricultural production in the world had made it possible to increase daily per capita intake of kilocalories from 2,452 to 2,700. This remarkable increase in agricultural production over half a century may be explained by:

- the spread in the developed countries of the modern agricultural revolution (involving motorization, large-scale mechanization, seed selection, use of chemicals and specialization), and its expansion into some sectors of the developing countries;
- the green revolution, especially in the developing countries, which involves the selection of high-yielding cereal and other plant varieties suitable for hot regions, as well as the use of chemicals;
- expansion of irrigated surfaces, from 80 million ha in 1950 to about 270 million ha in 2000; and
- the adoption of mixed farming systems combining crops, arboriculture, livestock and fish farming in densely populated areas that lack new lands for farming (FAO 2000:171-172).

Despite these advances, however, most farmers in the world were still not using mechanization or genetics, but were still using inefficient systems which only aggravated their poverty and marginalization.

In the mid-1900s, there were 700 million farmers in the world, fewer than 7 million tractors (4 million in the United States, 180,000 in Germany and 150,000 in France), and fewer than 1.5 million combine harvesters. At the end of the twentieth century, there were 1.3 billion farmers, 28 million tractors and 4.5 million combine harvesters,

mostly in the developed countries. The trend in fertilizer use was similar: in 1950, 17 million tons of mineral fertilizer were used, while eight times more were used in 2000. During that half-century, the use of agrochemicals to combat pests and diseases increased considerably.

Agricultural productivity also grew significantly over those 50 years. In the mid-twentieth century, wheat yields amounted to 1,000 kg/ha; maize, 1,500 kg/ha; rice, 1,600 kg/ha and barley, 1,100 kg/ha. Fifty years later, those yields had doubled and, in some cases, tripled. The same thing happened with milk production. In 1950, the average yield per dairy cow in France was 2,000 liters per year; in 2000, the yield was 5,600 liters. Nevertheless, the increase in global productivity was extremely unequal among countries, regions and production sectors. The highest yields were reached in commercial production systems that used more technology, including machinery and inputs.

In the mid-twentieth century, net productivity per worker of extensive cereal crops using motorized mechanization in the developed countries amounted to 30,000 kg per worker. Using mechanized farming with animal traction without fallow, it was 10,000 kg; using heavy cultivation with animal traction with fallow and irrigated farming with animal traction and two harvests per year, productivity per worker was 3,500 kg, whereas in traditional manual farming, productivity amounted to 1,000 kg of cereal per year per farmer. The ratio between the more efficient system and the more backward system was 30:1. In the year 2000, the disparity between more efficient mechanized systems and more backward manual systems was 500:1; in other words, the disparity increased twenty-fold over 50 years (FAO 2000:175-177).

The agricultural revolution of the second half of the twentieth century was based on the extensive use of internal combustion engines and electric motors, tractors and machinery for different farming operations during planting and harvesting, intensive use of fertilizers and insecticides and the use of increasingly improved means for conserving products. Biotechnology also made a contribution, as it allowed for the use of higher-yield crop varieties and animal breeds that were more resistant to disease. Increasingly efficient transport systems made it possible to connect producing regions with consumption centers, thus increasing the volumes transported, reducing loss and shortening transport times. Farming and livestock operations also went through a process of transformation, owing to the concentration, expansion, integration and scale production on large farms, as follows:

» **Mechanization and use of farm machinery.** Cereals, some legumes, cotton, sunflower and soya were the first crops in which motors and agricultural machinery were used systematically. Later on, the use of machinery was extended to potatoes and beetroots. Finally, stock raising also benefited from mechanization for forage harvesting, feeding and excreta elimination. This process was carried out in different stages. In the first stage, during the 1950s, low-horsepower tractors were used on farms of more than 15 ha. This made it possible to increase the surface area allocated per worker from 10 to 20 ha. During the next three stages, between 1950 and 1980, more powerful tractors were used (between 30 and 75 HP), and the allocated land area per worker rose to 100 ha. During the fifth stage, in the 1990s, four-wheel drive tractors of more than 120 HP were used, and the area handled by one worker increased to 200 ha.

  Similarly, for dairy production, in 1950, one worker could handmilk 12 cows twice a day. With the use of mechanical milking machines, one worker was able to milk 50 cows, and then 100 cows; by the end of the 1990s, one worker could milk 200 cows per day with automated milking equipment (FAO 2000:178-181).

» **Agrochemicals and breeding.** During that half-century, one of the key factors in the improvement of agricultural productivity was the use of fertilizers and agrochemicals to combat pests and diseases. For example, in the United States, average wheat yields rose from 1,100 to 2,600 kg/ha between 1950 and 2000, while fertilizer use increased six fold during that same period. In France, average yields rose from 1,800 to 7,100 kg/ha, and fertilizer use rose from 45 to 250 kg. In northeastern Europe, at the end of the twentieth century, wheat and maize yields of 10,000 kg/ha were obtained with the application of 200 kg/ha of nitrogen, 50 kg/ha of phosphate and 50/ha of potassium.

To obtain those yields, a lengthy process of experimentation, research and innovation was needed in order to develop high-yield varieties of cereal that would be resistant to cold and to major diseases.

Stock raising went through a similar process, as the use of better cereals and pastures was supplemented with breeding and improved management. At the beginning of the twentieth century, one dairy cow consumed, on average, 15 kg of hay daily to produce less than 2,000 liters of milk per year. One hundred years later, a highly bred milch cow consumed three times less hay and 15 kg of feed concentrate daily to produce more than 10,000 liters of milk per year.

» **Plant and animal health.** One of the greatest advances making it possible to increase agricultural and livestock productivity has been in the area of plant and animal health. Combating major pests and diseases, vaccinating livestock, using pesticides and antibiotics, biological control, prevention, and better management of production have made it possible to integrate health into the overall process of production. This has contributed to increasing yields of crop and livestock products.

» **Specialization of production.** With the introduction of machinery and fertilizers and the resulting increase in agricultural productivity, flat regions with good soils are no longer producing fodder for livestock. Conversely, uncultivated lands in hill areas, rainy lowlands and arid coastal areas have focused on pasture for livestock. In many regions, production has become specialized, with monocropping centered on cereals, oilseeds, vegetables, fruits and flowers, while access to markets has been facilitated by progress in transportation (FAO 2000:181-185).

» **The economic threshold for agricultural workers.** Although agricultural productivity has clearly improved, especially in the developed countries, achieving those standards has been a process fraught with difficulties in which only one sector of producers has been successful. Towards the end of the last century, it was estimated that in addition to achieving high productivity per worker, the threshold for being able to capitalize a unit of production on 200 ha of rented land would be €15,000 per year. Above that level, producers are able to invest, obtain credit and expand. However only a small sector has reached that threshold. Below that threshold, farming becomes a subsistence undertaking, leading to a vicious circle that prevents producers from being more profitable and productive. Thus, during the second half of the last century, most production units were not able to surpass that threshold and disappeared, leading to increased migration to the cities and abandonment of the country.

» **Ecological changes.** Specialization has changed the ecosystems associated with crops. The biological diversity that existed before the agricultural revolution has given way to more uniform ecosystems, as extensive fields are devoted to a single crop or breed of livestock with very little variety of plants and animals. At the same time, the widespread use of agrochemicals and fertilizers has led to higher levels of pollution of surface and underground waters, which directly affects the flora and fauna and soils of the ecosystem. For several decades now, this has posed a serious challenge to agricultural sustainability.

» **Demographic changes.** Increased productivity has led to significant changes in rural demographics. Machinery has displaced the human workforce, increased the land area per worker, reduced the number of farms or eliminated some, and contributed to rural-urban migration. While urbanization has increased, total rural population and population density have decreased, making it more and more difficult to provide adequate basic services. Conversely, in some regions of intensive production that require lots of workers, such as viticulture or flower cultivation, the worker population density has increased.

» **Economic changes.** One of the greatest changes brought about by the increase in productivity has been that most former farm workers were able to move to industry and services in urban societies after the Second World War. Since the 1970s, however, the demand for labor in the cities has remained stable while rural-urban migration has continued, causing an increase in urban unemployment. On the positive side, the higher productivity of agriculture, industry and services has made it possible to achieve improvements in labor practices, such as a shortening of the working week, lowering of the retirement age and longer schooling.

» **Cultural changes.** The technological changes that have transformed agriculture did not originate in the rural environment, but rather in public and private research centers. As a result, the heritage of traditional knowledge handed down by peasants and farmers has gradually been replaced by modern science and culture that originates outside the rural environment (FAO 2000:186-187).

Limits to the agricultural revolution

The agricultural revolution of the second half of the twentieth century was limited to the developed countries and large commercial farms in some regions of Latin America, northern and southern Africa and Asia. However, in other regions, such as sub-Saharan Africa, the Andes and Central Asia, farming is still done manually with animal traction.

The achievements of the green revolution have brought significant benefits to many regions which have been able to adopt high-yield varieties of maize, rice, wheat, beans, cassava, sweet sorghum and pigeon peas that were developed by international research centers such as the International Maize and Wheat Improvement Center (CIMMYT) and the International Rice Research Institute (IRRI). In some regions, productivity has increased significantly thanks to the use of animal traction and small tractors. As a result, countries such as China and India have reduced malnutrition, while other countries such as Thailand, Vietnam and Indonesia have become rice exporters.

It has not been possible, however, to eliminate extreme poverty and chronic malnutrition. The green revolution has not reached many regions, especially the uncultivated areas. Many farmers in the poorer regions are marginalized and cannot improve productivity owing to the lack of economic resources. Thus, they are victims of a threefold – economic. environmental and nutritional – crisis. The drop in prices for agricultural products has seriously affected them, and in order for their families to survive, farmers have to seek other sources of income, selling some of their few possessions and emigrating. This only increases their marginalization and sets them further back.

As a result of decapitalization, reduction of the labor force and degradation of soil fertility, farmers have had to opt for crops that require less fertilizer and labor and which generally provide fewer nutrients. Consequently, the bulk (three quarters) of the 800 million people suffering from undernutrition at the end of the last century were living in rural areas. These rural areas are the most vulnerable to the risks of agricultural activity. They have been at the mercy of natural phenomena such as floods, drought and extreme cold and are affected by the lack of infrastructure. The small size of holdings (minifundios), insecurity of land tenure, economic policies that favor importation of cheaper goods and the lack of support mechanisms are ongoing issues that aggravate their situation.

Despite this, farmers in the more marginalized areas are eagerly seeking ingenious alternative methods of production that will enable them to make better use of the natural resources that surround them. They combine crops, stock raising, arboriculture and aquaculture, crop rotation, irrigation and other practices which are evidence of a dynamic, innovative sector that is improving and changing (FAO 2000:188-191).

The limits of the agricultural revolution are also evident in the developed countries. In temperate regions with only one agricultural cycle, for example, it is very difficult to obtain more than 12,000 kg of cereals per ha or more than 12,000 L per year of milk per cow. In addition the excessive use of fertilizers and agrochemicals are degrading the soil and affecting the quality of foods. A high rate of emigration, increasing mechanization and abandonment of cultivated lands pose new challenges. Alternative forms of agriculture using sustainable methods are being developed in order to obtain organic products of greater value that protect the environment. These alternative methods will be increasingly important in the future.

At the end of the last century, the question was whether the agricultural revolution and the new forms of sustainable agriculture would be able to feed the larger population that would inhabit the world in the coming decades and whether it would be possible to mitigate poverty, marginalization and malnutrition in the more backward rural areas (FAO 2000:192-196).

Production and productivity

In the second half of the twentieth century, the demand for food grew exponentially as a result of the massive increase in the world population and the rise in wages. This

happened when most of the arable land was already in use and the agricultural frontier was shrinking except in a few local areas such as some regions of Africa and Brazil. A look at the growth of cereal production in the developed countries during those years shows that per capita production rose from 500 tons to nearly 650. Growth was not as significant in the developing countries, where it rose from 200 kg to nearly 260. In Latin America and the Caribbean, per capita production rose slightly, from 224 to 250 kg, whereas in the sub-Saharan African countries, it dropped from 150 kg to 130 kg (FAO 2000:244-245).

The increase in agricultural production may be explained as a result of changes in institutional structures, human capital, technology and innovation. The technological capital of a country is its capacity to develop, adapt and apply technologies that make it possible to increase productivity. Advances in infrastructure, credit and improvements in the legal system help increase agricultural productivity, as do training and extension programs and the use of good agricultural practices and innovation.

Investing in public goods directly impacts productivity improvement. The role of government has been to create and administer laws and institutions that promote private production and to invest in public goods when necessary. In some developed countries, government intervention in such matters has been inefficient; as a result, during the final decades of the twentieth century, with neoliberal policies, reforms were applied in order to privatize inefficient public enterprises and reduce the size and weight of the State in the economy. However, those policies did not take into account the central role of public investment in rural schools, extension work and agricultural research, all of which have an effect on the growth of the agrarian sector.

Increasing productivity entails increasing output per unit of resources used. The most commonly used economic index is that of productivity of labor or output per worker. In agriculture, the most common index is that of output per unit of land or yield of crops (FAO 2000:246-249, 253).

The increase in production of the main crops during the second half of the twentieth century shows the effect of the green revolution starting in 1960 in southern and southeastern Asia. As regards wheat production in the developed countries, the growth was remarkable between 1960 and 1970, when the average annual increase in yield was slightly over 3 %, and it slowed down over the next two decades. During that entire half-century, the area harvested gradually declined.

The trend in developing countries was different: average annual wheat yields rose by 4 % during the 1960s and by almost 5 % during the 1970s, followed by a decline of 3 % per year during the 1980s.

Maize productivity grew remarkably during the 1950s – at a rate of 5 % per year – and dropped significantly during the next three decades. In the developing countries, yields rose, especially during the 1960s, at an average annual rate of over 3 %, and then dropped to 2.7 % during the 1980s.

Rice yields in the developed countries also performed best during the 1950s, when they grew at an average annual rate of 1.5 %, and then fell drastically during the 1970s and 1980s. In the developing countries, on the other hand, yields were around 2 % during the 1950s, reaching 3.5 % during the 1970s, and dropping to 1.3 % during the 1980s.

Yields of soya in the developed countries grew at the highest rate during the 1980s, when the average yield was 2 %, whereas in the developing countries, the highest yields were obtained during the 1960s, when they grew at a rate of 4 % (FAO 2000:260-261).

Productivity of land and productivity of labor

Globally, the productivity of land increased between 1961 and 1990 at an average annual rate of 2.03 % and declined at a rate of 1.92 % between 1990 and 2005. The productivity of labor rose by 1.12 % during the former period and by 1.36 % during the latter. In Latin America (except Brazil), productivity of land between 1961 and 1990 rose by 2.56 %, whereas between 1990 and 2005, it rose by 3.01 %. Labor productivity increased by 1.93 % and 2.72 %.

In Africa, land productivity rates were 2.18 % and 2.21 %, and labor productivity was very low, between 0.68 % and 0.90 %. By contrast, the more developed economies saw a growth in productivity of land of 1.61 % between 1960 and 1990 and only 0.72 %

between 1990 and 2005; however, labor productivity rose at its highest rate, at 4.26 % during the earlier period and 4.18 % during the latter. By countries, China had the best performance, with a growth in land productivity of 2.81 % and 4.5 %, and labor productivity grew by 2.29 % and 4.45 % during those periods (Beddow *et al* 2009).

Prospects for agricultural production at the end of the twentieth century

At the end of the twentieth century, the study by the United Nations Food and Agriculture Organization (FAO) reached the following conclusion:

> *The past half-century has seen evolving perceptions regarding development, including its promises and constraints, ways to achieve it in the role that the public and private sectors should play in accelerating it. For a long time, the key contribution made by agriculture to economic and social development has not always been recognized. Moreover, world hunger has failed to attract the sustained attention it warrants. Against a rapidly accelerating process of international integration and interdependence, a flurry of national and international initiatives in the past decade have borne witness to greater public interest in problems and issues relating to poverty reduction, sustainable development and food security. Furthermore, it has been recognized that because of the interdependence of such issues, concerted action is required to address them* (FAO 2000:305-306).

As regards the trends in agricultural productivity, the study points out the following:

Extraordinary but uneven gains in agricultural production and productivity have been achieved, largely as a result of different approaches to augmenting countries' "technological capital". Technological advancements, rendered possible by research and investment efforts and by support from national and international agricultural research centers, have played an irreplaceable role. Changes in the relationship between population and resources have also been important factors; the worker-population ratio, which had been declining in many countries, is now growing in most, thus allowing those countries to benefit from the "demographic gift" that has already helped some of the most populous countries to address the challenge of development and increasing food supplies. Prospects for a continuation of the productivity growth seen in the past are hindered in many countries by land degradation, strained water resources and reduced irrigation investment opportunities. However, there is now evidence that biotechnology can contribute substantially to overcoming these problems, provided adequate precautions are taken against properly assessed negative outcomes (FAO 2000:305-306).

Among other things, the FAO study (2000:308-312) recommends the following:

- Improve access to food.
- Promote growth with equity.
- Recognize the importance of food and agricultural production.
- Build technological capital.
- Develop human capital.
- Create sound and stable institutions.
- Make incentives work.
- Keep pace with globalization.

Agricultural productivity in the 21st century

Increasing agricultural productivity is one of the strategic objectives in efforts to overcome the challenges facing agriculture in the 21st century. For many years now, the global food system has been in a state of vulnerability, unable to resolve the momentous problems of hunger, underdevelopment and marginalization facing humanity. These problems are expected to become even more urgent in the coming decades.

The food crisis of 2007-2008, triggered by a decline in the growth rate of agricultural output, high energy prices, strong demand for agricultural products in developing economies and the impacts of climate change, continued to affect the development of the global economy in the years that followed. Faced with this outlook, it became clear that new public policies were needed that would go beyond traditional agricultural production, to ensure that all the world's population was provided with access to safe, sufficient and nutritious foods obtained through sustainable growth.

Agriculture not only contributes to food production, but also to human health and nutrition, making it even more important to address the challenge of increasing agricultural output. Furthermore, in recent years there has been growing evidence showing that rising greenhouse gas emissions (GGE) and climate change are affecting agricultural productivity, a fact that will put additional pressure on world agriculture in the coming decades (IFPRI 2011: vii, 1-3, 39). Although industrialized countries have reduced their greenhouse gas emissions, in developing countries these have increased significantly over the past thirty years, surpassing emissions from developed countries by the end of the first decade of this century.

In rural areas, the prevailing inequality between the most developed and the least developed regions, as well as gender inequality between men and women, can be reduced by increasing agricultural output through programs and approaches that offer better opportunities to women. Expanding opportunities would provide larger incomes and lead to improvements in the health and nutrition of rural women.

Another of the greatest challenges facing humanity is population growth, which will demand larger volumes of food and will lead to increased degradation of farmland. These challenges can gradually be resolved by increasing agricultural productivity. At the beginning of this decade, nearly one-quarter of the world's total arable land was affected by degradation. Every year around 1 percent of the total arable area is lost. Some 1 billion people around the world and 42 percent of the poorest rural dwellers live on degraded lands (Figure 3). It is therefore imperative to halt land degradation, promote reforestation and support increased sustainable agricultural productivity.

It is also crucial to produce more food on the existing farmland. Research has shown that land productivity will have to meet more than three-quarters of the growth in global food demand between now and 2050. Satisfying this increased demand for food will entail increasing crop productivity in regions where there is now a large gap between actual and potential yields. Moreover, to boost agricultural productivity and address land degradation, it is vital to make improvements in managing soil fertility (IFPRI 2011:63-66).

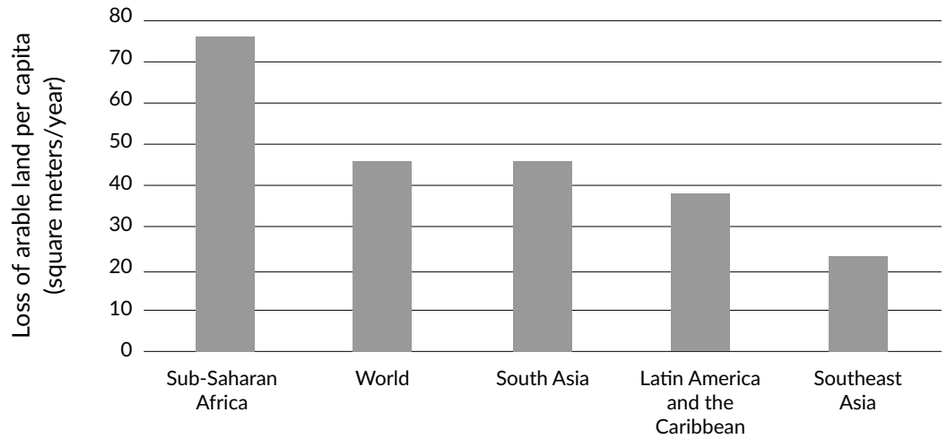

FIGURE 3. Annual loss of per capita arable land in developing countries, 1961-2009 (in square meters per year).

Source: Preliminary analysis based on linear regression model from data from Food and Agriculture Organization of the United Nations, FAOSTAT database.

It is now widely accepted that greater investment in agricultural research is an essential element for increasing agricultural productivity. Public spending, as a share of agricultural GDP, together with the number of researchers in agriculture, are indicators of progress in agricultural research, which contributes to increased productivity in the sector.

Total factor productivity (TFP) –or the total amount of output relative to the total amount of inputs used to produce that output – is a key indicator of the agricultural sector's performance. In the long term, the TFP is the main driver of growth in agriculture and can be affected by policies and investment. It is determined by the efficiency of resource allocation in production given a certain technology (the "efficiency" component) and the adoption of new technologies (the "technical change" component) that allow for new and more efficient ways of producing outputs. In the past, economic policies have had major negative impacts on agricultural growth in

several developing countries through price distortions that resulted in increased inefficiency and stagnation (IFPRI 2011:102).

In 2012, data from the UN Food and Agriculture Organization (FAO) suggested that the Millennium Development Goals (MDG) would not be achieved by 2015 due to the ongoing prevalence of undernourishment. It was therefore considered urgent to implement actions aimed at fulfilling the strategic commitments formulated by the global community of nations. The evidence showed that in order to increase agricultural productivity, it would be necessary to increase investment in research and innovation, and conduct further research on the nexus between agriculture, nutrition and health on the one hand, and food, water and energy, on the other.

The commitments assumed by world leaders since the Rio Summit, the Rio+20 meeting, the Group of 20 (G-20) and the Group of 8 (G-8) meetings, have underscored the need for increased investment in agriculture, especially in research, to boost agricultural productivity and improve food security. In June 2012, the G-20 agreed to promote greater public and private investment in agriculture and technology.

This agreement was a response to significant transformations occurring in world agriculture due to changes in demand for food, driven by growing incomes and urbanization in many developing countries. In addition, the energy markets were having a major impact on food security due to the growth of biofuels and the effects on agricultural costs. Therefore, it was considered that investment in research and development would result in improvements in agricultural productivity and would have a strong impact on food systems.

The question was, what would happen to commodity prices and food security if agricultural output were to be increased, in a context of high energy prices and lower demand for meat products. An increase in agricultural output could lead to lower food prices and increased food security. Changes in dietary patterns, productivity growth and the energy policies of emerging countries, such as Brazil, China and India, would have a strong impact on the future of food security, given the significant role of these countries as producers and consumers (IFPRI 2012:1-2,6-7).

The sources of agricultural growth have changed over the past several decades. Growth of total factor productivity, a measure of output growth that does not come from input growth, accelerated substantially between 2001 and 2009, compared with the average for the period 1971-2009. Until the late 1980s, farmers achieved most of their growth by using more inputs such as land, fertilizer and labor. This input intensification accounted for 90 percent of agricultural growth in the 1960s, 80 percent in the 1970s and 75 percent in the 1980s. Beginning in the 1990s, however, greater use of inputs accounted for less than 20 percent of agricultural growth, while more than 80 percent came from higher total factor productivity - that is, producing more with the same amount of inputs (IFPRI 2012:7).

Two of the largest developing countries in particular, Brazil and China, have had managed to sustain high growth in total factor productivity over the past two decades, while countries in several other developing regions, such as Southeast Asia, West Asia, North Africa and Latin America and the Caribbean (LAC) also registered accelerated total factor productivity growth during the last decade. The major exception has been the region of Sub-Saharan Africa, where total factor productivity growth has remained below 1 percent per year, given that growth in this region still comes largely from farmers' cultivation of new land and increased use of fertilizers and pesticides.

During the 2012 United Nations Conference on Sustainable Development, also known as the Rio+20 Meeting, the Heads of State decided to give a prominent place to the concept of the "green economy," a movement that integrates sustainable development and poverty eradication. At this event, the United Nations Secretary-General also launched the Zero Hunger Challenge, with the aim of ensuring that all people would have access to adequate food all year round. This initiative also called for the elimination of stunted growth in children under two years of age, the sustainability of all food systems, a 100 percent increase in smallholder productivity and incomes and zero loss and waste of food (IFPRI 2012:7-8).

At this meeting, world leaders concluded that eradicating poverty is the greatest global challenge facing countries and is an indispensable requirement for sustainable development. Their conclusions regarding agricultural productivity included the following:

110. Noting the diversity of agricultural conditions and systems, we resolve to increase sustainable agricultural production and productivity globally, including through improving the functioning of markets and trading systems and strengthening international cooperation, particularly for developing countries, by increasing public and private investment in sustainable agriculture, land management and rural development. Key areas for investment and support include sustainable agricultural practices; rural infrastructure, storage capacities and related technologies; research and development on sustainable agricultural technologies; developing strong agricultural cooperatives and value chains; and strengthening urban-rural linkages. We also recognize the need to significantly reduce post-harvest and other food losses and waste throughout the food supply chain. (United Nations Conference on Sustainable Development Rio+20 2012a:24).

Bio-economics has played an increasingly important role in the discourse on public policies and in research. This process seeks to produce food, energy and industrial products by moving beyond oil and using renewable resources. In 2012, the European Commission presented its Bio-economy Strategy with the aim of increasing investment in that area and strengthening the competitiveness of its agricultural production, aquaculture, forest resources and biomass production sectors.

Growth of agricultural production in the 21st century

World agricultural production grew at an average annual rate of 2.4 percent between 2001 and 2010, a period of accelerated growth that began in 1995, after 20 years of gradual decline. This period of low growth was the result of a sharp contraction in agricultural output in the former Soviet bloc countries, as well as in Western Europe and Japan. During those years, the trend of declining growth seen in the preceding decades was consolidated.

In 1965, 56 percent of the total agricultural supply was produced by developed countries, where 33 percent of the world's population lived at the time, while the developing countries, with 76 percent of the world population, produced just 44 percent of total agricultural output.

By 2010 this situation had changed drastically. The developed countries, now with 21 percent of the world population, were producing only 32 percent of the planet's agricultural output while the developing countries, where 76 percent of the global population already lived, were producing 68 percent of world's food. The greater portion of this output was produced by developing countries in Asia (East, Southeast and South Asia), which accounted for 44 percent, while Latin America, Africa and West Asia contributed the remaining 24 percent of the world's agricultural output.

Within the developing regions, the greatest growth in production has occurred in Northeast Asia, driven by China, which has sustained annual growth rates of 4 percent since 1971, while Southeast Asia, West Asia, North Africa and Latin America achieved an annual average growth rate of 3 percent. The region with the lowest growth rate was Sub-Saharan Africa, with 2.4 percent annually.

Over the past few decades, growth has varied widely from one region to another. In the developed countries the greatest growth rate in agriculture occurred during the 1970s, with 1.83 percent, but this fell drastically between 2001 and 2010 to just 0.47 percent.

In the transition economies of the former Soviet bloc countries, output has remained stagnant over the last four decades, except for a drastic fall of -4.03 percent in the 1990s.

Meanwhile, the Latin American countries have experienced a significant annual average growth rate of 2.89 percent over the past 40 years. The region's highest growth rate was achieved in the last decade with 3.21 percent.

As noted previously, the region of Northeast Asia has experienced the most dynamic growth over these past forty years, with an average annual rate of 4.1 percent. The best period was from 1981 to 2000, with a rate of 5.04 percent.

Between 1971 and 2010, Southeast Asia grew at an annual rate of 3.64 percent, the second highest growth rate in the world. The best decade was the first of this century with 4.23 percent annually. Sub-Saharan Africa has lagged farthest behind, with an

average rate of 2.44 percent during the period 1971-2010, after having recovered from a very low rate of just 1.05 percent in the 1970s. West Asia and North Africa, for their part, grew by 3.13 percent between 1970 and 2010, although their growth rates have fallen during the last two decades (Fuglie *et al.* 2012:16-18).

TABLE 2. Annual average growth rates of agriculture, by region (%).

REGION	1971–1980	1981–1990	1991–2000	2001–2010	1971–2010
High-income countries	1.83	0.97	1.25	0.47	1.14
Transition countries	0.81	1.42	-4.03	2.28	0.04
DEVELOPING COUNTRIES					
Latin America & the Caribbean	2.93	2.35	3.09	3.21	2.89
Northeast Asia	3.23	5.04	5.04	3.39	4.19
South Asia	2.19	3.7	2.76	2.8	2.86
Southeast Asia	3.66	3.32	3.41	4.23	3.64
Sub-Saharan Africa	1.05	2.68	3.11	2.97	2.44
West Asia and North Africa	3.31	3.84	2.61	2.75	3.13
World	2.08	2.42	2.09	2.42	2.25

Source: IFPRI 2012:19.

In recent decades there have also been significant changes in the composition of agricultural production. While the share of livestock products in total agricultural output has remained stable (37 percent), the share of grain crops has fallen from 25 to 21 percent; meanwhile, the share of horticultural crops has risen from 16 to 22 percent and oilseeds from 6 to 8 percent. This composition reflects changes in consumer demand and rising incomes, especially in developing countries, where consumers are increasingly demanding products with greater value added, encouraging farmers to improve their productivity and incomes.

The role of total factor productivity

As noted previously, total factor productivity (TFP) measures the ratio of total commodity output (the sum of all crop and livestock products) to the total inputs used in their production, including all land, labor, capital and materials. If total output is growing faster than total inputs, this implies an improvement in TFP. However, TFP does not take into account the environmental effects of agricultural activities, such as climate change, biodiversity loss, nutrient runoff into waterbodies and greenhouse gas emissions.

Analysis of long term TFP shows that that the average growth rate in global agricultural TFP accelerated between 1971 and 2009, rising from less than 1 percent per year in the 1970s to nearly 1.8 percent in the first decade of this century, using the method of adding total production costs, or 2.3 percent using the method of measuring inputs by their opportunity cost at market prices. Improvements in land productivity have remained stable at around 2 percent per year during the past 40 years, while labor productivity has grown at a similar rate.

Between 1961 and 2009, total resources and inputs grew around 60 percent, as fast as growth in total agricultural output, implying that improvement in TFP accounted for only 40 percent of total output growth. However, during the first decade of this century, the contribution of TFP accounted for 75 percent of growth in global agricultural production.

As shown in Table 2, at the global level, TFP annual growth rates averaged 0.65 percent between 1971 and 2009, but nearly doubled between 2001 and 2009. In the developed countries, during the period 1971-2009, TFP grew at an annual rate of 1.36 percent, but slowed to 1.14 percent in the first decade of this century. By contrast, in the former socialist countries growth rates fell to 0.13 percent in the first period and rose to 1.15 percent in the second. Meanwhile, in the developing countries TFP grew at a rate of 0.28 and 1.29 percent respectively. The highest rate of 1.43 was achieved by Southeast Asia in the first decade of this century.

Technological development and improvements in agricultural practices have made it possible to boost food production, even though the area under cultivation

has not increased and the world population has grown. Since the 1960s, agricultural production in developing countries has increased thanks to a number of factors, such as: the development of national capacities in agricultural research and innovation; support from international public research centers and the private sector, which have provided better genetic materials and modern inputs; and the creation of an enabling environment for the rapid adoption of new technologies, including rural institutions that offer financial and educational services, infrastructure that improves access to markets and economic and trade policies that enable the markets to signal resource allocation. These foundations will ensure even greater potential for growth.

TABLE 3. Annual growth rates for land, labor and total factor productivity, by region (%).

	2001–2009			1971–2009		
REGION	LAND	LABOR	TFP	LAND	LABOR	TFP
World	2.37	1.94	1.22	2.06	1.26	0.65
High-income countries	0.97	3.93	1.14	1.44	4.25	1.36
Transition countries	2.41	4.58	1.15	0.14	1.15	-0.13
Developing countries	0.82	0.36	1.29	1.11	0.24	0.28
Latin America & Caribbean	3.38	4.12	1.30	2.62	2.79	0.53
West Asia and North Africa	2.52	2.08	1.33	2.38	2.44	0.42
China and Northeast Asia	3.72	5.26	1.34	3.80	4.05	0.69
South Asia	2.69	1.34	0.85	2.82	1.34	0.20
Southeast Asia	3.76	4.00	1.43	2.74	2.24	0.45
Sub-Saharan Africa	2.34	0.77	0.85	2.27	0.62	0.50

Source: IFPRI 2012:23.

However, increasing productivity is not sufficient to achieve food security. It is also essential to improve livelihoods, especially for poor farmers, which means giving them better access to resources, technologies and food. Regions that have lagged behind in this regard, such as Sub-Saharan Africa, could follow the successful experiences implemented by Brazil and China, which have invested heavily in agricultural research, implemented comprehensive policy and institutional reforms and developed links with international sources of agricultural technology, thereby raising their agricultural productivity, reducing food prices and stimulating economic growth (Fuglie and Nin-Pratt 2012:25-27).

Intensification of sustainable agriculture

In recent years, the intensification of sustainable agriculture has been at the forefront of the discussion on global agriculture. It is now widely accepted that increased production must be achieved by increasing yields while at the same time using fewer resources, and minimizing or reversing negative environmental impacts. This approach, known as sustainable agricultural intensification, aims to make agricultural systems more efficient by adopting new technologies or improving current production systems.

A technical report entitled "Solutions for Sustainable Agriculture and Food Systems" (2013) suggests that sustainable agricultural intensification offers workable options for eradicating poverty and hunger while improving the environmental performance of agriculture, but requires transformative and simultaneous interventions throughout the entire food supply chain, from production to consumption. It also requires unprecedented, large-scale behavior change among consumers as well as producers of food.

Some of the technologies that have proven effective in sustainable agriculture intensification include: no-till systems (minimum or no soil disturbance), integrated soil fertility management, precision agriculture, organic agriculture, water harvesting, drip and sprinkler irrigation, use of heat and drought tolerant varieties, efficiency in nitrogen use and crop protection using chemical treatments (IFPRI 2013:43-45).

Agricultural productivity in recent years

This century, TFP has increased significantly, especially in developing countries. Sub-Saharan Africa has performed better in the 2000s than in the final decade of the last century. During the 2001-2007 period, the annual average growth rate was 2.2 percent; in 2008-2013 TFP grew at a rate of 2.4 percent, while between 1991 and 2000 the rate was just 1.5 percent.

In Latin America and the Caribbean, TFP growth peaked between 2001 and 2007, reaching an average rate of 2.9 percent, and then falling to 2 percent between 2008 and 2013, down to the same levels as the 1991-2000 period. In Asia, TFP grew at an annual rate of 2.5 percent during the first seven years of this century, slightly above the ten preceding years. However, it slowed markedly between 2007 and 2013, when TFP grew by just 1.5 percent. The Middle East and North Africa grew at a rate of 1.7 percent between 1990 and 2000, and 1.8 percent between 2001 and 2007, increasing slightly between 2008 and 2013 to 2.1 percent (IFPRI 2016:123-125).

Family farming

The United Nations designated 2014 as the International Year of Family Farming with the aim of highlighting the potential and challenges of small-scale family farming (FF) in the global, regional and national development agendas. Small-scale family-based agriculture is the main economic activity in many developing countries. It plays a central role in ensuring food security and improving nutrition, and is the main source of income for the world's poorest and most vulnerable families.

Family farming also plays an essential economic and social role, providing a livelihood for 2.5 billion people and producing much of the food consumed in the world's poorest regions, such as Sub-Saharan Africa. There are approximately 570 million farms in the world, with three-quarters located in Asia, and 60 percent of these are found in China and India. Around 90 percent of the world's farms are small-scale family-owned or family-operated enterprises. Moreover, family farms cultivate about 75 percent of the world's farmland and produce 80 percent of its food. The share of land held by these farming families varies across regions, ranging from 85 percent in Asia and 62 percent in Sub-Saharan Africa to 18 percent in South America.

As to their size, 475 million farms (80 percent of the total) operate on less than 2 hectares of land, accounting for only 12 percent of the world's farmland. There are also major variations across regions: in Asia and Africa farms average 1 to 2 hectares, while farms in the Americas average 74 to 118 hectares.

TABLE 4. Average annual growth of agricultural output and total factor productivity (TFP) and levels of land and labor productivity.

REGION	LAND PRODUCTIVITY				LABOR PRODUCTIVITY				OUTPUT GROWTH (%)			TOTAL FACTOR PRODUCTIVITY "TFP" GROWTH (5)		
	1990	2000	2007	2013	1990	2000	2007	2013	1991-2000	2001-2007	2008-2013	1981-2000	2001-2007	2008-2013
Africa South of the Sahara	180	243	334	439	1133	1418	1761	2225	3.5	4.5	4.3	1.5	2.2	2.4
Latin America & Caribbean	260	343	439	505	5759	7918	11205	14033	3.2	4.0	2.5	2.0	2.9	2.0
Asia	653	930	1169	1368	762	974	1247	1505	3.9	3.6	3.0	2.4	2.5	1.5
Middle East & North Africa	1066	1325	1584	1733	2698	3693	4372	5302	2.7	2.7	2.6	1.7	1.8	2.1

Land productivity is agricultural gross production per hectare of agricultural land; labor productivity is agricultural gross production per economically active person. Both types of agricultural gross production are measured in constant 2004-2006 US dollars.

Source: IFPRI 2016: 23-125

The evidence shows that small family farms have greater land productivity than large farms, due to a more intensive use of inputs, lower labor supervision costs and better local knowledge. However, they exhibit lower labor productivity than large farms due to overuse of family labor and underuse of modern agricultural technologies (IFPRI 2014-2015:25-27).

A document recently published by the Global Harvest Initiative (GAP 2016) emphasizes that accelerating agricultural productivity must be at the forefront of a comprehensive strategy to sustainably feed the world. Productivity itself is not simply about producing more food or achieving higher yields. Productivity growth also makes it possible to produce more while maximizing the use and impact of scarce resources, lowers the cost per unit of output, helping producers succeed in today's competitive business cycle, and enables agrifood systems to provide food for consumers at lower prices.

To increase productivity, farmers often use the following methods:

- Expansion of land.
- Irrigation.
- Intensification, through increased use of fertilizers, machinery, labor, seeds, herbicides and other inputs.
- Greater efficiency through adoption of technologies.

For crops, improved TFP results are achieved by adopting innovations such as pest resistant and drought and/or flood tolerant seed varieties, as well as bio-innovations that include precision use of bacteria and fungi to help farmers obtain better yields on the same area of land. Increases in TFP can also be achieved through the use of precision data and information technologies in farm equipment for applications of fertilizer, water and crop protection.

In livestock production, TFP increases are obtained through genetic selection, better quality feed and vaccines, which deliver more nutrition per volume. In forestry, improvements are achieved through genetically improved trees that allow for faster growth.

Providing farmers of all scales and sizes with access to better technological innovations, knowledge and training in better practices will contribute to the growth of TFP and to reducing the deterioration in the quality of soil, water and air (IFPRI 2014-2015:10-11).

02

GENERAL STRATEGIES AND GUIDELINES ESTABLISHED BY INTERNATIONAL ORGANIZATIONS

In June 2012, the United Nations Conference on Sustainable Development, known as Rio + 20, was held in Rio de Janeiro, Brazil. The assessment which served as the basis for that meeting noted that:

- World population was 7 billion, one fifth of which lived on less than USD 1.25 per day.
- One billion people went hungry each day.
- Greenhouse gas emissions continued to rise and one-third of the species was threatened with extinction if climate change was not halted.
- Widespread poverty and destruction of the environment needed to be addressed without delay in order to leave a habitable world for future generations.

To address this situation, the following was proposed:

- Transition toward greener economies, while focusing on poverty eradication.
- Protection of oceans from overfishing, from destruction of marine eco-systems and adverse effects of climate change.

— Expansion of the use of renewable energy resources.
— Achievement of better forest management.
— Improvement in the conservation and management of water resources (UN Conference on Sustainable Development Rio + 20 2012a).

The final document of the Conference, entitled *The Future We Want*, stated:

1. *We, the Heads of State and Government and high- level representatives, having met in Rio de Janeiro (Brazil) between June 20 and 22, 2012, with the full participation of civil society, renew our commitment in favor of sustainable development and the promotion of an economically, socially and environmentally sustainable future for our planet and for present and future generations.*
2. *Poverty eradication is the greatest problem facing the world today and an indispensable condition for sustainable development. In this regard, we are committed to urgently releasing humanity from poverty and hunger.*
3. *We therefore recognize that there is a need to further incorporate sustainable development at all levels, by integrating its economic, social and environmental aspects and recognizing the links between them, in order to achieve sustainable development in all its dimensions.*
4. *We recognize that poverty eradication, the modification of unsustainable practices and the promotion of sustainable forms of production and consumption, as well as the protection and management of the natural resource base of economic and social development are general objectives and indispensable requirements of sustainable development. We also reaffirm the need to achieve sustainable development by promoting sustained, inclusive and equitable growth, creating greater opportunities for all, reducing inequalities, improving basic living standards, promoting equitable social development and inclusion, and promoting integrated and sustainable development of natural resources and ecosystems that support, inter alia, economic, social and human development, while at the same time facilitating the conservation, regeneration, restoration and resilience of ecosystems to new and emerging problems.*

21. *We are deeply concerned that one out of every five people on this planet, that is, more than 1 billion people, continues to live in extreme poverty, and that one in seven or 14 per cent is malnourished, while certain public health problems, such as pandemics and epidemics, remain an ubiquitous threat. In this context, we take note of the ongoing discussions on human security in the General Assembly. We recognize that, by 2050, a world population of more than 9 billion people is projected and it is estimated that two-thirds of that population will live in cities; we must intensify efforts aimed at achieving sustainable development, and in particular, the eradication of poverty, hunger and preventable diseases.*
22. *We recognize that there are examples of progress in sustainable development at the regional, national, sub-national and local levels. We note that efforts to achieve sustainable development have been reflected in regional, national and subnational policies and plans and that Governments have increased their commitment to sustainable development since the adoption of Agenda 21 through legislation and institutions, and the development and implementation.*
32. *We recognize that each country is faced with particular difficulties in achieving sustainable development and we highlight the particular difficulties faced by the most vulnerable countries, particularly the African countries, least developed countries, landlocked developing countries and Small Island Developing States (SIDS), as well as the specific challenges faced by middle-income countries. Countries in conflict also need special attention.*

The conclusions of the Rio + 20 Conference underscored the importance of the green economy:

56. *... we believe that the green economy, in the context of sustainable development and poverty eradication, is one of the most important instruments available for achieving sustainable development and that it could provide policy-making alternatives, but should not consist of a set of rigid norms. We emphasize that the green economy should contribute to poverty eradication and sustainable economic growth by enhancing social inclusion, improving human well-being and creating employment opportunities and decent work for all, while maintaining healthy ecosystems on Earth.*

Policies to promote the green economy should foster sustained and inclusive economic development, promote innovation, provide opportunities, benefits and

empowerment for all, strengthen international cooperation, help bridge the gap between developed and developing countries, reduce technological dependence, improve the well-being of indigenous peoples, local and traditional communities, ethnic minorities, women, children and young people, persons with disabilities, small farmers and subsistence farmers. They should also promote productive activities in developing countries that contribute to the eradication of poverty and promote sustainable patterns of consumption and production.

And in relation to agricultural productivity, included in the section on food security and nutrition and sustainable agriculture, the Conference noted:

110. *In noting the diversity of agricultural conditions and systems, we have decided to increase sustainable agricultural production and productivity globally, in particular by improving the functioning of markets and marketing systems and strengthening international cooperation, particularly in favor of developing countries, by increasing public and private investment in sustainable agriculture, land management and rural development. The main areas requiring investment and support services are sustainable agricultural practices; rural infrastructure, storage capacity and related technologies; research and development on sustainable agricultural technologies; the promotion of cooperatives and strong agricultural value chains; and the strengthening of links between urban and rural environments. We also recognize the need to significantly reduce post-harvest losses and other food losses and wastage throughout the food supply chain.*
111. *We reaffirm the need to promote, increase and support more sustainable agriculture, including crops, livestock, forestry, fisheries and aquaculture, to improve food security, eradicate hunger and be economically viable and at the same time conserve land, water, plant and animal genetic resources, biodiversity and ecosystems, and increase resilience to climate change and natural disasters. We also recognize the need to maintain the natural ecological processes that underpin food production systems.*
112. *We emphasize the need to improve sustainable livestock production systems, including improved irrigation and pastureland schemes that are consistent with national policies, laws and regulations, improved sustainable resource management systems and measures to eradicate animal diseases and prevent their spread, recognizing that there is a close relationship between farmers' livelihoods, including shepherds', and livestock health.*
114. *We resolve to take measures to improve agricultural research, extension services, training and education in order to increase agricultural productivity and the sustainability of agriculture through the voluntary exchange of knowledge and good practices. We also resolve to improve access to technical expertise and specialized skills, through new information and communication technologies that offer farmers, fishermen and foresters the option of choosing between various methods of achieving sustainable agricultural production. We call for the strengthening of international cooperation in agricultural research for development (UN Conference on Sustainable Development Rio + 20 2012a).*

On 25 September 2015, the United Nations Summit on Sustainable Development in New York adopted the Sustainable Development Agenda, whose final document was *Transforming Our World: The 2030 Agenda for Sustainable Development*. This document, signed by 193 Member States of the United Nations, includes the 17 Sustainable Development Objectives. Its aim is to end poverty, fight against inequality and injustice and tackle climate change without anyone falling behind, by 2030.

On that agenda, world leaders stated that poverty eradication was the greatest challenge for the world and a prerequisite for sustainable development. The agenda established 17 objectives and 169 goals to reaffirm and move beyond the Millennium Development Goals. The agenda seeks to make human rights a reality for all people and to achieve gender equality and the empowerment of all women and girls.

Prior development priorities such as education, poverty eradication, health, education, food security and nutrition were kept, but economic, social and environmental objectives were added. The new goals and targets would come into effect on 1 January 2016 and would guide country decisions through 2030.

The declaration affirms that sustainable, inclusive and continued economic growth is essential to achieve prosperity, and that "we will adopt policies that increase production capacity, productivity and productive employment".

Objective 2. Ending hunger, achieving food security and improving nutrition, and promoting sustainable agriculture explicitly points to the importance of agricultural productivity:

2.3 To double by 2030, the agricultural productivity and income of small-scale farmers, particularly women, indigenous peoples, family farmers, cattle farmers and fishermen, through, inter alia, safe and equitable access to land, other resources and inputs, and knowledge, financial services, markets and opportunities for adding value and obtaining non-agricultural employment.

2.4 To ensure by 2030, the sustainability of food production systems and implement resilient agricultural practices that increase productivity and production, contribute to the maintenance of ecosystems, strengthen the capacity to adapt to climate change, extreme weather events, droughts, floods and other disasters, and progressively improve land and soil quality.

2.5 To preserve by 2020 the genetic diversity of seeds, crops and domesticated and farm animals, as well as their corresponding wild species, through good management and diversification of seed and plant banks at the national, regional and international level, and promote access to the benefits arising from the use of genetic resources and related traditional knowledge and their fair and equitable distribution, as agreed internationally.

2.a To increase, including through increased international cooperation, investments in rural infrastructure, agricultural research and extension services, technological development and gene banks of plants and livestock in order to improve agricultural production capacity in developing countries, particularly in the least developed countries. (United Nations Assembly 2015: 17-18).

In addition, in Objective 8: To promote sustained, inclusive and sustainable economic growth, full and productive employment and lawful work for all, the proposal was to:

8.2 Achieve higher levels of economic productivity through diversification, technological modernization and innovation, inter alia, by focusing on high added value and labor intensive sectors.

The World Bank has stressed that one billion people in the world are still living in extreme poverty. Agricultural growth remains central to reducing poverty, especially in the poorest countries, where a large proportion of the population depends on agriculture for subsistence. At the same time, global demand for some of the largest agricultural commodity groups is increasing due to population and income growth, changes in diet and demand for biofuels.

For this reason, constant increase in agricultural production through greater productivity is required. Increased productivity requires focusing attention on the availability of improved grain production techniques, water supply and agrochemicals, farmers' access to markets, a legal environment and an environmental policy. The bank recognized that without the increase in agricultural production and productivity, it would not be possible to achieve the Millennium Development Goals in overcoming poverty and malnutrition. However, any increase in production would have to be made in an environment in which natural resources are scarce and the promotion of efficiency is critical (World Bank 2011).

In evaluating the activities carried out by the World Bank Group between 1998 and 2008 in 108 countries to promote the development of world agriculture and increased agricultural productivity, the projects financed by the World Bank were focused on irrigation and drainage, research and extension, access to credit, access to land and formalization of property rights, roads and marketing infrastructure, as well as markets and agribusiness.

The international body noted that the food crisis of 2007-2008 put the growth of agriculture and food production at the top of the global development agenda. Agricultural productivity growth had been low in recent years due to land and water restrictions, low investment in rural infrastructure and agricultural innovation, lack of access to inputs and adverse weather effects. Support for agriculture had declined

gradually since the 1990s and by the middle of the following decade, partly due to the success of the green revolution and the false impression that food shortages were a thing of the past.

Grain production can be increased by the expansion of cultivated areas and more intensive exploitation of arable land, as lands with potential expansion are mostly available in parts of sub-Saharan Africa and Latin America.

FAO projections indicated that 80 per cent of the increase in food production in developing countries would be derived from crop intensity, and only 20 per cent from the expansion of arable land. The growth in agricultural productivity would have to be achieved through temporary land use, in areas that were set aside during the Green Revolution. This presents a major challenge, as these regions have higher risk environments for production and often weak market infrastructure services. One of the areas of greatest potential is sub-Saharan Africa, where only 18 % of potentially irrigable land is under irrigation systems. The international body also stated that high energy prices could restrict agricultural productivity through its impact on the price of fertilizers. Consumption of these is very unequal, since in the developed countries it is seven times greater than in the lesser developed countries.

The World Bank study notes that one of the critical factors for increased productivity will be systems to ensure food security and efficiency in transport as the global food trade grows and markets become more integrated (World Bank 2011: 2-4).

The private sector needs to be more involved in promoting agricultural development. The growing demand for animal protein and biofuels offers increased opportunities for the private sector to invest in grain crops, livestock feed, sugar cane and non-food grains. In developing countries, governments are reviewing their policy and legislation framework to boost the inclusión of foreign capital in the agricultural sector.

Cross-country analyses indicate that GDP growth in the agricultural sector is at least twice as effective in reducing poverty as GDP growth in other sectors, as shown in the following table:

TABLE 5. Effect of a 1 % increase in agricultural output on poverty reduction.

(1) Region
(2) Percentage of population in poverty
(3) Persons in poverty (millions)
(4) Reduction in number of poor in relation to a 1 % increase in returns (%)

(1)	(2)	(3)	(4)
East Asia	15	278	0.48
South Asia	40	522	0.48
Sub Saharan Africa	46	291	0.72
Latin America	16	78	0.1
Mid East and North Africa	7	21	–
Western Europe and Central Asia	5	24	–

Source: World Bank 2011:4.

In a previous study, the World Bank had warned of the need to reverse climate change and stressed the relationship between this and the decline in agricultural productivity:

> *As the planet warms, rainfall patterns change and episodes of extreme events such as droughts, floods and forest fires are multiplying. Millions of people in densely populated coastal areas and island countries will lose their homes as sea levels rise. The poor in Africa, Asia and elsewhere are facing the prospect of loss of crops with tragic consequences, declining agricultural productivity, and increased hunger, malnutrition and disease.*
>
> *Developing countries will bear the brunt of the effects of climate change, while striving to overcome poverty and promote economic growth. For these countries, climate change represents the threat of multiplying their vulnerabilities, eroding the progress achieved with so much effort and seriously undermining development prospects. It will be even more difficult to achieve the Millennium Development Goals, and to ensure a secure and sustainable future beyond 2015* (World Bank 2010:5).

The World Bank (World Bank 2015) has focused on promoting increased agricultural productivity and resilience, especially for small farmers. As noted, the challenge of agriculture is to produce 50 per cent more food by 2050 and provide a better quality of life for 75 per cent of the world's poor living in rural areas. Agriculture must be able to use land and water resources more efficiently, protect the environment and seek to bridge the gaps between the most developed and lagging regions, as well as providing equal opportunities for women.

The World Bank has continued its work of assisting developing countries in making progress in poverty reduction, for which better performance of agriculture has proven to be particularly effective. Given the volatility of agricultural prices, the Bank focused more on providing long-term solutions, through improved resilience of agricultural systems and increased support for climate-friendly agriculture, long-term risk management and a better nutritional supply. The priority thematic areas that the Bank would support with funding during that triennium were to:

i. Increase agricultural productivity and resilience through support for improved land and water management in irrigated and rainfed areas, including improved technologies through the Consultative Group on International Agricultural Research (CGIAR), and greater support through critical inputs such as fertilizers and agricultural equipment.
ii. Link farmers to markets and strengthen value chains to improve market access and trade by supporting better infrastructure, technological information, post-harvest management and access to funding.
iii. Facilitate non-agricultural income through greater investment in skills development.
iv. Reduce gender-related hazards, vulnerability and inequality through risk management mechanisms, increased transparency in food markets and improved access to services, resources and opportunities for women.
v. Strengthen environmental services and sustainability, including support for improved livestock, forest and ocean management systems, as well as carbon sequestration (World Bank 2013:17).

In addition, the World Bank has placed greater emphasis on climate-smart agriculture under the theme of enhancing agricultural productivity, increasing lending and investments that support climate change adaptation and mitigation. This includes improved management of land and water, development and adoption of more drought tolerant and flood tolerant plant varieties, as well as support for animal and forest management systems that reduce greenhouse gas emissions. Likewise, it has supported increased private sector investment and increased attention to food supply, including projects that focused explicitly on nutrition, as well as support for improving food management.

The importance of climate-smart agriculture, which leads to improved productivity, resilience and reduction of greenhouse gas emissions, was recognized at the United Nations Conference on Climate Change held in Cancun in 2010, in Duran in 2011, and at the UN Conference on Sustainable Development Rio + 20 in 2012. In countries of the Organization for Economic Co-operation and Development (OECD), a trend towards greener agricultural support is developing, with more positive environmental externalities and reduced emissions. Reducing global warming cannot be achieved without reducing greenhouse gas emissions from agriculture, as well as reducing deforestation. The increase of carbon in the soil can improve its productivity and the resilience of agricultural systems. This increase in productivity can be complemented by reductions in climate change and GHG emissions.

The World Bank has pointed out that climate change will make it difficult to grow enough food for an increasing world population in light of changing weather, as well as availability and quality of water resources. To avoid further damage to already stressed ecosystems, growth in agricultural productivity should be almost doubled, while minimizing the negative environmental impacts associated with it. This requires improved land and water management, with a comprehensive approach, production and trade practices, climate resistant crop varieties, forest management, climate information, and risk management systems. The gender gap in productivity and income persists, as do gender differences in access to resources and credit, as well as in the treatment of markets and institutions, all of which reduce opportunities for women (World Bank 2013:2-8).

Innovation, improvement in efficiency and a comprehensive approach can help improve agricultural productivity through sustainable intensification while avoiding damage to ecosystems. Similarly, the experience gained between 1998 and 2008 shows that improved management of water, soil and crops in rainy areas increases agricultural productivity, while promoting equal opportunities for women. In addition, the rise and volatility in food prices in 2008 had a strong impact on raising levels of malnutrition and reducing poverty. In fact, this increase is estimated to have caused 105 million people to fall into poverty in low-income countries in 2008, and negatively affect an estimated 40-44 million people in 2011 and 2012.

Lessons from climate smart agriculture demonstrate that public support that focuses on research, investment in soil and water conservation, climate services and land tenure is more effective and benefits more farmers in the long run than do inputs. They also teach that water management is a critical factor in countries with water stress; measures to increase agricultural water productivity are most beneficial if combined with measures for broader economic diversification. For programs to be successful, a long-term commitment is needed, as well as increased private investments.

Climate smart agriculture increases agricultural productivity in an environmentally and socially sustainable way, strengthens farmers' resilience to climate change, lowers the contribution of agriculture to climate change by reducing greenhouse gases, and increases carbon retention in agricultural land. It is estimated that for each degree Celsius of global warming, the crop fields will decrease by 5 %. Since 1980, world wheat and maize production has been between 3 and 5 % lower because of the changes that have made the climate warmer. The increasing frequency and intensity of drought and floods have greatly affected agriculture. Agriculture has the biophysical potential to reduce about 20 % of annual CO_2 emissions.

Increased agricultural productivity can reduce pressure for land use change and reduce deforestation caused by agricultural expansion for food, fiber and fuel.

Strengthening farmers' resilience can promote adaptation to the increasing frequency and intensity of droughts and floods, as well as changes in long-term temperature, improve soil and water management, climate forecasting, early warning systems and risk insurance. The development of new technologies such as drought and flood resistant crops can improve climate resilience.

Reducing greenhouse gases from agriculture to mitigate climate change, beyond reductions in CO_2 emissions, requires reducing methane and nitric oxide emissions. Reducing methane emissions, calls for improved livestock nutrition and forage management, reduced frequency and intensity of biomass burning, dry land for rice cultivation when not in planting season, and better management of waste in intensive livestock systems. In order to reduce nitric oxide emissions, appropriate use of nitrogen fertilizers and better use of legume trees is required to reduce dependence on nitrogen fertilizers.

Increased carbon storage in agricultural soils also helps to mitigate climate change. Carbon storage activities can also improve productivity and resilience and allow for higher productivity, more resilience, and greater carbon capture in the soil. This includes techniques such as intercropping, integrated livestock and crop management, conservation agriculture and agroforestry activities. Carbon storage is higher in more degraded lands (World Bank 2013:26).

The Bank has promoted a series of activities to increase agricultural productivity, such as support for the adoption of new technologies, better seed varieties, feed for livestock, improved water management, land tenure security, increasing access to inputs, strengthening agricultural innovation systems, services to reduce gender inequality, linking farmers to markets, strengthening value chains, facilitating non-rural income for farmers, reducing gender risk, vulnerability and inequity and strengthening environmental services and sustainability (World Bank 2013:11-12,17).

This international organization has noted that increased crop production and resilience to climate change are the most important actions required for global and sustainable food security. After several years of decline in the growth rate of the largest grain crops, a low growth rate of between 1 % and 1.8 % began from 2006. This growth has been achieved despite the fact that the agricultural frontier has had little growth and water restrictions; as a result, it is critical to improve productivity in the use of water.

The future for increased land productivity will be based on the generation and adoption of new climate-smart technologies and practices for better integrated management of land, water and fertilizers. There is also a need to improve water management in irrigated and temporary lands, as well as governance of land tenure and land markets and innovation systems, agricultural research, extension, education, training, including promoting more nutritious food and crop diversification (World Bank 2013:28-33).

The OECD, for its part, has noted the close relationship that exists in recent years between prices of energy, food and raw materials. It stressed that the main challenge facing global agriculture is how to increase sustainable agricultural productivity to meet the growing demand for food, feed, energy and fiber. In its estimates for the period 2012-2021, the international body was of the view that world production of these would have a slow growth rate, i.e., an annual rate of 1.7 %, although oil prices would remain more or less at the levels of the previous decade in real terms, relatively high, which would impact the increase in agricultural products. This makes it possible to predict a shortage in some productive resources, greater pressure on natural resources and high costs of some inputs.

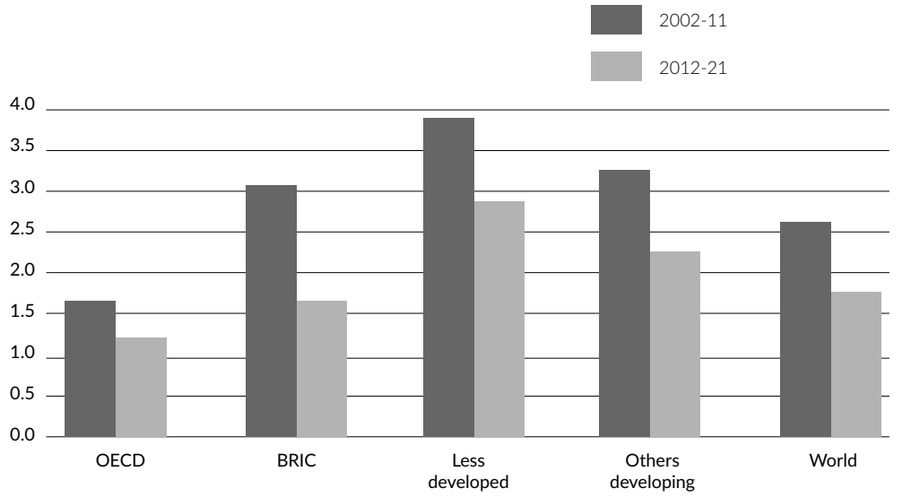

FIGURE 4. Average Annual Growth of Net Agricultural Production.

Source: OCDE and FAO 2012:2.

Within this scenario, estimated agricultural growth would be higher in developing countries, with an annual average rate of 1.9 %, while in developed countries it would be 1.2 %. World population growth, urbanization and rising wages will increase demand for processed and animal products as well as feed for livestock by the end of that period. Developing countries would also have the greatest growth in their agricultural exports, which account for the bulk of exports in products such as rice, oilseeds, vegetable oil, processed meat, sugar, beef, poultry meat and fish (OECD-FAO 2012:1-2).

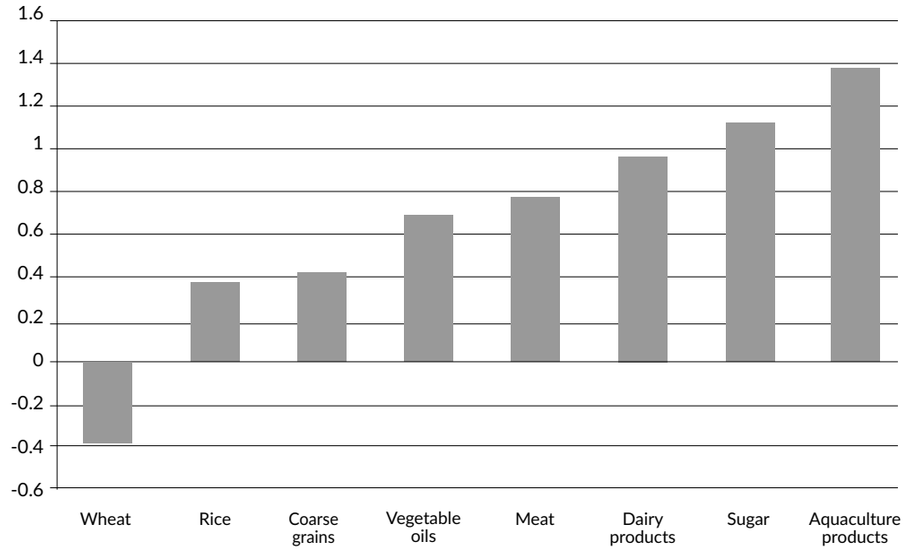

FIGURE 5. Projected average annual growth of world food consumption per capita for the period 2012-2102.

Source: OCDE and FAO 2012:2.

Medium-term estimates of world agriculture predict that world agricultural production will have to grow by 60 % by 2050, which means producing an additional 1 billion tonnes of grain and 200 million metric tonnes of meat per year by that year, in addition to increased generation of biofuels. In contrast, the total area under cultivation in the world can only grow by less than 5 % during that period. Therefore, meeting

this increased demand for food and biofuels can only be achieved with increased productivity, which will be key to ensuring food access to a larger population and food security. The required productivity can only be achieved if the existing gap between developed and developing countries is reduced.

This growth in productivity needs to be sustainable. Currently, a quarter of agricultural land is heavily degraded and agricultural water is showing increasing scarcity in many countries. A negative impact from increasing climate change is also expected.

Therefore, better agricultural practices should be fostered, an adequate commercial, technical and regulatory environment created, agricultural innovation systems strengthened, and the specific needs of small farmers addressed (OECD-FAO 2012:3-4).

The OECD noted in its subsequent report on the outlook for world agriculture that the world economy had not yet recovered after the 2008 crisis and that econo-mic growth had been uneven and modest. China, India and other emerging countries had slowed their growth and energy prices remained high, affecting global economic recovery.

OECD projections for 2023 indicated that growing crop diversity would continue and 150 million more tonnes of grain would be produced than during the period 2011 to 2013, where the forage sector would increase further with an additional 160 million tonnes. Ethanol consumption would grow more slowly than in the previous decade. It was also estimated that the demand for wheat would increase by 12 %, that of rice by 155 % and that of oilseeds 26 %. As in previous years, it was expected that, with population growth and change in dietary preferences, demand for meat and dairy products would increase. Global meat consumption would grow to an annual rate of 1.6 % during that decade. Poultry meat would be highest in demand, followed by pork.

Developing countries will continue to be the fastest growing in agricultural production, with an increase in their protein consumption. By 2023, developing countries would produce 75 per cent of the additional agricultural output that would be needed, 60 per cent of additional grain production and 65 per cent of that of oilseeds (OECD-FAO 2014:24-37).

The growth in wheat, coarse grain and rice production, as well as that of other crops, will have to be achieved with the increase in yields, despite the increase in production costs due to the rise in the prices of energy inputs, fodder and labor. In addition, land degradation, water scarcity and increasing environmental pressures must also be overcome. To raise productivity, as China's example shows, it is necessary to encourage innovation, improve the efficient use of water, greater integration into domestic and international agrifood markets and improve land market.

It is expected that by 2023 the production of oilseeds, sugarcane and cotton will occur through a combination of increased yields and expansion of cultivated areas, as these products are obtained in regions such as Latin America, India and sub-Saharan Africa where it is still possible to increase the harvest area. With respect to milk production, yields in developed countries are expected to increase and herds in developing countries will increase (OECD-FAO 2014:38-43).

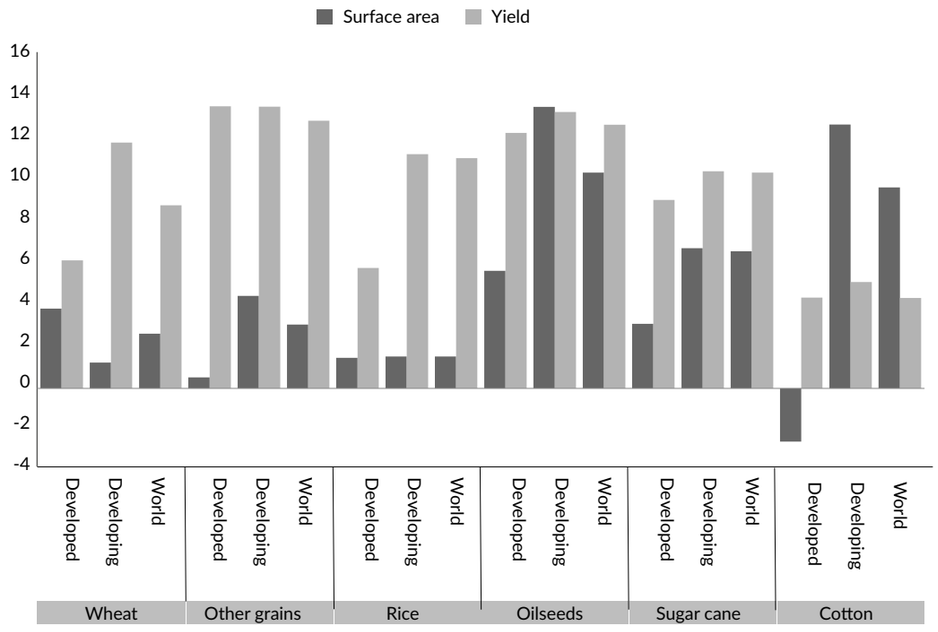

FIGURE 6. Expansion of cultivated area and yield (percentage change for 2023 compared to 2011-2013 period).

Source: OECD and FAO 2014b:43.

03

AGRICULTURAL PRODUCTIVITY IN THE AMERICAS: CHALLENGES AND OPPORTUNITIES

In the context described previously, which poses an enormous challenge for humanity and for global agriculture in the coming decades, the LAC region has a great opportunity to contribute to global food security, if it can consolidate a more productive and sustainable agricultural system, which also helps to alleviate poverty and improve living standards for its inhabitants.

The LAC region contains one third of the world's fresh water resources, the largest per capita volume of any developing region. It also has more than a quarter of the world's medium to high potential farmland and, after Sub-Saharan Africa, is the second region with greatest potential for rainfed agriculture. In addition, LAC is the world's largest food exporting region. Its farmers, with their extensive experience and productive capacity, are one of its main assets, along with its great biodiversity, particularly in tropical areas. Another important aspect is the region's political, economic and civil stability, together with its productive infrastructure, financial and monetary and research centers which stand out among the developing regions.

The Inter-American Development Bank (IDB) considers that the next two decades will offer LAC a critical window of opportunity to advance toward new forms of productive and environmentally sustainable agriculture, by taking full advantage of the potential existing in its public and private sectors (IDB 2014:1,7-8).

With regard to export capacity, LAC contributes just over 15 percent of the total value of global agricultural exports, particularly products such as centrifuged sugar, plantain, papaya, avocado, soybean meal, soybean oil, green coffee, asparagus, banana, orange juice concentrate and tropical pineapple. Table 6 below shows the share of these and other products in the value of global agricultural exports for the period 2010-2013.

TABLE 6. Latin America and the Caribbean: share of the value of world agricultural exports 2010-2013 (main products).

PRODUCTS	SHARE (5)	PRODUCTS	SHARE (%)
Sugar, centrifuged	69.9	Chicken meat	34.6
Plantain	66.5	Other melons (incl. cantaloupe)	34.2
Papaya	63.2	Beef and calf meat preparations	33.4
Avocado	61.8	Orange juice	32.3
Soybean meal	60.9	Deboned bovine meat	31.1
Soybean oil	60.6	Raw tobacco	30.6
Green coffee	57.5	Maize	30.3
Asparagus	56.4	Grapes	30.2
Banana	56.1	Sorghum	28.8
Orange juice concentrate	53.2	Grape juice	28.4
Tropical pineapple	53.2	Refined sugar	27.8
Soybean	50.6	Watermelon	27.6
Mango, mangosteen and guavas	39.2	Lemons and limes	27.2
Plumbs, dried (prunes)	37.6	Natural honey	26.4
		OVERALL TOTAL	15.2

Source: FAO 2017.

Agricultural productivity has increased significantly in the region. According to the IDB, if total factor productivity is maintained in LAC - in recent years it achieved an average annual growth rate of 2.67 percent – it will be able to meet regional demand for food in 2030 and increase its share of global food exports.

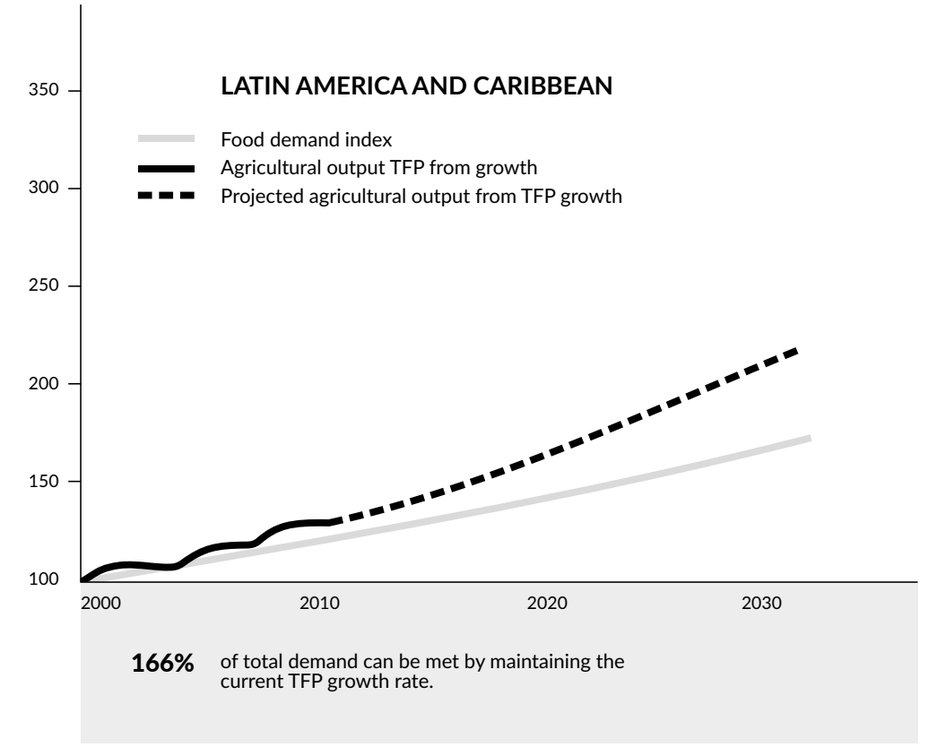

FIGURE 7. Projected TFP growth in Latin America toward 2030.

Source: Truitt and Zeigler 2014:9.

Some countries –such as Argentina, Brazil, Chile, Mexico and Peru– have achieved significant TFP growth rates and have greater potential for growth than other regions, such as East Asia and Africa, which were only able to satisfy 79 and 25 percent of their food needs, respectively, during that period.

In spite of the region's enormous potential, there are major disparities between different Latin American and Caribbean countries. Agricultural production is highly concentrated in LAC, with Brazil, Argentina and Mexico accounting for 72 percent of the region's entire agricultural production. However, within the LAC countries the poorest sectors still face severe food insecurity and, even though the region has benefited from rising commodity prices in recent years, the most vulnerable sectors and the urban poor have seen their situation deteriorate. Similarly, net food importing countries, such as Mexico, Central America and the Caribbean, have also suffered negative impacts because of their dependence on food imports. In spite of a 37 percent increase in agricultural production from 1999 to 2009, rural poverty in the region has remained at 53 percent, with around 53 million people estimated to be undernourished (IDB 2014:8-11).

One of the greatest challenges facing Latin American and Caribbean agriculture is ensuring its sustainability. It is estimated that the region has already lost 40 percent of its original forests. Consequently, it is vital to preserve its natural resources. Public policies and investments for increasing agricultural productivity should therefore promote better management of inputs and protection of crops and irrigation water. Livestock production should include improved livestock practices that reduce greenhouse gas emissions.

Climate change is having increasingly severe impacts on Latin American and Caribbean agriculture. The Central American and Caribbean countries are considered to be the most vulnerable areas in the world with respect to hurricanes. The rise in surface water temperatures in the oceans (due to El Niño and La Niña) has increased the intensity of storms and floods. Four out of the ten strongest hurricanes to hit the region have occurred in the last ten years.

Another area severely impacted by climate change is the Central Andean sub-region, where temperature increases exceeded global rises by 70 percent, affecting eco-systems, particularly in mountain areas. In recent years, the valleys of northern Argentina and Chile have suffered extreme climate events more frequently as a consequence of higher temperatures and retreating glaciers. The Caribbean has already witnessed a two-fold increase in the number of powerful hurricanes per decade over the last 50 years.

Given that climate change seriously affects agricultural activities and increases the risk of contamination of water bodies, it is imperative to promote climate smart agriculture (IDB 2014:11-14).

Improving the region's productive potential requires appropriate public policies, increased public and private investment to strengthen value chains and better access to technology and training. In recent years, the agro-export sectors have increased investment in order to produce food with greater value added and supermarkets have a stronger presence in retail food sales.

Although there are many success stories in the region's agricultural sectors - for example, Brazilian soybean and cattle and numerous others - many of the region's small and medium-scale producers are not yet ready to produce with the scale, quality and safety demanded by international markets. Lack of access to credit, financial services, inputs, agricultural health services, infrastructure and marketing networks, strongly limits their development.

The IDB has noted that in order to accelerate growth in agriculture it is necessary to invest more in public goods, such as rural infrastructure, research and development and extension services and implement policies to promote private investment to boost productivity. However, instead of investing in public goods, a large portion of government expenditure in the LAC countries continues to be spent on subsidies. A study of ten Latin American countries found that, on average, 54 percent of total government expenditures in this sector were spent on direct subsidies and credit subsidies to producers, which meant subsidizing private goods, while 45 percent was spent on public goods such as technology generation and transfers, soil conservation, animal and plant health, communications and information services, rural roads and social services (López, IDB 2014:17).

The IDB has also emphasized the importance of providing more support to small and medium-scale farmers, who constitute the majority of the region's producers. Smallholders account for 80 percent of farms in LAC, occupy 35 percent of farmland and employ 64 percent of the sector's workforce. It is essential to help these producers diversify their products, which not only consist of basic foodstuffs,

but often include products with greater value added and are also involved in contract agriculture.

Similarly, it is essential to improve the security of land ownership rights, a factor that has been shown to boost farmers' investment in agriculture. For this reason, simpler, cost-effective systems of land management must be established. At the same time, it is necessary to improve food safety and quality through good agricultural practices, product traceability systems, compliance with quality standards and better post-harvest handling, storage and distribution.

It is also important to encourage greater commitment to scientific and agricultural research and development (R&D) in order to improve the long term productivity of agriculture. While it is true that LAC countries have increased public investment in agricultural R&D, this investment is very limited compared with the developed countries and is concentrated in just a few countries.

Brazil, Argentina and Mexico accounted for 86 percent of the region's R&D spending growth from 2000-2008. Brazil invests 1.5 percent of its agricultural GDP in agricultural research, about 40 percent above the average amount invested by the rest of the LAC countries. The private sector has also increased its R&D investments in recent years. Nevertheless, the region invests only USD 1.10 in research for every USD 100 in goods produced by the agricultural sector, while investment levels in the more developed countries are three times higher.

Private investment is a vital factor for the development of agricultural research. Unfortunately, the system for establishing intellectual property (IP) protection for the companies that develop these technologies is very slow or almost non-existent in the LAC region, which means that these technologies are not made available. It is estimated that obtaining IP protection for a single crop costs, on average, USD 250 million. Moreover, the regulatory systems are slow, costly and often have a political bias that makes them inappropriate. Therefore, developing effective systems of intellectual property protection is essential to encourage private investment in R&D. The IDB document issues the following recommendation in this regard:

Governments should increase their investments of public monies in agricultural research and development to a minimum of 1 percent, and ideally 2-3 percent, of agricultural GDP, while focusing on benefitting all farmers of all sizes and scales, especially with regard to innovations that address the unique needs of small and medium-scale farmers.

To encourage increased spending on R&D by the private sector, policy makers should work to strengthen intellectual property (IP) protection. The goals should be to provide an enabling environment for innovation by establishing predictable national and regional regulatory systems that include IP protection and that safeguard data generated in the regulatory process (IDB 2014:22-26).

The use of new technologies has had a major positive impact on improving agricultural output. However, it is essential that producers learn to use these innovations. This requires training in the use of improved seeds, precision application of fertilizer and pesticides, intercropping to add nitrogen to soil naturally and genetic improvement techniques, among others. In addition to vital technical knowledge, producers should also acquire business and marketing skills to successfully participate in agricultural value chains.

In Latin America and the Caribbean, the traditional agricultural extension services based on technology transfer have shown limited results. Small and medium-scale producers have tended to lag behind in their adoption of new technologies, because they seldom have access to resources to pay for extension and training services that would improve their productivity. While some countries have made progress in delivering training services, with the support of non-governmental organizations (NGOs) and producers' organizations, much still remains to be done. Stronger links are required between producers and agricultural innovation systems to ensure better interaction and feedback between farmers and researchers, teaching staff, extension workers and trainers.

Farmers must also have access to information and communications technologies to be able to make appropriate and timely decisions about when to plant and harvest, and to be kept informed of market prices and the weather, etc. With modern

technological advances, this can be done through mobile phones with appropriate connectivity. Basic services and infrastructure are also needed to provide producers with access to useful, safe and reliable applications and platforms. In this regard the IDB recommends:

> *Governments and the private sector must work together to reinvigorate agricultural extension services and ensure that policies, incentives and innovation systems increase the level and scale of technical assistance to farmers. Stronger and more effective extension services should form part of integrated packages of support that combine flexible financing, risk management and new technologies and mechanization to achieve productive, sustainable and financially successful farming operations. NGOs and multilateral organizations can and should play a critical role in helping to replicate effective extension models across the region. In order to expand opportunities to deliver extension services to farmers, policy makers should prioritize the further expansion of mobile broadband networks into agricultural areas. At the same time, governments and the private sector should pursue policies and investments that encourage more open source access to information and data in order to facilitate farmers' access to accurate and timely information on market prices* (IDB 2014:28-33).

One of the main constraints to increasing productivity in LAC is the deficient transportation and logistics infrastructure. In this regard, the LAC countries occupy some of the lowest places in the world ranking. Lack of roads and port infrastructure increase the transportation costs of products, making them less competitive. In this context, the IDB has recommended:

> *In order for Latin America and the Caribbean to realize its agricultural productivity and export trade potential, the governments of the region must increase investment in infrastructure to at least 4 percent of GDP. This commitment to modernizing rural roads, ports and railways—as well as customs processes, irrigation, energy and commercialization infrastructure— will reduce transportation costs and increase the competitiveness of domestic agricultural producers and firms (IDB 2014:34-35).*

Another essential element for increasing agricultural productivity is irrigation and the management of water resources, and farm mechanization. Only 15 percent of the arable land in LAC benefits from irrigation systems. One of the region's strengths is that it has an abundance of water resources; however, efforts must be made not only to increase its irrigation infrastructure, but also to manage its water resources sustainably.

It is also essential to promote the mechanization of Latin America and Caribbean agriculture, eliminating barriers that hinder this process and trying to modernize the machinery used, given that nearly half of all tractors and combine harvesters are more than 20 years old. In this regard, the IDB recommends:

> *Public policy makers and agricultural enterprises must work to advance research and continual adaptation that will increase efficiency in irrigation and water management, and promote the widespread adoption of techniques that will lead to a more sustainable use of water for agricultural purposes.*
>
> *Public and private sector entities should seek to establish innovative partnerships that promote research, development and the adoption of appropriate mechanized agriculture, particularly on small and medium-sized farms. Of critical importance is the incorporation of a gender perspective to ensure women's access and avoid displacement, and to include approaches linked to servicing networks and expanded access to credit for the purchase and use of farm machinery* (IDB 2014:36-39).

One factor that has hindered the development of the region's agriculture has been the imposition of tariff and health barriers to protect local production and commercial activities. These barriers have gradually been eliminated, paving the way for ever-increasing trade liberalization through various multilateral, regional or bilateral agreements. However, in addition to traditional protectionist measures imposed by governments, such as tariffs, quotas and subsidies, in recent years some private buyers have imposed non-tariff measures. These practices must be reviewed, since free trade makes agriculture more competitive and productive, reduces production costs and improves access to international markets for local producers who meet consumer demands. The IDB has issued the following recommendation:

Policy makers in the region should ensure that trade policies support agricultural productivity, focusing especially on eliminating import and export barriers and integrating smallholder farmers into value chains. Sanitary and phytosanitary standards should be harmonized across the region to facilitate cross-border trade in agricultural products.

Policy makers should press for broad liberalization of trade barriers along the entire agricultural value chain, whether in the context of multilateral, regional or bilateral trade agreements or, where possible, through unilateral action.

Private sector enterprises should work more closely together to encourage a reduction in practical barriers to trade, both within the region and globally. Where trade associations or other producers' organizations exist, they should intensify their focus on securing policy changes that will improve access to inputs, capital equipment, technology and related services, as well as expanding market access for their members' exports.

Multilateral organizations should push for the development of trade integration corridors, while encouraging governments to promote private sector access to markets and to facilitate the development of regional and global value chains in the agricultural and food sectors (IDB 2014:40-43).

Smallholder farmers are the most vulnerable to natural disasters, pests and diseases, degradation of natural resources and volatility of market prices. Furthermore, most of them do not have access to the risk mitigation instruments that are currently available on the market and are used by large-scale producers. Nor do they have access to credit on appropriate terms and conditions, which prevents them from scaling up their operations and boosting their productivity. Only 17 percent of cultivated land in LAC is covered by some type of insurance. It is therefore crucial to provide smallholders with risk mitigation instruments, insurance and credit so that they are covered against climatological and market contingencies and are able to invest more in modernizing and improving the efficiency of their productive activities. The IDB recommends the following:

Policy makers and private financial entities should raise their level of understanding of agricultural financing and investment for smallholder farmers, particularly in the area of finance for commercialization, agricultural input purchases and agricultural insurance. Financial instruments must be developed with a specific focus on the credit constraints of smallholders (IDB 2014:44-45).

It has been demonstrated that producers organized in cooperatives and associations are better positioned to reduce input costs, scale up their operations, obtain credit, access commercial networks, negotiate better terms and conditions with financial institutions and buyers, and more effectively modernize their production and marketing activities. This facilitates their integration into value chains and enables them to comply with health, safety and quality requirements more easily than if they operate as isolated producers. For this reason, the IDB has issued the following recommendation:

Policy makers should seek to strengthen producer associations and cooperatives, particularly in the areas of technical training in agricultural production, as well as in post-harvest handling and storage, business management, marketing and negotiation (IDB 2014:48-49).

The IDB considers it indispensable to reduce post-harvest losses. According to a study by Gustavsson *et al.* (2001, cited by IDB 2014) more than one third of the food produced worldwide is lost or wasted. In the LAC countries, annual losses are estimated at nearly 200 kilograms per capita. These losses are often due to inadequate post-harvest handling and storage practices as well as limited or lack of value added activities, a problem compounded by deficient storage infrastructure. Food losses also occur during processing, due to inadequate technology and poor practices. Improving these conditions would significantly reduce losses. This should be accompanied by appropriate education and training for farmers. To address this problem, the IDB makes the following recommendation:

Policy makers should work with the private sector to increase data collection and the use of information technology to better understand the extent and nature of farm level and post-harvest losses, and to invest in tools to acquire precision information

and data analysis that can help address these challenges. They should also encourage public-private partnerships to innovate, test and deploy post-harvest technologies for smallholders (IDB 2014:52-53).

In this document, the IDB offers the following final recommendations:

In order to realize the potential of a more productive and environmentally sustainable agricultural system for the LAC region and for global food security, the region's governments and their multilateral partners must put agriculture at the very center of their development agenda…

Policy makers should focus on shifting priorities away from targeted spending on direct subsidies to producers and direct them toward public goods –especially agricultural research and development, extension services, production infrastructure, trade and integration policies and supporting technical innovation that is applicable to farming. Investments in these areas are proven to advance overall agricultural productivity.

For their part, private sector companies and organizations should seek to align at the industry level to foster an enabling environment for policies that ensure greater access for farmers to appropriate technology, inputs, mechanization and education and training. In addition, they should make a special effort to partner with governments and farmers, to help farming operations of all sizes to participate in regional and global markets (IDB 2014:56).

In document prepared in 2011, the Economic Commission for Latin America (ECLAC) stated that LAC's agriculture should reclaim its place in a global context characterized by rising prices of raw materials and growing demand from China and India as importers of the region's products. During the period 2000-2008, LAC exported seven times more products to China. Based on FAO and OECD estimates, ECLAC considered that the second decade of this century would be one of increased growth for regional agriculture compared with the preceding decade, and that this growth would be driven by the higher prices projected for agricultural products (Sotomayor *et al.* 2011:37-38).

In a previous study, ECLAC, FAO and the Inter-American Institute for Cooperation on Agriculture (IICA) had noted Latin America's great potential to increase agricultural production, being one of the few regions of the world with sufficient available land and water. At the time, the region had an estimated 416 million hectares with agricultural potential that was not a part of forest ecosystems. However, there was a notable disparity between countries: while some, like Brazil, had enormous tracts of available farmland and abundant water resources, other countries, such as those in the Caribbean, had very limited land available. Countries such as Colombia, Ecuador, Mexico, Peru and the Central American nations were categorized in an intermediate band.

Among the Latin American countries, Brazil has the largest agricultural area, with 264. 5 million hectares, followed by Argentina, with 132.9 million and Mexico, with 102, 5 million. Brazil is also the country with the most farms, with 5.2 million, followed by Mexico, with 4.5 million and Peru, with 1.7 million. As to average farm size, Argentina ranks first, with an average farm size of 561.9 hectares, followed by Uruguay with 287.3; by contrast, the average farm size in Mexico is 25 hectares, in Ecuador 16 and in Peru 13 hectares.

On average, agricultural GDP accounts for 5 percent of national GDP in the LAC countries. Paraguay is the country where the agricultural sector's relative weight is greatest within its economy, representing 23.6 percent of total GDP, followed by Haiti with 22 percent, and Guyana with 20 percent. By contrast, in Argentina agricultural GDP represents 9 percent of total GDP, in Brazil 5 percent, in Mexico 3.3 percent, equal to Chile, while in the Bahamas it is less than 2 percent and in Trinidad and Tobago less than 1 percent.

As to the growth of their agricultural sectors, Paraguay recorded the highest growth rate during the 2008-2014 period, with an average of nearly 7.98 percent, followed by the Dominican Republic with just over 4 percent and Ecuador and Brazil with over 3 percent. However, several Caribbean countries experienced a slowdown, such as St. Lucia with a decrease of more than 1.7 percent and Bahamas with just under 2.9 percent (ECLAC 2017).

TABLE 7. Latin America and the Caribbean: typology of countries by agricultural model.

(1) Region/country
(2) Total land area (millions of hectares)
(3) Agricultural land (millions of hectares)
(4) Number of farms (thousands)
(5) Average farm size (available hectares of arable land)
(6) Agricultural land per inhabitant (hectares per capita)
(7) GDP 2008 (billions of dollars)
(8) Agricultural GDP 2008 (percentage of DGP)
(9) Agricultural GDP 2008 (billions of dollars)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Argentina	273.7	132.9	277	562	6.7	328	9.0	30
Bolivia	108.3	36.8	315	72	10.8	17	10.4	2
Brazil	845.9	264.5	5 220	63	4.3	1 653	5.0	83
Chile	74.4	29.8	280	106	4.4	171	3.3	6
Paraguay	39.7	20.4	290	112	6.2	17	23.6	4
Uruguay	17.5	14.9	57	287	5.2	31	9.7	3
Central America	50.8	18.3	s.i.	s.i.	s.i.	136	9.6	13
Colombia	111.0	42.6	1 200	35	2.4	243	7.0	17
Ecuador	24.8	7.4	843	15	2.0	54	6.4	3
Mexico	194.4	102.5	4 500	25	1.7	1 094	3.3	36
Peru	128.0	21.4	1 700	13	4.3	129	6.6	9
Venezuela	88.2	21.4	501	60	3.0	305	s.i.	s.i.
Caribbean	22.6	11.8	s.i.	s.i.	0.4	61	3.0	2

Source: Sotomayor *et al*. 2001:47.

According to ECLAC, rural poverty in the region declined by 65.4 percent between 1990 and 2008. However, with the exception of Chile, Uruguay and Costa Rica, rural poverty remains very high, exceeding 40 percent in the rest of the Latin American and Caribbean countries.

LAC contains the highest concentration of arable land in the world, with 576 million hectares, equivalent to 30 percent of the world total. It also has 30 percent

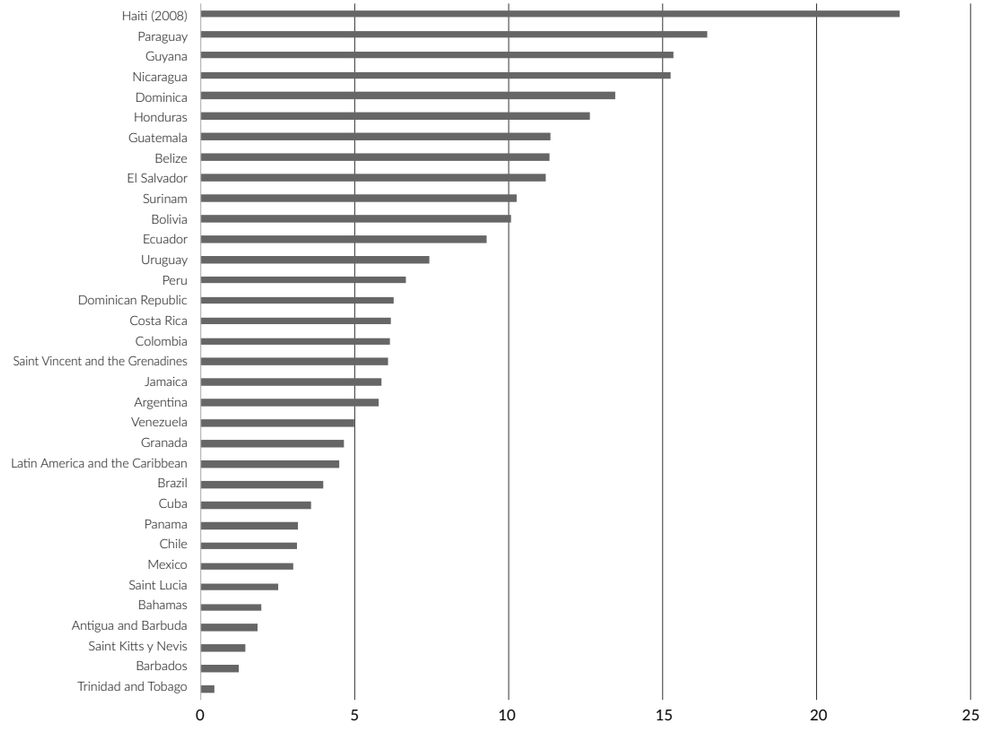

FIGURE 8. Latin America and the Caribbean: agricultural value added as a share of GDP by country, 2012.

Source: ECLAC 2016.

of the planet's renewable water reserves, 25 percent of its forests, 46 percent of tropical forests and one third of the world's biodiversity. Preserving these vital natural resources is a great responsibility for the region's countries and a challenge for their agriculture. Brazil, along with the Amazon jungle, an area it shares with several neighboring countries, is the zone of greatest risk, due to increased deforestation driven by extensive cattle ranching and the expansion of soybean plantations. Argentina is another risk area due to massive expansion of soybean crops. In addition, to these problems, large areas of farmland in Mexico, Central America and the Caribbean are affected by degradation and soil erosion due to poor farming techniques, intensive

soil rotation, and the depletion of water resources, as well as the negative impacts of climate change (ECLAC 2017:54-59).

ECLAC considers that productivity growth is the central problem facing Latin American and Caribbean agriculture. In a previous study conducted in 2007, the Commission concluded that between 1961 and 1980 the region's land and labor productivity had grown in a balanced way, though the gap in relation to developed countries had increased. This lag was mainly the result of a large segment of the region's producers being unable to adopt new technologies, due to the limited scale of their operations and lack access to credit, inputs and investment and the absence of public policies to articulate supply and demand for agricultural products and research.

Based on case studies, ECLAC concluded that the existence of highly efficient producers and other very backward producers in similar situations showed that there was potential to help those lagging behind to become more productive, by following the example of the most efficient farmers. Similarly, it was demonstrated that certain producers faced with the same constraints and level of investment as others obtained better results through innovation.

An issue that has been the subject of intense discussion is how to make family farming more productive. Some policy makers consider that the Ministries of Agriculture cannot do much because it is a problem of education and assistance. Others emphasize that it is possible to increase the productive potential of family farms through specific development policies, such as the very successful Zero Hunger Program in Brazil. They also note the high correlation between poverty and environmental degradation, which makes it even more important to follow successful examples of increasing productivity sustainably and with greater resilience (ECLAC 2017:69-75).

ECLAC considers that the debate on whether to prioritize the domestic market or the export market is a false one. The domestic market is very important in all countries; similarly, exports enable countries to improve their competitiveness and boost the domestic market. ECLAC recommends that countries establish public policies that promote farmers' competitiveness and protect them from the distortions and volatility of international markets. Given that the process of ever larger trade flows will continue

in the coming years, producers and governments alike must address this as a scenario that implies risks and opportunities.

Faced with the dilemma of whether to invest more in public or private goods, the IDB considers that priority should be given to investment in public goods, since State subsidies and transfers to farmers, applied especially by developed countries, should disappear, as these distort markets and are not conducive to productive processes. In LAC, only Mexico, Brazil and Chile make transfers to farmers, though these are quite low compared with developed countries. In recent years there has been a trend toward increased investment in public goods by the region's countries (ECLAC 2017:76-88).

A un document that assesses the outcomes of the Earth Summit in relation to sustainability (United Nations Conference on Sustainable Development, Rio+20 2012b), notes that the productivity gap between the LAC region and developed nations is becoming wider and that the region has not succeeded in transforming its production structure, which remains heavily based on natural resource-intensive sectors.

In relation to sustainable development, the document expresses concern at the increase in pollution caused by agricultural activities:

> *Across the region, the agricultural sector makes a significant contribution to GDP, export revenues, employment and rural livelihoods. In the last two decades the area under cultivation and irrigation has expanded, particularly for the production of raw materials for export. The livestock and aquaculture sectors have also grown. This expansion has had a major impact on changes in land use and on greenhouse gas emissions. After East Asia, LAC is the region whose agricultural sector generates the most emissions. As in other regions, nitrous oxide emissions are due mainly to the use of fertilizers in soil while methane emissions are due to the enteric fermentation in cattle. The expansion of the area used for agriculture and livestock production has accentuated the use of nitrogen fertilizers and has prompted the growth of livestock populations, with the aforementioned consequences* (United Nations Conference on Sustainable Development Rio+20 2012b).

The growth of agriculture has exacerbated the problems of deforestation, soil degradation and biodiversity loss and increased greenhouse gas emissions. These problems are further aggravated by the use of polluting pesticides and greater demand for water resources. The region's livestock sector has grown markedly at an annual rate of 4 percent, double the global growth rate. Most of these adverse environmental effects are the result of extensive cattle ranching. However, although intensive farming is being used to boost productivity, this also has the effect of degrading the quality of the air and water, given the accumulation of nutrients in those farm systems (United Nations Conference on Sustainable Development Rio+20 2012b:22-23, 69).

The UN document also notes the evident lack of environmental regulation mechanisms in the region, where 73 percent of water resources are used in agriculture and where the main impact of agricultural expansion and increased water extraction has been the contamination of ground and surface waters. However, there have been major advances in the growth of sustainable agriculture such as organic farming and certified production. Latin America has an estimated 8.1 million hectares under certified organic agriculture, accounting for 23 percent of the world total, and 257,238 certified producers (18.7 percent of the total), with an annual growth rate of 1 percent. Moreover, progress has been made in the use of drip irrigation, drought tolerant crop varieties, sustainable technologies such as bio-composting, artisanal production of seeds and integrated management of pests and diseases.

Another risk factor is the process of land concentration that has taken place in recent years, with much land being leased or sold to local or foreign private investors. This represents a threat to food security and the sustainability of regional agriculture.

At the same time, another major concern is that agriculture could be seriously affected by climate change. One scenario predicts that productivity could decline by a third in tropical and subtropical regions as a result of thermal stress and drier soils. In addition, salinization and desertification would likely increase in farmlands located in arid zones. More frequent floods and droughts would affect rainfed agriculture. Irrigation would be threatened by salinization, increased flooding and rising sea levels. It is estimated that in South America productivity could fall between 12 and 50 percent, while in Mexico the figure could be even higher, between 30 and 85 percent.

However, some regions could benefit from climate change, such as temperate zones with soybean and wheat crops and pasturelands (United Nations Conference on Sustainable Development Rio+20 2012b:110).

The UN has emphasized that combating desertification, land degradation and drought are priorities for the LAC countries. This has been among the organization's tasks since 1998, when it established the Action Program for Latin America and the Caribbean under the United Nations Convention to Combat Desertification (UNCCD), in an effort to respond to the severe reduction in the productivity of region's ecosystems, the reduction in crop, livestock and forest yields, and biodiversity loss.

Some climate change scenarios include the following projections: Bolivia's agricultural productivity could fall by 17 percent in 2020 and 18.5 percent in 2050. In Chile, productivity could decline by 3.5 and 7.2 percent; in Ecuador by 8 and 16.3 percent; in Paraguay by 8 and 16.1 percent; and in Peru by 5.5 and 7.1 percent, respectively (United Nations Conference on Sustainable Development Rio+20 2012b:135).

One of the reasons for the lag in agricultural productivity in the region is the lack of investment in R&D. In many Latin American countries, spending on R&D is less than 0.5 percent of GDP, while in developed countries investment ranges between 2 and 3.5 percent of GDP. Another major difference is that in developed countries the private sector plays a strong role in R&D, while in LAC countries the government is the main investor, accounting for more than 60 percent.

The UN report concludes that although there have been undeniable advances in the region, enormous challenges remain with regard to social inclusion, poverty eradication and environmental protection. These challenges will be made even greater by climate change, and will require increased actions and larger budgets to eliminate vulnerability factors in the region, such as poverty and lack of access to basic services, and to strengthen its governance mechanisms to ensure a more effective management of sustainable development (United Nations Conference on Sustainable Development Rio+20 2012b:245).

TABLE 8. Latin America and the Caribbean: Average annual growth of agricultural output and total factor productivity (TFP) and levels of land and labor productivity.

	LAND PRODUCTIVITY				LABOR PRODUCTIVITY				OUTPUT GROWTH (%)			TOTAL FACTOR PRODUCTIVITY "TFP" GROWTH (%)		
COUNTRIES	1990	2000	2007	2013	1990	2000	2007	2013	1991-2000	2001-2007	2008-2013	1981-2000	2001-2007	2008-2013
LAC	260	343	439	505	5 759	7 918	11 205	14 033	3.2	4	2.5	2	2.9	2
Argentina	192	252	297	302	16 822	22 219	30 008	32 629	2.8	4.1	0.8	2.2	2.5	0.4
Bahamas	1 656	1 776	2 238	2 593	3 312	4 618	5 819	7 259	1.5	3.4	3.8	−0.4	6.8	−3.4
Barbados	2 847	2 778	3 095	3 393	6 011	7 144	9 903	11 876	−0.8	−0.1	−0.7	−0.0	2.6	0.2
Belize	725	1 043	1 131	1 176	5 076	6 474	5 926	5 701	5.5	1.4	1.5	2.5	0	−1.8
Bolivia	48	65	87	103	1 388	1 507	1 711	1 796	3.6	4.3	3	0.9	0.7	3
Brazil	253	341	467	562	4 341	6 685	10 647	15 172	3.9	5.2	3.4	2.4	4.2	2.8
Chile	279	411	485	556	4 747	6 444	7 833	9 196	3.4	3	2.4	1.4	1.7	2.9
Colombia	216	255	329	349	2 907	3 186	3 897	4 295	1.6	2.9	1.1	0.4	1.3	0.5
Costa Rica	707	1 236	1 516	1 641	5 292	6 956	8 344	9 822	3.4	2.6	2.1	2.7	1.8	2.1
Dominican Republic	629	753	1 004	1 189	2 563	3 439	5 064	6 873	1.7	3.9	3.1	0.7	2.9	3.7
Ecuador	479	732	887	969	3 412	4 808	5 164	5 737	4.6	1.5	1.7	3.4	1.2	−0.2
El Salvador	599	676	745	739	1 287	1 529	1 829	2 014	1.8	1.4	0.5	0.1	0.1	0.6
Guatemala	469	635	899	1 111	1 355	1 906	2 060	2 249	3.5	5.1	3.5	1.7	1	3.8
Guyana	105	186	195	255	3 138	5 671	6 168	8 219	5.7	0.4	4.6	6.1	−0.2	5
Haiti	582	568	605	661	521	486	505	504	0.3	2	1	−2.0	0.2	1.2
Honduras	355	442	613	670	1 747	1 762	2 865	3 268	1	5.9	1.9	0.6	2.6	1.1
Jamaica	1 031	1 118	1 204	1 287	1 785	2 158	2 504	2 777	0.9	0.6	0.6	0.6	0.8	0.6
Mexico	216	278	330	364	2 640	3 346	4 210	4 963	2.7	2.5	1.6	2	2.1	1.5
Nicaragua	162	201	258	338	1 667	2 640	3 658	5 020	4.7	3.7	4.2	1.9	2.6	4.8
Panama	383	373	418	442	3 202	3 101	3 552	3 938	0.2	1.8	1	−1.5	0.7	0.6
Paraguay	156	143	218	279	4 638	4 061	5 603	6 952	0.8	6.4	5	−1.0	4	2.9
Peru	156	256	322	410	1 223	1 760	2 083	2 637	5.7	3.6	4.6	2.8	2.2	3.4
Surinam	1 343	1 073	1 606	1 745	4 076	3 147	3 513	4 388	−2.2	2.5	4.3	−2.2	4.6	0.1
Trinidad and Tobago	1 743	2 189	2 910	2 672	2 632	2 993	3 274	3 206	0.9	1	−1.4	2.1	2.3	−0.8
Uruguay	147	191	237	293	11 776	14 499	18 477	24 306	2.7	2.8	4.3	1.3	1.4	2.7
Venezuela	196	263	312	362	4 914	6 986	8 886	11 367	2.9	2.4	2.5	1.7	1.8	1.2

Source: International Food Policy Report Institute 2016:123-125.

TABLE 9. Latin America and the Caribbean: agricultural public expenditure.

(1) Agricultural expenditure in billions of 2005 dollars
(2) Expenditure in billions of 2005 PPP dollars
(3) Per capita agricultural expenditure in 2005 constant US dollars
(4) Per capita agricultural expenditure in 2005 PPP dollars
(5) Ratio of agricultural expenditure to agricultural GDP (%)
(6) Share of agriculture in total public expenditure (%)

	(1)			(2)			(3)			(4)			(5)			(6)		
COUNTRY	1980	1995	2013	1980	1995	2013	1980	1995	2013	1980	1995	2013	1980	1995	2013	1980	1995	2013
Argentina /d	0.17	0.14	0.9	0.35	0.3	1.86	5.99	4.13	22.47	12.38	8.55	46.47	2.16	1.84	5.58	0.65	0.58	1.65
Bahamas /c	0.01	0.02	0.01	0.01	0.01	0.01	44.49	54.29	40.22	42.71	52.11	38.61	11.45	7.47	9.35	1.45	1.67	0.97
Barbados	0.03	0.03		0.02	0.03		102.17	108.39		97.09	103.01		12.77	28.29		3.2	2.8	
Belice	0.01	0.01		0.02	0.01		68.56	37.12		122.3	66.21		12.96	6.96			4.61	
Bolivia	0.03	0		0.11	0.01		5.07	0.43		20.27	1.72		2.61	0.32		3.33	0.35	
Brazil		7.23	6.65		16.1	14.81		44.63	33.18		99.46	73.93		20.6	11.94		5.7	2.29
Chile	0.18	0.17	0.61	0.3	0.28	1.03	16.04	11.47	34.87	26.91	19.25	58.49	9.16	4.26	10.59	1.77	1.18	1.66
Colombia	0.13	0.23	0	0.31	0.57	0	4.75	6.37	0.02	11.58	15.53	0.04	1.4	2.21	0.01	2	1.77	2.1
Costa Rica	0.05	0.09	0.46	0.11	0.19	0.94	21.98	26.12	93.82	45.06	53.55	192.35	5.24	5.65	30.31	3.38	3.15	5.38
Dominican Republic	0.24	0.19		0.48	0.37		41.37	23.4		81.67	46.19		13.96	10.13		16.71	7.83	
Ecuador /c			0.19			0.48			12.89			31.87			4.05			1.59
El Salvador	0.01	0.03	0.05	0.02	0.07	0.1	2.06	5.26	7.45	4.51	11.51	16.29	0.36	1.73	2.47	5.8	1.69	0.98
Grenada		0.01			0.02			109.41			171.72			31.37			9.65	
Guatemala	0.15	0.05	1.19	0.41	0.14	3.21	21.88	5.25	77.17	58.86	14.12	207.54	6.95	1.82	29.36	7.88	2.72	23
Jamaica /a		0.07	0.08		0.11	0.14		27.79	30.42		46.42	50.81		7.89	13.2		2.13	2.17
Mexico /c	6.6	2.78	4.8	10.09	4.25	7.34	93.79	29.1	40.7	143.41	44.5	62.24	24.42	10.65	15.17	14.56	4.08	2.32
Panamá	0.09	0.04	0.1	0.2	0.08	0.21	45.89	12.82	25.58	99.33	27.75	55.37	17.62	5.04	9.81	5.29	1.64	1.36
Paraguay	0.02			0.06			5.28			19.11			1.56			3.47		
Peru			0.33			0.82			10.74			26.83			3.76			1.93
St. Vincent and the Grenadines	0	0		0	0.01		17.47	29.81		28.64	48.86		9.38	8.74		3.81	3.46	
Trinidad and Tobago /a	0.14	0.09	0.15	0.25	0.17	0.27	127.51	75.69	111.42	234.64	139.28	205.04	68.72	66.01	181.53	5.1	4.49	2.18
Uruguay	0.03	0.04		0.07	0.09		11.58	13.05		25.08	28.25		2.25	3.63		2.08	1.04	
Venezuela (Bolivarian Republic) /d			1.55			3.81			54.31			133.21			15.47			2.06

Note: PPP (purchasing power parity) dollars measure the relative purchasing power of currencies across countries by eliminating national differences in the pricing levels for a wide range of goods and services. Because of dramatic differences in countries' spending on agriculture, entries have different numbers of decimal places.

A = last year of data available is 2012; B = last year of data available is 2011; C = last year of data available is 2010;
D = last year of data available is 2009; and E= last year of data available is 2008.

Source: IFPRI 2016:113-116.

A joint study by IICA, FAO and ECLAC on the performance of and outlook for agriculture in LAC (IICA *et al*. 2015) found that the annual rate of growth of agricultural value added (AVA) for LAC during the 2010-2013 period was 2.9 percent, higher than the figure of 2.6 percent for the economy as a whole. This growth was largely due to the outstanding performance of agriculture in 2013, which grew by 5.5 percent. These indicators suggest the recovery of LAC's agricultural sector, which had lagged behind the growth of the overall economy in the last 40 years.

TABLE 10. Growth of agricultural value added (AVA) in LAC 2011-2013 (%).

LAC AVERAGE			2.9
Growth above LAC average		Growth below LAC average	
Honduras	6.8	Uruguay	2.8
St. Lucia	6.5	Costa Rica	2.7
Paraguay	6.2	Brazil	2.4
Granada	6.1	Argentina	1.7
Belize	6.0	El Salvador	1.5
Guatemala	4.7	Chile	0.6
Dominica	4.5	Suriname	0.2
Bolivia (Plurinational State of)	4.3	**DECLINE**	
Panama	4.0	Nicaragua	-1.5
Colombia	3.9	St. Kitts and Nevis	-1.8
Mexico	3.6	Barbados	0.5
St. Vincent and the Grenadines	3.6	Bahamas	-6.7
Dominican Republic	3.3	Trinidad and Tobago	-12.4
Guyana	3.3		
Ecuador	3.1		

Source: IICA *et al.* 2015.

The gross value of agricultural production (GVP) for LAC during the period 2006-2011 grew at an average annual rate of 3.2 percent, with increases in productivity accounting for 2.2 percent of the total; the other 1 percent was due to the expansion in the use of resources. However, this growth had significant variations in the region. In countries such as Jamaica, Brazil, El Salvador, Venezuela, Mexico and Haiti, agricultural productivity increased faster than production, indicating a contraction in the amount of resources allocated to the agricultural sector. In the rest of the countries, both productivity and the resources used for production increased.

This study also shows that the labor productivity of LAC's agricultural sector has grown at a slower rate than in the United States. The fall in the growth of labor productivity in LAC has meant that over the years the gap with the United States has widened, up to 14.32 in 2012 (IICA *et al.* 2015:39-44).

The three organizations noted that in recent years, agriculture's role in LAC as a buffer in times of economic crisis had declined. The currency devaluations implemented in many countries of the region were expected to encourage agricultural exports, continuing the process to reconfigure Latin America's agrifood exports toward markets with greatest demand, such as China. A deceleration in global demand for agrifood products was also expected, which would affect the prospects for the growth of production and exports in LAC countries (IICA *et al.* 2015:45-50).

04

STRATEGIES AND GUIDELINES DEFINED BY IICA

Increasing agricultural productivity in the Americas is one of IICA's main objectives. The Institute considers it essential to increase output in order to produce more and better food to meet growing demand, which will become even greater in the coming years. However, this increase must also help to raise the living standards of rural families, reduce poverty and contribute to the conservation of natural resources. Furthermore, greater productivity must be sustainable in order to mitigate the effects of climate change.

IICA's 2010-2020 Strategic Plan states the following:

The Institute will concentrate on the generation and provision of hemispheric public goods, focusing on those development issues best addressed on a hemispheric or regional scale; promote the diversification of production, agricultural exports and the identification of new market opportunities; promote increased productivity and competitiveness; promote a more sustainable agriculture and natural resource management and the prosperity of rural communities; provide the countries with

technical support in its areas of competence, in response to strategic and specific demands in the priority areas defined by the Member States which constitute new challenges for agriculture; and seek opportunities to work with other development agencies, especially multilateral banks, to create synergies, avoid the duplication of efforts and reduce inefficiency in the use of resources (IICA 2010:10).

To make agriculture more competitive and sustainable, while also ensuring the well-being of the rural population, promoting the conservation of natural resources and efforts to improve food security, it is essential to improve productivity. This is particularly important given that demand for food is outpacing supply and that private and public investment has stagnated or declined over the last 25 years, resulting in very low levels of productivity in the least developed countries. Added to this are the major changes that have occurred in recent years in Latin American and Caribbean agriculture: continued expansion of the agricultural frontier, which has destroyed forests, increased pollution and the impact of climate change. This has also led to increased desertification and salinization of soils.

In addition, there is a clear trend toward greater demand for water for non-agricultural purposes. With the deterioration of aquifers and the decline in the quality of runoff water, this means that less water will be available per unit of agricultural production in the coming years. For those reasons, any increases in production will have to come from increased productivity. (IICA 2010:13, 14, 16, 17).

The IICA Strategic Plan establishes competitiveness as the first challenge for hemispheric agriculture, which will require countries to increase productivity through a new technological paradigm to replace that of the Green Revolution, focusing on the aspects of innovation and sustainability. Of special importance are innovations derived from biotechnology, such as genetically improved varieties, organic compost and biological control methods.

It is also essential to improve the productivity of crops such as potato, cassava, sweet potato, plantain and other native crops of importance to some countries. Some of the greatest achievements in improving productivity have occurred in the fruit and vegetable crops (IICA 2010:19-20).

For all these reasons, IICA's 2010-2020 Strategic Plan established as Strategic Objective No.1:

Make the agricultural sector more productive and competitive:

- The first strategic objective encompasses all aspects of production, with agriculture viewed as a key component of a complex system of value chains in which production reaches consumers in agricultural markets and is supplied by competitive agribusinesses, including small-scale agriculture.
- The evidence shows that agriculture will face additional pressures and opportunities in the near future, derived not only from increased demand for its products, as a natural consequence of population growth and higher incomes, but also because of the clear decline in the growth rates of yields of the main crops, limited availability of land to expand the agricultural frontier, loss of natural resources, the emergence of new or more virulent pests and diseases and the expected impact of climate change. These factors, together with globalization, the integration of regions, borders and markets, and the emergence of a mass of consumers who are more demanding in their requirements and more aware of the quality of foodstuffs and of the way in which these are produced, pose new challenges and open up opportunities across all links of the agrifood chains.
- Addressing this complex situation requires countries to implement public strategies and encourage the design of private sector strategies to promote innovation, attract investment, reduce uncertainty in agriculture and develop new business models that will improve the sector's productivity and competitiveness. In addition, more balanced trade and market mechanisms will be needed to enable the least developed countries and stakeholders to take full advantage of the opportunities offered by trade, at all levels. This scenario will require consensus on policies that transcend the traditional roles of the Ministries of Agriculture, and should incorporate other public and private stakeholders that play important roles in all the endogenous and exogenous elements that contribute to the systemic competitiveness of agriculture. IICA should promote innovation to boost competitiveness, increase production and contribute to improving the operation of agricultural markets, in a socially and

environmentally sustainable manner. These efforts must ensure the inclusion of small and medium-sized farmers, who face problems in accessing modern markets, and the development of markets for the basic or traditional products consumed by the poorest social groups (IICA 2010:34-35).

Among its technical cooperation goals, the Plan states the following in relation to productivity and food security:

> *IICA will support its Member States in developing policies, strategies and institutional frameworks aimed at increasing the contributions of agriculture, especially small-scale farming, to the food security of countries, both from the perspective of the national vision, and from that of access of small-scale farmers to incomes that enable them to buy food and produce basic foodstuffs. IICA proposes to contribute to the implementation of policies, strategies and capacities that improve production, productivity, value added processes and access to input and commodity markets, to financing and agricultural insurance.*

In relation to natural resources and climate change and productivity the Plan states:

> *IICA will contribute to the institutions of the countries, especially the Ministries of Agriculture, in the development of public policies, the design and implementation of sectoral strategies, the application of policy instruments and the provision of timely information, so that all this will contribute to reduce levels of uncertainty among agricultural producers and help them improve their productivity and competitiveness* (IICA 2010:39,43-44).

IICA's 2014-2018 Medium Term Plan mentions increased productivity as one of the main challenges facing the continent's agriculture. The Institute notes that in order to meet growing demand for food over the coming decades, the LAC countries will require innovative alternatives to the current production models, given that growth rates for agricultural productivity and yields have shown clear signs of stagnation. Although the region has responded to increased demand for food by expanding the area of land under cultivation, a large part of the existing farmland is now degraded.

IICA also refers to a number of variables affecting agricultural productivity in the hemisphere: price volatility, the presence of pests and diseases, climate variability, natural disasters, land and water rights, the aging of the rural population and the migration of its young people to urban areas. To these factors must be added the problem of competitiveness. In order to resolve this situation, the Plan states the following:

> *The challenge of boosting productivity and competitiveness calls for the generation, adaptation and validation of technologies, and the development of innovative processes to improve yields and make more efficient, sustainable use of natural resources, especially water and soil. Good practices should be adopted, such as making intelligent use of energy sources, using agricultural machinery and implements that are less contaminating, improving post-harvest management, using new inputs, including the so-called bio-inputs, producing higher quality products, making changes in organizational management and distributing the benefits of trade more efficiently.*
>
> *A significant factor for improving productivity and competitiveness is to raise the levels of public and private investment in the sector. This calls for stronger institutional frameworks and better governance by means of clear policies and rules of the game to safeguard investments as well as intellectual and industrial property rights and to foster public-private partnerships. At the same time, sound risk management programs and projects will provide a certain safety margin for this activity that is so heavily dependent on climatic and economic externalities (IICA 2014:6-7).*

The Institute emphasizes the need to improve water productivity in agriculture, through technological, institutional and organizational innovations. Moreover, the Medium Term Plan, incorporates the four strategic objectives of the 2010-2020 Strategic Plan and defines eleven related contributions of IICA. The first three of these contributions refer explicitly to improving productivity:

1. Strengthening the capabilities of the Member States at the national, regional, multinational and hemispheric levels to establish public policies and institutional frameworks in order to make agriculture more productive and competitive, improve the management of rural territories, adapt to and mitigate the effects of climate change and promote food and nutritional security.

2. Implementing, through public and private institutions, technological, institutional and business innovations aimed at boosting the productivity and competitiveness of agriculture and the production of basic foodstuffs of high nutritional qualityl.
3. Increasing the capabilities of the public and private sectors to ensure agricultural health and food safety and thereby improve productivity, competitiveness and food security (IICA 2014:24-25).

In its 2014-2018 Medium Term Plan, the Institute defines various outputs and services aimed at achieving the eleven major contributions. These include policy proposals and strategies, specialized methodologies and instruments, capacity-building processes, development cooperation and investment programs and projects, management of development projects, mechanisms for cooperation and consensus and implementation of information networks, innovations and studies (IICA 2014:26.29).

Similarly, the Plan describes IICA's decision to focus its efforts via the implementation of four Flagship Projects. The fourth of these projects is entitled:

4. *Productivity and sustainability of family agriculture for food security and the rural economy (IICA 2014:40).*

IICA, ECLAC and FAO have presented the following policy recommendations related to improving agricultural productivity:

— Increasing agricultural productivity is undoubtedly the best way to achieve the growth, stability, and sustainability of LAC's agricultural sector, especially in a scenario in which growth in LAC's agricultural productivity has slowed due to the widening gap in agricultural productivity within and between countries, the deceleration of the world demand for agrifood products (which will affect the growth prospects of LAC exports), and the possible the end of the "super cycle" in agricultural prices.

— To increase agricultural productivity, countries in the region should promote investment in research and development (R&D), a factor that has proven to be most important for achieving that goal. Also needed are efforts to develop financial incentives for producers, promote rural education, improve extension services, invest in rural infrastructure and improve market access.

— Rural credit is another element that should be strengthened, as it plays a key role in improving the distribution of the benefits derived from R&D, especially to ensure that the technology reaches family farmers and helps to close the productivity gaps between producers.

— An important action for reducing differences in productivity and helping to achieve more equitable income distribution within countries is the strengthening and improvement of rural and agricultural education, as well as the development or enhancement of producers' skills.

— Another action that can help to promote equity and increase productivity is the improvement of land distribution. This also makes productivity more uniform across producers, leading to more efficient use of labor, partly due to the fact that the cost of supervision is lower.

— Coupled with the above, more equitable access to assets and the means of production would have positive effects on productivity and productive efficiency, and that, in turn, as part of a virtuous circle, would help to bridge gaps in productivity and income between countries, regions, rural areas and producers.

— The State should ensure the provision of public goods that benefit everyone, such as general improvements in infrastructure and mechanisms for the protection of property rights. Public goods of this kind are neutral policy interventions that benefit every sector of the economy by lowering the cost of doing business in a country, improving market access, attracting more investment, and, in general, helping to improve national productivity and competitiveness.

— Investment in rural infrastructure— roads, refrigeration and storage networks, slaughterhouses, markets and information and communications networks, and even the construction of infrastructure for technology research and innovation (laboratories, experimental stations, etc.) and the framework for rural financing— is vital to promote faster adoption of agricultural technologies and practices.

— Countries must also have efficient transportation networks (roads, ports, railways, air transport, etc.) and the logistics required for the fastest and cheapest possible flow of goods and services to and from markets, and the

timely and convenient movement of workers. A telecommunication network facilitates the free and rapid flow of information for decision making based on timely and reliable information.

- With regard to market conditions, the State must ensure that there is more competition and open trade, and that farmers and others involved in the sector respond to market signals, so that research, resource allocation, the adoption of new technologies, and innovations match those signals and changes in relative prices. Several studies show that improving access and integration into markets increases producers' technical efficiency. With permanent changes in access to, and the availability and prices of, inputs, having an inventory of technologies that make it possible to use fewer inputs in relation to changes in market conditions becomes strategically important.
- In light of the potential growth of inflows of capital and FDI, countries should adopt measures to ensure that such investment has the greatest possible impact on productivity, competitiveness, and the sustained growth of agriculture. The State can attract and promote FDI not only as a source of capital, but also as a mechanism that promotes technology transfer and the improvement of individual and institutional capabilities in the host country, via competition, the demonstration effect, and practical learning, that lead to improved productivity. Competition, more productive linkages, labor mobility and the demonstration effect (Castillo *et al.* 2011), can have an impact on technological change, the accumulation of knowledge and capacity building, factors that are all essential for productivity. Inflows of capital should be complemented with local investment in R&D activities, which is essential so that knowledge is transferred and triggers productive innovations.
- At the same time, in order for FDI to have a bigger impact on development and productivity, human capital should also be increased.
- Although FDI is vital for the development of agricultural sectors and natural resources, if investment is highly capital intensive it may not produce the desired social benefits (job creation, for example), and displace other investments that are useful for the country. Furthermore, the negative impact on the environment must also be borne in mind (WTO, 2014). One challenge is to coordinate extractive activities with the rest of the productive structure, creating, for example, synergies and positive linkages between mining and agriculture in rural territories, not only to raise productivity but also to help diversify rural income. The race to attract investment should not be based on minimum levels of internal regulation that pose a threat to the interests of the country as a whole.
- Finally, countries should promote trade as an instrument of economic growth and development, for which they should eliminate protectionist measures, improve access to markets and avoid policies that distort competition, so that decisions are taken based on market signals. In the face of weakening international demand, it is timely to continue promoting the intraregional integration agenda, which will make it possible to increase agricultural trade flows between the LAC countries (IICA 2014:58-60)...

The Ministers of Agriculture of the Americas met in Cancun, Mexico, on October 20-22, 2015, to hold discussions, adopt commitments and secure the support of international cooperation to promote "the increased productivity, competitiveness, inclusiveness and sustainability of agriculture in order to contribute to the sustainable development of the countries of the Americas". In their Declaration, the Ministers of Agriculture stated the following:

Mindful that:

7. *Agriculture is a strategic activity for the development and well-being of the countries, makes a significant contribution to economic development with social inclusion and to rural and national prosperity, and is crucial to achieve food security and end poverty.*
8. *Agriculture, in general and particularly in the Americas, faces various challenges to maintain and improve on the productivity growth rates observed in recent years.*
9. *Agricultural productivity rates in the Americas vary significantly across countries and types of agriculture.*
10. *Raising the productivity of agriculture is a task that has to be addressed rapidly and decisively, adopting a comprehensive collaborative approach and sustainable practices.*

11. *Increasing productivity calls for a transformation of agriculture through a wide range of innovations designed to ensure competitiveness, sustainability and inclusiveness.*

12. *The countries of the Americas have great potential to increase agricultural production and productivity; nevertheless, it should be borne in mind that while some have adequate natural resources, such as water, land, energy, biodiversity, knowledge and human talent, others, particularly SIDS, are challenged by vulnerability and natural resource constraints, which hinder their efforts to increase agricultural productivity.*

13. *Raising agricultural productivity requires the rapid development of the technical and functional capabilities of individuals, organizations and of society in order to address its complexities with sustainable solutions and adaptations to climate change.*

14. *Increasing agricultural productivity is a multifactorial (land, capital and labor), multidimensional (economic, social, environmental and institutional) and multisectoral (public, private and civil society) effort, and achieving this goal in a competitive, sustainable and inclusive manner calls for participation, consensus-building and joint action by the appropriate national and international public and private sector stakeholders.*

15. *Increasing agricultural productivity in a sustainable and inclusive manner is one of the pillars essential to achieving the food security of our peoples.*

We call upon:

16. *The cooperating countries and entities, international funding agencies and providers of funds and research centers, regional research and innovation mechanisms and national, regional or hemispheric programs of greater scope centered on actions related to increasing agricultural productivity, bearing in mind the national priorities and development policies designed by beneficiary countries.*

We commit to:

17. *Strengthening, where relevant, the professional leadership, participation and proactive capacity of the ministries of agriculture in the definition and implementation of national policies to improve the State's oversight of agriculture and to guide the sector through the structural changes required to enhance agricultural productivity as deemed necessary, pursuant to national development policies.*

18. *Maintaining dialogue with the representatives of the agricultural sector and other sectors, to analyze and draw up agreed proposals on the increase of agricultural productivity in a competitive, sustainable and inclusive manner to contribute to the eradication of poverty, as well as to facilitate greater information, in order to increase public awareness.*

19. *Continuing to promote the implementation of policies, programs and instruments to foster productivity, investment, innovation, infrastructure, science and technology, agricultural health and food safety, as well as adaptation to and mitigation of climate change, with special emphasis on family and small-scale farming, through the following actions, as necessary, to:*

    a. *Revitalize and encourage investment directed to the provision of public goods in, and for, agriculture.*

    b. *Modernize, as required, the institutions of the agricultural public sector and promote the appropriate priorities required to address the challenges of agriculture.*

    c. *Promote rural and territorial development through participatory management and policies for the transformation and sustainable development of the agricultural sector.*

20. *Evaluating, working and promoting, with the pertinent stakeholders and authorities, where necessary, a modern, inclusive educational system for stakeholders in agriculture and the rural milieu, with strategic actions to:*

    a. *Strengthen professional capacities, designing training programs in agriculture, rural economy and rural development studies with respect for ancestral and traditional know-how.*

    b. *Promote improvements in the quality and coverage of rural education, educators' capabilities and educational infrastructure and establish training programs for new agricultural producers, targeting young people, small family farmers and women.*

c. *Establish programs to enable farmers to acquire additional knowledge and skills.*

d. *Strengthen the entrepreneurial and organizational capabilities of agricultural and rural producers and establish programs to strengthen producers' capacity to develop and become involved in productive projects.*

e. *Promote and support nutrition education programs with a view to reducing malnutrition, obesity, food loss and waste, and emphasizing the consumption of healthy locally produced foodstuffs and improving their use.*

21. *Promoting and contributing to the strengthening of a culture of innovation, through sustainable agriculture adapted to climate change, integrating value chains that foster productivity and focusing on strategic actions intended mainly to:*

a. *Develop public policy instruments that promote, based on national and regional priorities, public and private investment and mechanisms that facilitate close links between the two sectors.*

b. *Promote efficient and sustainable management of natural resources in the products, services, processes and technologies used in agriculture and its value chains.*

c. *Strengthen the relationship between technology research and develop-ment centers and the productive sector.*

d. *Identify, assess, disseminate and make use of local and ancestral knowledge.*

e. *Strengthen the dissemination of scientific knowledge and research systems whose work involves improvements in production and strategic nationa-l priorities.*

f. *Promote the creation of interinstitutional and interregional networks that facilitate flows of information, including scientific and evidence-based information, and knowledge management among stakeholders in agriculture and value chains.*

g. *Improve the collection, availability and usability of agricultural and nutritional data to spur innovation, reduce duplication of efforts, enable better decision-making and increase transparency.*

22. *Supporting cooperation in international agricultural trade, by promoting and implementing actions to:*

a. *Collaborate in the establishment of policies governing safety, health, and trade based on scientific principles.*

b. *Undertake efforts to achieve further inter-American trade integration.*

23. *Spearheading the implementation of joint initiatives with organizations and sectors that strengthen the business and entrepreneurial culture in agriculture and the rural milieu, including actions intended to:*

a. *Support the business and organizational development of agricultural and rural producers in order to improve their negotiating skills, their participation in markets and their strategies for sustainable and inclusive development.*

b. *Increase opportunities for access to productive assets, financing and integrated risk management, with the inclusion of young people and women farmers and rural producers.*

c. *Support the implementation of programs on social responsibility for businesses and responsible investment principles in agriculture and value chains.*

d. *Strengthen the inclusion of small-scale and family producers in value chains.*

e. *Simplify formalities and improve business conditions for agricultural enterprises.*

24. *Promoting the harmonization of development cooperation provided by the international cooperation agencies that operate in each of our countries, and the alignment of their cooperation with our national priorities with regard to more productive, sustainable and inclusive agriculture. To that end, we will undertake the following actions:*

a. *Request the international and regional organizations that operate in our countries to include in their cooperation programs an agenda for the sustainable intensification of agriculture based on the priorities of the country concerned.*

b. *Work in a coordinated manner with international cooperation agencies to close the gaps that exist in agricultural productivity.*

c. Promote the strengthening of collaboration between related international organizations on the preparation of analyses, studies and proposals for the competitive, sustainable and inclusive improvement of productivity.

d. Request collaboration for the design of national policies and programs for productive, sustainable and inclusive agriculture. (Meeting of Ministers of Agriculture of the Americas 2015:2-8).

05

MAIN ACTIONS AND PRODUCTIVITY PROJECTS BOOSTED BY IICA

Within the framework of the recommendations contained in the Declaration of Ministers of Agriculture of the Americas (San José, 2011), IICA directed its actions that year to “promote innovation to increase and intensify production and productivity, improve incomes, reduce poverty and inequity, diminish the environmental impact of the food sector, respond to natural disasters, increase access to new technologies, adapt to climate change and, consequently, achieve food security and quality of life for all our citizens “. In that year, IICA restructured its technical cooperation model through IICA-country strategies to respond more effectively to the demands of its member countries and continued with the six cooperation programs on priority issues for countries which included innovation, promotion of agri-business, agricultural health, development of rural areas, food security and climate change.

In order to fulfill its strategic objective number 1, “Improving productivity and competitiveness of the agricultural sector”, IICA fostered technological and organizational innovations that contributed to the promotion of agricultural competitiveness and productivity.

All actions related to innovation in regional and international cooperation programs, those related to national innovation systems, knowledge management and information and communication technologies (ICTs) for innovation, promoted by IICA in 2011, had as one of their major objectives to increase the agricultural productivity of the countries responsible for each project (IICA 2011: 8-11).

The Institute also undertook several actions to increase agricultural productivity in countries through new uses of agriculture in Suriname, St. Kitts and Nevis, St. Vincent and the Grenadines, The Bahamas, Nicaragua and the Dominican Republic. It carried out activities related to agro-biotechnology and bio safety in Paraguay, Canada, Mexico, Brazil, Barbados, Costa Rica, Bolivia and Chile. It promoted the use of clean energy in Argentina and supported the linkage of producers to markets in The Bahamas, St Lucia, St Kitts and Nevis. Likewise, in Costa Rica, it contributed to implementing the Program to Promote the Competitiveness of the Rice Chain (PRONARROZ). It also contributed to the creation of the Scientific Network on Localized Agrifood Systems (REDSIAL) in Latin America. Similarly, in order to strengthen the agro-entrepreneurial and associative capacities of small and medium-sized producers, IICA promoted actions to strengthen value added in the Dominican Republic, Argentina, El Salvador, Guatemala, Venezuela, Honduras and Colombia.

The Institute also directed actions toward promoting risk management and reduction in Haiti in order to strengthen agricultural productivity. Additionally, it carried out actions to promote the modernization of markets and marketing systems, through the Market Information Organization of the Americas (MIOA), for which IICA acts as the Technical Secretariat. Within this category, it promoted activities in Uruguay to democratize access to information on agricultural markets. It also promoted training in food safety in Nicaragua, Central America and the Caribbean to strengthen the capacity of farmers to produce safe food, and carried out activities to strengthen the modernization of national sanitary and phytosanitary services in 29 LAC countries, including the Dominican Republic, Haiti, Venezuela, Ecuador, Paraguay, Bolivia, Brazil, Mexico, Guyana, Suriname, Uruguay, Barbados, St Lucia and Dominica (IICA 2011:11-21).

During 2012, in accordance with the guidelines defined by the 42nd General Assembly of the Organization of American States held in Cartagena, Colombia (IICA nd), IICA continued to orient its technical cooperation activities with countries in the Americas in order to strengthen technological innovation, which will enhance the productivity, sustainability and competitiveness of hemispheric agriculture. It also continued to implement the strategies and guidelines defined in the 2010-2014 Medium-Term Plan and the IICA-country strategies.

In his 2102 report, the IICA Director General indicated that there was need to:

Inovate for more productivity, incorporate producers of all kinds into value chains, adapt agriculture to climatic variations, use land and water resources in a sustainable way, and above all, feed an ever-growing population - challenges that demand action from governments, citizens, public institutions and producer organizations, along with the support of international organizations (IICA 2012).

Among the actions carried out to meet IICA's Strategic Objective 1 (to improve the productivity and competitiveness of the agricultural sector), the Institute in 2012, continued to strengthen national technological innovation systems in El Salvador, Nicaragua, Costa Rica, Uruguay, Paraguay, Peru, Bolivia, Mexico, Belize, Antigua and Barbuda, Bolivia, Chile, the Dominican Republic, and St Kitts and Nevis. It highlighted the model of innovation called the 'Family Agriculture Plan of El Salvador'.

In order to promote the use of agro-biotechnologies, IICA promoted training and education to strengthen the capacities of producers and officials in Costa Rica, Ecuador, Nicaragua, Panama, El Salvador, Chile and Paraguay. The application of instruments developed by IICA to carry out diagnostics and promote institutional development, facilitated improvement in the management of national systems for the control of organic production in Guatemala, Honduras, Nicaragua and Panama. The Institute also promoted the training of producers in Belize, Grenada, Paraguay and Suriname.

During 2012, IICA continued to foster the use of clean energy by promoting 18 renewable energy generation projects in Bolivia, Colombia, Ecuador and Peru, within

the regional Energy and Environment Partnership program. It also offered technical cooperation to pine nut producers in Ecuador to produce biofuel oil, and trained producers and officials to integrate agricultural production into the markets through technical assistance, training and networking. The Business Chain Program, designed by IICA, was made available to the Guatemalan Exporters Association to link small producers of vegetables and coffee to the international market. Countries supported included The Bahamas, Guyana, Haiti and Venezuela (IICA 2012:2-8).

In order to modernize the markets, the Institute provided training in 25 countries of the hemispheric in topics related to market information, ICT use, competitiveness and market linkages. The countries supported include Costa Rica, El Salvador, Panama, nine countries of the Caribbean Community, Ecuador, Paraguay, Guatemala, Colombia, Dominica, Haiti, Grenada, Honduras, St Kitts and Nevis and Trinidad and Tobago. It also promoted agricultural insurance to manage and reduce risks in Argentina, Bolivia, Chile, Ecuador, Guatemala, Honduras, Nicaragua, Paraguay, Uruguay, Venezuela and Bolivia.

IICA's technical cooperation has enabled Latin America and Caribbean (LAC) countries to increase their participation in international forums on sanitary and phytosanitary measures (SPS) and to strengthen their effectiveness, also in the development of international regulations on agricultural health and food safety. Proposals for international standards in sanitary measures were widely discussed in 28 countries.

The Institute contributed to strengthening the capacities of countries to improve official agricultural health and food safety services by making available to member countries various instruments such as the Performance, Vision and Strategy (PVS) instrument for National Food Safety Control Systems and Services, with which eight reports and ten work plans were carried out in Jamaica, Suriname, The Bahamas, Guyana, Nicaragua, Ecuador and Venezuela. As part of this undertaking, IICA developed the International Plant Protection Convention (IPPC) online course on Pest Risk Analysis (globally accessible on the IPPC website), which was delivered to more than 80 professionals from Mexico, the Dominican Republic, Central America, Ecuador, Columbia, Peru, Bolivia, Paraguay and Brazil.

The Institute also supported the annual action plans of the Southern Cone Plant Protection Committee (COSAVE) and the Standing Veterinary Committee of the Southern Cone, as well as the Sanitary and Phytosanitary Measures Plan of the Central American Agricultural Council (CAC). It also provided support to Haiti and the Dominican Republic by strengthening their quarantine support services and training 60 regulatory bodies in the area of health and safety in the Andean Region.

With the support of the Pan American Health Organization (PAHO) and the Global Initiative for Leadership in Food Systems at the University of Minnesota, Part II of the Food Safety Leadership Program (ELFS) which trained 34 professionals from 20 countries on the topic, was implemented. Similarly, 230 personnel from the Andean Region, Brazil, Nicaragua and Barbados were trained in food safety and food inspection and certification systems. Due to the efforts of the Institute, funding was obtained for the project "Virtual Regional Food Inspection School" for the seven Central American countries and the Dominican Republic. In addition, training on good agricultural practices was promoted in Argentina, Dominica, Guatemala, Nicaragua and Venezuela, as well as risk analysis and critical control and traceability points in Barbados and Panama.

The Institute also contributed to 51 % of the territory of Mexico being declared free of the fruit fly, through the Moscafrut Program. It strengthened the skills of technicians in the National Carambola Fly Program of the Ministry of Agriculture in Brazil, Suriname, and Guyana, and supported Jamaica in the implementation of the Beekeeping Project of the Banana Tree Support Program (IICA 2012:8-15).

In 2013, IICA focused its actions on strengthening innovation, a major tool in improving productivity and increasing agri-food production in the Americas. In particular, and in order to strengthen agricultural productivity, IICA made available to the member countries 30 validated instruments to strengthen the capacities of producers and public officials in agribusiness, marketing, health, food safety, policies and institution frameworks. One of these instruments served to evaluate the preparation of producers for exporting to the United States, another to evaluate the contribution of livestock to the generation of income and achieving food security and two others were linked to business management and the development of institutional capacities for agri-business risk management.

This contributed to strengthening the capacities of the public sector and 30 producer organizations in Ecuador, Paraguay and Guatemala, as was the case with Brazil, Argentina, Uruguay, Paraguay and Chile. Likewise, more than five thousand agricultural stakeholders were trained in the areas of partnership, entrepreneurship, exports, domestic trade, value addition, best manufacturing practices, health, food safety and value chains. The Institute promoted actions to consolidate the Markets Information Organization of the Americas, which is already integrated into 33 countries of the region and offering information on agricultural markets (IICA 2013:2-7).

In accordance with the 2014-2018 Medium-term Plan, in health matters, the Institute supported 29 countries in the region in the development of international standards for phytosanitary measures. It also promoted in countries the dissemination of information on the standards for the World Organization for Animal Health (OIE) through online meetings.

With regard to food safety, the Institute supported 18 countries in their work on Codex Alimentarius. Specifically, IICA led projects to create the Virtual Regional Food Inspection School for the Central Region and the Dominican Republic and the Virtual Regional Phytosanitary Inspection School. It also trained 4600 maize and bean farmers in Guatemala in the use of good agricultural practices (IICA 2013:7-8).

In 2014, the Institute carried out several actions aimed at increasing the productivity and competitiveness of agriculture in the Americas. The central focus of its agenda was food security, which sought to make agricultural activities in the region more productive, competitive and sustainable. In that year, the implementation of the 2010-2014 Medium Term Plan ended, in which, in addition to continuing with its technical cooperation strategies, it initiated a new cooperation model, focused on delivering solutions.

In accordance with the 2014-2018 Medium-Term Plan, the Institute directed its productivity-related actions in keeping with the fourth flagship project, geared toward improving the productivity and sustainability of Family Farming (FF). In 2014, which was declared by the FAO as the International Year of Family Farming, IICA led the organization of several events to analyze the situation of FF on the continent. These were: a) “Central American Meeting on Agriculture 2014”, held in San Salvador in partnership with the Executive Secretariat of the Central American Agricultural Council (SECAC), the FAO, the Rural Regional Dialogue Program, the Tropical Agricultural Research and Higher Education Center (CATIE), and the Center for International Cooperation in Agricultural Research for Development (CIRAD); b) “International Seminar: Family Agriculture in Latin America and the Caribbean: Historical Background, Current Situation and Challenges for the Medium and Long Term”, held in Santiago, Chile in partnership with ECLAC, CIRAD and FAO; (c) “Ninth International Forum on Sustainable Rural Development, Agriculture, Territories and Rural Affairs”, organized by IICA in Rio Grande do Sul, Brazil, with that country’s Ministry of Agrarian Development, the State Government of Rio Grande do Sul and the World Bank.; and d) “Family and Youth Agriculture” Forum, held in Costa Rica with a group of senior government officials, led by President Luis Guillermo Solís, and representatives of the Diplomatic Corps along with international organizations.

Based on the results of these events, the attention to FF was strengthened and national and regional initiatives were revitalized. In conjunction with ECLAC and CIRAD, IICA published “Public policies and family agriculture in LAC: Balance, challenges and perspectives”, which includes eleven case studies and a cross-sectional analysis (IICA 2014: 5, 6, 18).

The Institute contributed to the formulation of public policies for FF through the preparation of seven studies on the position of FF in seven countries of the region, in order to assist governments in establishing specific policies for their development. It also presented a study to Paraguay on the characterization of FF in that country and conducted training and dissemination activities in Argentina, Belize and Brazil.

As part of the project “Technological Innovation Strategy to Improve the Productivity and Competitiveness of Production Chains in Central America and the Dominican Republic (PRESICA)”, implemented by the innovation institutes in Central American and Dominican Republic and IICA with financing from the IDB, and the Regional Agricultural Technology Fund (FONTAGRO), officials from the ministries of agriculture, finance and planning, researchers and associations of producers verified the results of the project during a forum entitled “Innovation and its Impact on FA”.

Similarly, IICA published the book "Lessons of Family Farming in Latin America and the Caribbean," with support from FONTAGRO and the IDB. It also published the document "Contribution of FONTAGRO to Agricultural Development in Latin America and the Caribbean: Post collaborative projects", based on a study conducted by FONTAGRO, the IDB and IICA.

Regarding the relationship between FF and climate change, IICA contributed to the evaluation of 80 project profiles submitted to FONTAGRO and the Global Environment Facility (GEF), with the latter financing the eight best proposals for adapting Family Farming to climate change.

In 2015, the Institute consolidated the new model of technical cooperation, aimed at providing countries with high impact results that would contribute to productive, sustainable and inclusive agriculture in the Americas, and which would require the participation of all stakeholders, both public and private, national and international, linked to the agricultural sector. As such, it undertook more than 250 projects and technical cooperation actions, in order to achieve a more productive, sustainable and competitive agriculture, with emphasis on Family Farming. In that year's message, the Director General of IICA emphasized that agriculture is the basis of food security, but that increasing food availability was not enough; it was also necessary to improve access to food and its use. To achieve this, IICA carried out a series of actions to increase productivity through the use of technological tools and indigenous methods, as well as through actions aimed at improving agricultural health and food safety and reducing production losses (IICA 2015:5-6).

The main achievements in 2015 related to productivity were:

- The development and linkage to markets in eleven agricultural chains in ten countries, through the establishment of committees for competitiveness, management training, entrepreneurship, associativity and value added, and the operation of market information systems.
- The promotion of technological and commercial innovations aimed at improving agri-ecological production, agri-industry, fish farming, beekeeping and water resources management, and at reducing food losses. Products such as rice, vegetables, poultry, cacao, coffee, flowers, avocado, tomato, potato and cassava demonstrate the improvements in approaches.
- Ensuring agricultural health and food safety in the Americas through the training of health officials, standardization of processes to access markets, use of good agricultural and production practices, emergency response and food safety, and management of risks, particularly those associated with climate change.

In the area of technological innovation, IICA and the IDB supported the 2015 FONTAGRO call to generate innovations aimed at the sustainable management of natural resources in Family Farming in LAC. A decision was taken to fund the following projects from the 146 received and assessed:

- Supply centers for traditional seed varieties (Chile, Argentina, Paraguay and Uruguay).
- Technological innovations to generate resilient livelihoods in rural families along the Dry Corridor (Nicaragua and Honduras).
- Innovation platform for the sustainability of family livestock systems in Uruguay and Argentina.
- Bio-intensive cultivation for rural families in the Dry Corridor (Nicaragua and Honduras).

Specifically, in terms of innovation and FF, IICA improved the capacities of more than a thousand technician personnel and leaders to implement technological innovation, innovative extension strategies and new mechanisms of commercial involvement in the region. In Central America, the EU-funded Regional Program for Research and Innovation for Agricultural Value Chains (PRIICA) provided more than 25 technologies and practices validated in collaboration with some 4000 beneficiaries, organized in 24 local innovation consortia in partnership with the national agricultural research institutes of six Central American countries. These technologies and practices were related to tomato, cassava, potato and avocado varieties, with integrated pest and soil management, and also with fertilization and post-harvest processes and commercialization, including business plans for income generation for small farmers (IICA 2015:5-7).

In the area of food safety and health, IICA trained more than 1,000 officials from ten member countries as well as 51 companies in requirements for food export to the United States.

The Institute promoted greater competitiveness in six productive chains: cashew (Honduras), sweet potato (Jamaica), coffee and cocoa (Panama), flowers and sheep (Paraguay), goat (Trinidad and Tobago) and poultry farming (Venezuela). With regard to reduction in food losses, and with the support of PRIICA, the "Methodology for the Evaluation of Agrifood Chains for Identification of Problems and Projects (MECA)" was made available to countries in Central America. This systematic method identifies and quantifies the factors leading to post-harvest losses, and detects problems in the quality of a product (IICA 2015:8-18).

In 2016, IICA pointed out that the four main challenges identified by the hemisphere's agriculture ministers continued to be: (a) increasing productivity, (b) increasing the sector's adaptation to climate change, (c) reducing poverty and inequality and d) achieving food security. In order to address these, it was imperative to strengthen the international cooperation mechanisms. In that year, the Institute consolidated its cooperation model aimed at achieving results through the articulation of 12 regional integration mechanisms and the development of five hemispheric projects, 12 multinational projects and 31 rapid response actions. It also executed 208 projects funded with external resources, valued at close to USD 110 million.

The Director General of IICA stated in his annual report that:

These projects and actions allowed us to strengthen the capacities of public institutions to formulate and implement agricultural policies and strategies; to modernize services relating to research, extension, agricultural health and marketing; to support FF; to improve the coordination of production chains; to increase resilience, sanitation and market access for agricultural production; to guarantee more opportunities for development for those who have the least access to them; and to promote regional development, innovation and sustainability as the main route for improving agricultural production and the well-being of its stakeholders (IICA 2016:6).

Among the most relevant results of these projects that are linked to increased productivity are:

» **More competitive agricultural chains**. More than 3500 people linked with various chains (cashew, coffee, cacao, poultry, vegetables, cattle, sheep, flowers, goats, sweet potatoes, bee products, bamboo, corn and sugar) in 20 countries improved their capacities to access markets, add value to their products, strengthen partnerships, generate new business and innovate.

» **FF with more opportunities.** Honduras, Peru, Colombia, Paraguay and Venezuela received policy proposals to improve FF performance, while Chile, Paraguay, and Guatemala expanded the capabilities of their FF extension services.

» **Agricultural health.** Timely assessments of current or potential pests and diseases, such as molluscs (Andean Region), coffee rust (Central America and Jamaica), carambola fly (Guyana and Suriname) and Huanglongbing (Argentina) were carried out. Strategies, also designed to strengthen plant and animal health services, assisted in the training of personnel to participate in international meetings, and promoted awareness of legal frameworks, including the US Food Safety Modernization Act (FSMA) which facilitates easier trade between exporting countries.

» **Reduction in food loss.** The updating and application of agrifood chain analysis tools, such as the MECA methodology, is a first step for member countries to generate strategies to reduce post-harvest losses and improve the efficiency of their chains.

Among the main achievements in the field of agricultural innovation are:

» **High quality seeds.** The EU-funded PRIICA enabled Central American research institutes to release cassava, potato, avocado and improved tomato germplasm for 5314 beneficiaries. This, together with a large number of training events, improved productivity, competitiveness and food security in that region. In addition, community seed banks and other mechanisms facilitated access to and production of high quality seeds.

» **Farms with an agri-ecological approach.** Nine procedures for the integrated management of avocado, potato and tomato crops, such as fertilization, soil management, water management, pruning and grafting, demonstrated the capacities of PRIICA beneficiary countries in Central America to safeguard the environment and the health of their producers. Sixteen hundred and twenty-five beneficiaries in the Central Region applied good agricultural practices.

» **Forestry innovations.** Knowledge on the sustainable use of biodiversity was strengthened in the Andean Region through the course based on experience gained from the Sustainable Forest Management Program, funded by the Ministry of Foreign Affairs of Finland.

» **Better management of genetic material in the Caribbean Region.** Under the EU-funded Agricultural Policy Program, together with the Caribbean Agricultural Research and Development Institute (CARDI), germplasm management facilities and animal breeding facilities were improved in eight countries. These actions facilitated a greater distribution of materials throughout the Caribbean.

» **Promotion of innovation.** Three technological innovation processes were implemented within the framework of the Innovation Management Network in the Agri-food Sector (Innovagro Network), which integrates 82 public and private institutions from 16 countries in Latin America and Europe: a) method for the biological control of the olive fly in Spain, b) the latest nano particulate aqueous technology for producing vaccines for farm animals in Argentina and c) a computer application to define the fertilization needs in rice crops in Uruguay. Seminars, videoconferences and workshops were organized to strengthen the capabilities of 3500 persons.

With regard to agricultural health, the main results include:

» **Strategies for animal and plant health services.** Through the use of the tool developed by IICA known as PVS, it was possible to define strategic actions for the plant health services of Ecuador, Argentina and El Salvador. The emergency response capacity in Uruguay and Chile was determined and Ecuador's veterinary and food safety services were strengthened.

» **Compliance with international regulations.** IICA was instrumental in implementing good agricultural practices in the region to facilitate compliance with the US FSMA, by sensitizing public and private stakeholders to this regulation and certifying 45 food safety professionals from Antigua and Barbuda, Barbados, Grenada, Jamaica, St Lucia and Trinidad and Tobago as lead instructors.

» **Comprehensive risk management plans:** With the cooperation of IICA, several countries managed to improve capacities for the design and participatory management of public policies and strategies for the integrated management of health risks associated with climate change. Examples are the national plan formulated in Costa Rica to address emergencies in the poultry and pork sectors, the Action Plan of the Animal Welfare Commission of Brazil and the development of a manual on the implementation of good agricultural and livestock production practices for a resilient agriculture, which was already being used by 389 technical personnel from ten countries.

» **Standardization of food safety controls.** Four hundred and seventy-nine inspectors successfully graduated from food inspection and food auditing courses conducted within the framework of the Virtual Food Inspection School in Central America and the Dominican Republic, which facilitated the consolidation of a network of experts in this area.

Strengthening of health measures in the Caribbean. A number of institutional efforts, coupled with action with partners such as the EU, strengthened the capabilities of the Caribbean region in plant health, mainly in plant virology, communication, pest diagnosis and quarantine. The validation of a legislative model for plant health, animal health and food safety by CARIFORUM countries was the basis for formulating a standardized legislative framework, creating regional mechanisms for articulation and increasing the participation of countries in international meetings on Agricultural Health and Food Safety (AHFS) by 60 %. On the other hand, 1350 public and private

stakeholders were trained in AHFS requirements, which improved safety systems for more than 25 private companies.

» **New capabilities in plant health.** Institutions in Argentina, Brazil, Bolivia, Chile, Paraguay, Peru and Uruguay, members of the Plant Protection Committee (COSAVE), strengthened their technical capacities in plant health and have the tools to carry out general phytosanitary surveillance processes. In addition, their phytosanitary inspectors were integrated as students in the International Module of the Virtual Regional School for Phytosanitary Inspection, which seeks to prevent the entry of pests into countries and guarantee health in the trade of agricultural products. For their part, Venezuela, Guatemala, Honduras, Colombia and Ecuador participated in programs to strengthen phytosanitary management.

» **Impact of animal health programs**: Within the framework of the Standing Veterinary Committee (SVC), the six member countries of the Southern Region have a methodology for the economic evaluation of their programs.

» **Good practices in poultry production in Venezuela:** In this country, 100 public and private interest groups were trained in good agricultural practices for poultry production and a study was developed to establish good poultry practice guidelines.

In the area of business and associative development of production chains, the achievements include:

» **Competitive chains.** Chains relating to coffee and cocoa in Panama, sheep and floriculture in Paraguay, fruit in El Salvador, goat milk in Trinidad and Tobago, poultry in Venezuela, vegetables in Argentina and sweet potato in Jamaica strengthened their competitive, sustainable and inclusive management, through processes for establishing or strengthening of associative boards, the use of manuals and the development of business plans. Nineteen hundred stakeholders from these chains were trained in technological options for the management of milk, postharvest fruit, ornamental bio inputs, sweet potato cultivation, pest and disease control, economic and risk assessments, cadmium and carbon footprint management.

» **Associative meetings.** The application of the methodology developed by IICA on associative encounters and internships in FF allowed 65 organizations from Colombia, Guatemala, Honduras, Nicaragua, Uruguay, Chile, El Salvador, Venezuela and Ecuador to strengthen their associative management capacities to improve their performance, access to services and their commercial linkages.

To reduce food losses, the following actions were taken:

» **Analysis and efficiency in the chains.** MECA was updated with the support of its original authors and the Postharvest Education Foundation. This methodology identifies weaknesses along the chains that cause food loss and seeks solutions to the problem. The methodology was applied in Peru in the hard yellow maize chain with the support of the Ministry of Agriculture and Irrigation (MINAGRI), the Norte Chico Agricultural Cooperative (COOPANORTE) and the Ecumenical Center for Promotion and Social Action (CEDEPAS Norte). It was also applied in Uruguay in the lettuce chain with the collaboration of the Model Market and the General Agricultural Directorate (DIGEGRA) of the Ministry of Livestock, Agriculture and Fisheries (MGAP).

In addition, there were 745 events, in which approximately 52 000 persons were involved in training programs, training or knowledge exchange led by IICA, with more than 500 partner institutions promoting better agricultural practices, innovation, health, trade, land and water management and the development of opportunities for rural stakeholders (IICA 2016:4-23).

06

RECENT SUCCESSFUL PROJECTS WITH IICA COOPERATION

In order to comply with the mandate of the Ministers of Agriculture of the Americas, as well as the strategies and guidelines established in the 2010-2020 Strategic Plan and the 2010-2014 and 2014-2018 medium-term plans, IICA has implemented a series of actions and promoted various projects and initiatives linked to the increase in agricultural productivity within the hemisphere, particularly, in the FF.

Among the most important projects are:

A. Support for the design and implementation of the Program for the Promotion of Competitiveness of the Rice Chain (PROARROZ) in Costa Rica

Scope:
National, with specific actions in some regions.

Type of project:
Program that is in the process of validation and approval in order to be leveraged with external resources. The formulation and some specific management activities of the project are being supported with IICA resources as seed funding.

Issue:
Rice is an essential product in the diet of Costa Ricans, who consume some 57 kilograms per person per year, which places them uniquely below the Asian countries with respect to this consumption. In nutritional terms, rice accounts for approximately 17 % of the total amount of kilocalories consumed (more of half the total amount of grains) by the Costa Ricans.

Price setting regimen for rice in Costa Rica:
As a mechanism for protection and promotion of production, Costa Rica maintains a nominal tariff of 35 % and a price setting scheme for all the segments of the production chain. The lowest fixed price that the producer receives represents a subsidy, classified as highly distorting of the trade, in accordance with the criteria outlined by the World Trade Organization (WTO) and, thus, is subject to an annual monetary limit.

The levels reached in recent years by this bottom price to the producer, and the resulting increase in domestic production, have facilitated a rapid growth in the amount of the subsidy given to rice producers, which surpasses the maximum limit applicable to Costa Rica by more than 500 %.

This has engendered consultations within the WTO by trading partners who are concerned about this situation. At the domestic level, industrial groups who are worried about the increase in the cost of raw materials, and consumers, argue that the fixed price affects the lower classes within the country, who pay a surcharge for local rice.

Impact of the price setting regimen for rice on Costa Rica:
Price setting has directly impacted the consumer and the rice producer. In order to establish price levels for the producer, the mechanisms used are based on national averages, which rewards the major producers more than the small and medium-sized producers, whose production yields are lower and their production costs are higher than the national average. The fact that more than 80 % of the national output is produced by less than 20 % of the farmers makes this data all the more poignant.

The impact for the consumer is evidenced mainly by the increase in the final price of rice as a consequence of the price setting scheme. The price fixed by law for local rice is approximately 80 % higher (August 2010) than the cost of imported and nationalized rice (without taking the tariff into account) of United States origin, which is evidently reflected in the final price to the farmer. This is very important when one considers that the proportion of income that the poorest segment of the population devotes to the purchase of food is approximately 40 %, and that the expenditure on rice represents nearly 9 % of the average expenditure of the household.

Problems caused by the price setting regimen for rice:
The high prices, which are not bound to international rice prices, have resulted in an increase in the number of producers, in the surface area planted, and consequently, in local production. For example, as a result of higher local prices for grain, the number of rice producers increased by more than 37 % in 2009 and 2010 (in comparison to 2008 and 2009). This generated an increase in the production of this grain by more than 30 %. Far from being a positive fact, this situation exceeded the drying and storage capacity that the country has.

Within the framework of the WTO, of which Costa Rica has been a member since 1995, the agricultural trade rules established in the Agreement on Agriculture (AoA) stipulate a specific limit that each country can grant in distorting subsidies. In this regard, for the specific case of Costa Rica, the principal distorting subsidy is the price support for rice, which occurs because of the official fixing of the purchase price by the industrialist to the farmer.

The maximum amount committed to by Costa Rica with regard to the Aggregate Measures of Support (AMS) is USD 15 945 000, a figure that has been increasingly surpassed since 2007. In 2009, the amount of this subsidy rose to USD 91 743 858, and for the year 2010 to a similar amount. These problems of international scope, in addition to the internal problems relating to the utilization of the support mechanism

for rice prices, both for the producer and for the consumer, make it impossible to maintain this price control instrument.

In light of this situation, a commission comprising three ministries was created: the Ministry of Agriculture and Livestock (MAG), the Ministry of the Economy, Industry and Trade (MEIC) and the Ministry of Foreign Trade (COMEX), for the purpose of finding a solution that takes into account the four elements related to this topic: legal framework of the AoA, potential impact on the consumer, producer, and industrial rice activity.

The solution to this problem should be geared toward replacing price setting for rice. In light of this situation, some small and medium sized rice producers will require public support in order to improve their levels of competitiveness, while others will need different production alternatives that will guarantee them an adequate and sustainable income level. Based on this premise, the Government of Costa Rica invited IICA to prepare this program is aimed at improving the competitiveness of the rice producer with less than 50 hectares.

In order to facilitate implementation of the program, the Government of Costa Rica designated a Rice Program Management Unit which represents the public institutional framework in the issue, and is in charge of spearheading the process.

General objective:

To support the management of the program to promote the competitive development of small and medium sized rice farmers through improvement in production and by seeking options for diversification based on technological innovation that makes it possible to increase the income of small and medium sized rice farmers in Costa Rica.

Specific objectives:

1. To support the dissemination, awareness, and approval of the PROARROZ proposal.
2. To support the formulation and implementation of PROARROZ in order to promote an increase in the productivity, performance and the generation of new production alternatives that enable diversification.

Beneficiaries:

The direct beneficiaries of this initiative are 727 small and medium sized farmers who are at levels 1 and 2 of rice production, and who were also registered as producers before the period 2005-2007.

These farmers account for 74 % of the total number of farmers devoted to this activity. They constitute the segment that is most vulnerable to situations of production and market risk.

Duration: four years

Activities:

1. Increase in the productivity, yields and capacity for commercial management of the small and medium sized farmers (SMSF).
2. Generation of new productive alternatives that facilitate diversification and commercial management capability in the SMSF.
3. Sensitization meetings for the PROARROZ program held in the provinces and rice- cantons around the country.
4. Support for the formulation of the PROARROZ Program carried out jointly with public and private stakeholders.
5. Development of Program implementation activities in accordance with the logical framework.

Subprojects:

Period 1

Subproject 1: Data analysis and characterization of SMSF with potential for rice production or for product diversification.

Period 2

Subproject 2: Promotion of seed and grain production and rice storage.
Subproject 3: Promotion of associations for the rice postharvest.
Subproject 5: Development diversification in agro-productive options.
Subproject 6: Creation of competitive funds for diversification initiatives.

In order to develop the aforementioned subprojects, it is imperative to carry out technological and commercial innovation activities throughout all the links of the rice chain.

In this regard, it is proposed that work be carried out jointly with the National Rice Corporation (CONARROZ), the National Institute for Innovation and Transfer of Agricultural Technology (INTA), the National Seeds Office and the MAG. The role of IICA as a facilitator of the process and support in strategic topics and knowledge management will be carried out by means of the following results, products, indicators, and activities.

Period 3

Subproject 4: Marketing and strengthening of business and organizational management.

Products:

1. Document with technical and conceptual contributions by the key stakeholders in the PROARROZ Program.
2. PROARROZ Program Document.
3. Reports on progress in the indicators of achievement of proposed subprojects.

Expected results:

1. Producers, consumers, industrialists, and public rice institutions related to the chain endorse the proposal by the PROARROZ Program.
2. Producers, consumers, industrialists, and public institutions related to the rice chain have a program document, for use in fundraising.
3. The SMSF take note of and use new technologies, processes, and innovations that can improve their competitiveness.

Indicators of achievement:

1. IICA received a note of approval for the PROARROZ Program profile from CONARROZ.
2. CONARROZ, MAG, MEIC, and COMEX send a letter of approval of the PROARROZ Document Program.
3. Progress reports approved by the management of the Program.

B. Argentine Food Quality Program (PROCAL)

Quality management and food differentiation program

Objectives:
Contribute to greater competitiveness of the Argentine food and agriculture sector by incorporating greater value added among the different links that make up the food and agriculture chains in order to help to increase the sales of differentiated Argentine food based on the improvement of their competitive strengths. The general objective of the project is to increase the adoption and development of value added tools (quality management and food differentiation systems) on the part of the companies.

Beneficiaries:
The image of the country as a food provider at the global level, consumers and food companies that make up the sector, especially the SMEs, as well as the companies providing service and the public workers at the national, provincial and municipal levels.

Components:

- Component 1: Development of quality management - differentiation. Optimize differential attributes and improve the image or services associated with the products in order to achieve greater and better positioning of food in the markets.
- Component 2: Institution building. Ensure implementation of actions through the creation, systematization and application of standards with respect to food quality and differentiation. Create a comprehensive assistance center for support and assistance to the food SMEs.

In the first stage of the PROCAL, the initiative brought together efforts from the State, the provincial governments, municipalities, and producers, for the purpose of setting up quality systems on different agricultural farms. It was based on three pillars: pilot projects, training and dissemination. An important lesson was learnt by many farms throughout the country. The work carried out for six years demonstrated that the PROCAL was more than a quality diffuser system. The program actually functioned as a true catalyst for cultural change within the national food production system.

- Integration of over 200 professionals throughout the country into the workforce.
- Training of 49 associated and organized groups in production and marketing.
- Generation of successful models of joint implementation.
- Replication of concepts and training formats by private and public educational institutions.
- Increase in sales by beneficiary producers.
- Generation of new businesses and opening of markets.
- Establishment of networks with public and private entities.
- Development of new investments.
- Improvements in the performance of outputs.
- Increase in exports.
- Development of regional economies.
- More than 19 000 users constantly informed.

C. Microfinance and Agricultural Insurance Project in Haiti

Financing and agricultural insurance system in Haiti (SYFAAH)

Financing associates:

- Ministry of Global Affairs of Canada, Swiss Confederation through its Federal Department of Foreign Affairs, French Development Agency.
- Associate consultants: Financière agricole du Québec - Développement international (FADQDI) and IICA.
- Associates in project implementation: financial institutions desirous of professionalizing their practices with respect to agricultural credit (including the Le Levier Credit Unions), groups of farmers, Ministry of Agriculture, Natural Resources and Rural Development (MARNDR).

Description of the project:

This project, carried out jointly by Développement International Desjardins (DID), FADQDI, and IICA, is aimed at establishing in Haiti a system of financing and agricultural insurance that will generally provide a structure for the availability of financial services for agro-entrepreneurs, with the final objective of reactivating the agricultural and rural economy, creating jobs, and improving food security in Haiti. This system includes the professionalization of the entire sector, which means strengthening the capacities of agro-entrepreneurs, financial institutions, and the State, for the purpose of effectively managing two national guarantee and insurance funds.

DID will function as the manager of the project and will help to strengthen the supply of agricultural credit with the following activities:

- Selecting the participating financial institutions.
- Analyzing their market potential in the agricultural sector.
- Adopting a strategy of professionalization with respect to agricultural credit.
- Proposing an adequate organizational structure.
- Defining adequate credit products.
- Training specialized personnel in agricultural credit.
- Preparing and implementing standards for management and supervision of credit risk.
- Having two new suppliers of funds for the SYFAAH project in Haiti.

Given the growing popularity of the SYFAAH project which has been under the responsibility of the DID since 2011, the Swiss Confederation, through the Federal Department of Foreign Affairs, and the French Development Agency added their financial backing to the assistance provided to the project by the Government of Canada (through the Ministry of Foreign Affairs, Trade and Development of Canada).

The Swiss Confederation will inject an additional amount of 6 million Canadian dollars into the project, while the French Development Agency will inject 2.1 million Canadian dollars, making it possible to broaden the impact of the project by incorporating new activities for a greater number of farmers in more agricultural sectors.

The purpose of the SYFAAH project is to provide an overall structure for the supply of financial services directed toward the Haitian agro-entrepreneurs, with the final objective of reactivating the agricultural and rural economy, creating jobs, and improving food security in Haiti in a sustainable manner. The plan is to strengthen the capacity of the agro-entrepreneurs, the financial institutions, and the State, in addition to establishing two national guarantee and insurance funds.

Carried out jointly by DID, FADQDI and IICA, the SYFAAH project also works in close collaboration of the Ministry of Agriculture, Natural Resources, and Rural Development and of the Federation of Haitian Credit Unions, Le Levier, and the Société Générale Haïtienne de Solidarité (SOGESOL), two important microfinancing institutions in Haiti which operate in the rural areas. Also participating in this project are some insurance companies and several groups of farmers who work together for a stronger agricultural sector.

D. MIOA, with cooperation from IICA and USDA

What is the MIOA?
The MIOA is a budding cooperation network, comprising institutions that are either governmental or linked to the government, whose functions and principal objectives consist in compiling, processing, and disseminating data related to the markets and to the agricultural products.

The basic purpose of the MIOA network is to promote transparency in the markets through timely and systematic exchange of information. In this process, the OIMA network works to define standards and make recommendations for the use of terminology and common methodologies. It seeks to facilitate technical assistance among its members and is linked to international technical cooperation organizations.

The principal objectives of the MIOA network are as follows:

- Promote cooperation among the member institutions and facilitate the exchange of knowledge and experiences with respect to collection and dissemination of information.
- Help to create standards with regard to terminology, methodology, and technology to be used within the network.
- Facilitate the timely and systematic exchange of information on markets among its member institutions.
- Act as a channel and facilitate a multiplier effect for acquiring financial backing from international aid organizations.

The MIOA network is defined as a catalyst entity for the common efforts towards achieving the proposed objectives. These objectives arise from the needs and concerns expressed by the institutions that are a part of the network. The intention is to resolve these needs and concerns with the resources of the members themselves, as well as contributions from national and international cooperation entities.

The member institutions of the MIOA network represent 33 countries across the Americas. All of them have a direct link to the generation of information from agricultural markets in their own countries, either for issuing prices for agricultural products, market analysis and projections, or both.

The level of development that the agricultural market information systems have achieved in the countries of the America has depended on the economic conditions of each country, the development of their markets and the importance that each country places on information as a tool in the management of agriculture and its markets.

The MIOA network does not claim to intervene in the natural processes of each country, but will direct its efforts toward promoting the use of information as a valid point in agricultural management.

In a scenario in which market integration is advancing, information and communication are elements that can prove to be the difference in the way in which each country's agriculture deals with the competitiveness that globalization imposes on it.

The strategy defined by the MIOA network to deal with this challenge focuses on the search for support and cooperation mechanisms that allow all the member institutions to strengthen their systems, acquire a common language, provide and receive help from others' experiences and expand their capacity to generate, process and disseminate information to the stakeholders in agriculture, both about their own countries and about the Americas in general.

In order to become a member of the network, the institutions should be government bodies or should be linked to government. Their functions or principal objectives should consist of compiling, processing, and disseminating information related to markets and to agricultural products and signing a letter of agreement that gives an official character to their incorporation.

Purpose:

- Facilitate timely and constant exchange of information from the agricultural product market among the members of the MIOA.

Objectives:

- Facilitate the exchange of information on agricultural markets among the member countries.
- Facilitate the exchange of technical knowledge and identify opportunities for training in order to improve market information systems in the member countries.
- Promote the idea that timely and reliable information from markets contributes to efficient marketing of crops and assistance in the identification of market opportunities.

Strategies

1. Facilitate the exchange of information on agricultural markets among the member countries:
   a. Develop, identify, use, and share relevant information with respect to Information and Communication Technology (ICT).
   b. Hold regular meetings of the MIOA, as well as special workshops.
   c. Work jointly with national, regional, and international organizations.
   d. Promote standardization of the terminology and methodology used by the agricultural market information systems.

2. Facilitate the exchange of technical knowledge and identify opportunities for training in order to improve market information systems in the member countries:
   a. Support bilateral, multilateral and global exchange of specialists.
   b. Identify, share, and promote good practices for agricultural market information systems.
   c. Seek support from local and international organizations.
   d. Coordinate and carry out training and workshops in specialized areas.
   e. Promote the use of ICT.

3. Promote the importance of the fact that timely and reliable information on markets contributes to efficient product marketing and to the identification of market opportunities:
   a. Create and share informational and promotional materials on the MIOA.
   b. Promote contact between member countries and key stakeholders.
   c. Provide institutional leaders with periodic information in terms of efforts and achievements.

Achievements:

During the 13 years since the creation of the MIOA, the following achievements have been recorded:

- Formal creation of the Organization in 2000.
- Development of a website with links to all the member countries.
- Development of professional and personal relationships among market information specialists.
- Sharing of information, such as:
  - Impact of natural disasters.
  - Availability of new products.
  - Changes in regulations.
  - Market intelligence.
  - Food security.
- Sending of information in response to specific requests.
- Numerous bilateral and multilateral efforts with respect to technical assistance and exchange of specialists.
- Evaluation of Agricultural Market Information Systems (AMIS) in the member countries to be used as a baseline.
- Development of the document “Best practices in information systems.”
- Strengthening of capacities of information systems administrators.
- Two hemispheric workshops for AMIS administrators.
- Several regional workshops for strengthening the capacities of market reporters and data collectors.
- Development of professional and personal relationships between market information specialists in the Americas.
- Broad and ever-growing acknowledgment of the MIOA as the world leader in AMIS for agricultural products.

- Continuous efforts as an organization that supports technical assistance and capacity building in national and regional projects by other organizations.
- Accurate and timely information from agricultural market through processes that enable users to: a) obtain the information, b) obtain it correctly and c) disseminate it.
- Better visibility and value of the information systems in the member countries.
- Strengthening of the approach to service to users and quality control.
- Recognition and support by the Ministers of Agriculture at the IABA Hemispheric Meeting, 2011:

Ministerial declaration: "supporting the work of the Market Information Organization of the Americas (MIOA) to promote greater collaboration between the Member States on innovative means to collect, process, analyse and disseminate information relative to markets and agrifood commodities fostering greater market transparency and efficiencies."

What is the next step for the organization?

- Develop and establish a process for ensuring sustainability of the long-term work of the MIOA: political and financial support.
- Promote greater support and collaboration among the member countries.
- Continue with activities related to capacity building in order to strengthen the market information systems of the member countries.
- Develop and continue partnerships with organizations such as: IICA, Latin American Federation of Supply Markets (FLAMA), WUVM, Technical Center for Agricultural and Rural Cooperation (CTA), FAO, The Caribbean Community (CARICOM), United Nations Conference on Trade and Development (UNCTAD), IDB, U.S. Agency for International Development (USAID), Secretariat of Central American Economic Integration (SIECA), ACC, CAN, Administrative Contracting Services (ACH), others.
- Support the commitment of the G-20 with respect to agricultural market information systems.
- Work toward a World Organization of Agricultural Market Information Systems.

E. Regional Energy and Environment Partnership (EEP) Program (Finland, Bolivia, Colombia, Ecuador and Peru)

1. **Energy and Environment Partnership with the Andean Region.**
   Country: Peru

Specific objectives:

- Strengthen the body of knowledge through the establishment of practical solutions and an institutional framework that support the development of renewable energies and energy efficiency in the Andean Region.

Expected results:

- The Energy and Environment Partnership (EEP) Program with the Andean Region has promoted in the Andean Region new technologies, management models, business models and financial instruments, through projects or studies in access and use of services and modern energy solutions.
- Projects supported and their results analyzed through a continuous system of Monitoring and Evaluation (M&E), in order to take maximum advantage of verified evidence-based information.
- The EEP Program possesses relevant information on experiences and lessons learned from the projects executed.
- The EEP Program has developed mechanisms with government agencies to standardize and align policy instruments in order to avoid conflicts and resolve bottlenecks in the access and use of sustainable energy in the Andean region.
- The EEP Program has implemented innovative actions that make it easier to ensure replication and scale-up of access and use of sustainable energy in the Andean region.
- The national and regional working groups/networks have been strengthened with respect to the items on the AEA Agenda: access and use of sustainable energy in the rural areas for productive purposes.
- The working groups/networks have access to information on topics, experiences, and lessons learned, which have been identified by the Program and other national, regional and international partners.

- The EEP Program has strengthened networks and partnerships to finance activities to support access and use of sustainable energy in the Andean region.

Financial institutions:

- Ministry of Foreign Affairs of Finland.

2. **Photovoltaic solar energy as an alternate rural energy source.**
   Country: Ecuador

General purpose:

- To improve the small-scale fishing chain with a renewable energy integration model that has been validated for frost production.

Specific objectives:

- Increase the additional net income of the UCOFROST plant.
- Reduce the loss of fish production by increasing the use of ice for conservation.
- Reduce the environmental impact of electricity generation, based on photovoltaic solar energy for the UCOFROST plant.
- Strengthen the capacities of the partners in the Union of Small-scale Fishing Cooperatives in the North of Emeraldas (UCOOPANE) for operation and maintenance of the photovoltaic system.

Expected results:

- Design, set up and operate a photovoltaic system (solar panels) for supplying electricity to the UCOFROST ice processing plant.
- Increase ice production at the UCOFROST plant in order to improve conditions for conservation of artisanal seafood production in the San Lorenzo canton.
- Strengthen the capacities of the local stakeholders (beneficiaries, local governments) by adopting an approach based on gender equity, on environmental, productive, organizational, and technical issues for renewable energy sources introduced into the small-scale fishing chain in the northern area of the province of Emeraldas.

External resources:

- USD 250 429.

Financial institutions:

- National Board of Parochial Governments of Ecuador.

3. **Rural network of advisory sales and services of renewable technologies.**
   Country: Peru

General objective:

- That the rural and peri-urban families increase their level of use of renewable energies in order to improve their standards of economic, social and environmental development.

Specific objectives:

- Have a validated model for distribution and sale of efficient and effective renewable technologies that contributes to the achievement and expansion of the mission and vision of the Yachaywasis Eco Tecnologies as Prosynergy self-sustainable social companies, for the purpose of promoting integrated, sustainable and inclusive development of the rural population of Peru.

Expected results:

- Local businesses provide advisory services and sale of quality renewable technologies to the population in the districts of the area of intervention of Yachaywasis Ecotecnológicos.
- Timely logistics management system (orders, purchases, assembly, distribution, inventories, replenishment) that makes it possible for the network of advisory sales and services to deal with the client's needs in a timely and quality manner.
- The marketing and sales strategy facilitates reaching a high level of purchasing intent among potential clients.
- The administrative, monitoring, and evaluation system is efficient for management of the rural network of advisory services and sales and contributes to gender equity, reduction in inequalities and climatic sustainability.

External resources:

- USD 239 302.

Financial institutions:

- Prosynergy.

4. **Development of the technical assistance market for efficient use of solar energy in greenhouses.**
   Country: Peru

General objective:

- Modify the use of renewable energy technologies, as alternatives for agricultural production in the Andean Highlands.

Specific objective:

- Promote access for producers from the Andean Highlands to the management of renewable energies, through the delivery of technical assistance services by the Programa Andes Tropicales (PAT).

Expected results:

- Boost the economic capacity of producers in the Cusco region through products and services from technical assistance providers from the PAT.
- Management systems functioning based on aspects of gender equality, reduction in inequalities and climatic sustainability.

External resources:

- USD 150 110.

Financial institutions:

- Barthélmy de las Casas Center for Regional Andean Studies.

F. Virtual Regional Food Inspection School for the Central Region and the Dominican Republic

The Virtual Regional Food Inspection School (ERVIA), run with financial support from the Standards and Trade Development Promotion Fund (STDF), was created in 2013 to strengthen food inspection capacities, improve safety, contribute to the protection of public health, and facilitate trade. The school ensures that inspectors have up-to-date and modern knowledge in all the countries of the region.

On 26 February 2015, nearly 300 food inspectors from Central America and the Dominican Republic commenced training in order to update their knowledge and share experiences of their work, through a series of courses organized by IICA.

The courses sought to facilitate standardization of safety controls in these countries and promote the food trade in the region. These training events, which are part of the ERVIA, would be conducted through IICA's Moodle platform, which is available on its website http:/moodle.iica.ac.cr/moodle/.

The purpose of the courses was to benefit small and medium-sized producers by teaching them good agricultural practices emanating from appropriate inspections in primary production. According to Robert Ahern, leader of the AHFS area at IICA, 'we expect that with the creation of a corps of inspectors to handle standardized controls, there will be fewer obstacles to regional trade, and that modernization and permanent improvement in regulations will be promoted'. He added that standardization of regional inspection procedures will contribute to a consolidation of the customs union in Central America.

The project would have eight groups financed by the STDF.

Those in charge of directing the virtual classrooms were recognized academics from universities in Belize, Costa Rica, Panama, José Matías Delgado (El Salvador), Rafael Landívar (Guatemala), National Agriculture University (Honduras), National Autonomous University of Nicaragua - León, and ISA (in the Dominican Republic).

Training, in six modules covered topics such as basic food chemistry, dangers associated with food safety, good agricultural practices, risks and controls associated with meat storage processes, legislation and modern principles of inspection.

At the end of the project in 2016, it was hoped to have trained between 25 and 35 % of the food inspectors in each country.

That year, the virtual school would also be at the disposal of representatives from the private sector interested in participating in the initiative. Upon conclusion of the project, a course for auditors in food safety would be made available.

Contribution to regional integration

Food inspection in Central America and the Dominican Republic is the responsibility of government entities, whose responsibilities are established by legislation in each country.

The objective of the project is to offer basic information in technical and attitudinal matters to the food inspectors in order to promote modernization and mutual recognition of the national food inspection systems. The goal of this is to contribute to the development of the region by facilitating trade and promoting safe food consumption.

“Although good progress has been made in regional standardization of regulations, at the national level more work needs to be done in strengthening and standardizing the inspection processes, as a means of building confidence in the food safety control systems, without affecting trade”, stated Ana Marisa Cordero, IICA specialist in AHFS.

ERVIA has been endorsed by the CAC, which is made up of the Ministers of Agriculture in the eight countries, as well as the Central American Health Ministers Council and the Dominican Republic (COMISCA).

Furthermore, it is in keeping with the Food Safety Modernization Act of the United States (FSMA), which seeks to regulate good agricultural practices and to ensure that there is a preventive safety control system in food production and processing plants.

In June 2016, it was reported that inspectors from food safety services in Central America and the Dominican Republic would have another opportunity to upgrade their skills in their profession, thanks to the thrust of eight universities in Central America and the Dominican Republic. Working in collaboration with official safety entities, IICA developed a regional school specializing in this topic.

IICA completed the implementation of the project in June of 2016. However, both academics in the universities and official entities involved with ERVIA agreed to work together so that the school could continue to function, this time under the coordination of the University of Costa Rica, represented by Professor Marjorie Henderson of the National Center for Food Science and Technology (CITA).

For the current coordinator of the school, Ana Marisa Cordero of IICA, the delivery of ERVIA as an international public good to the countries responds to the commitment of the Institute to provide high-quality technical cooperation to its member countries with concrete results.

“Structural sustainability, the manner in which the universities and official services will organize themselves in order to continue with ERVIA, serves as a basis for the functioning of all the processes that we want to promote, and for continued strengthening of food inspection in the region”, assured the coordinator.

For Pedro de Padua from the Ministry of Public Health of the Dominican Republic, it is a positive sign that the official entities and academics are working together to generate training programs. “ERVIA will go from being a project to a program, a permanent initiative for the benefit of consumers and for trade in the region” he stated.

Meeting in the United States, the representatives of both sectors agreed that the School should be maintained as a tool for updating and harmonization of standards at the regional level, given the positive results that have been obtained since its creation.

ERVIA is the first school of its kind offering virtual training courses in keeping with modern food inspection techniques that are founded on risk reduction.

In total, 479 inspectors have passed through the course: 144 in Costa Rica, 104 in El Salvador, 64 in Nicaragua, 48 in Honduras, 47 in the Dominican Republic, 43 in Guatemala, 23 in Panama and 6 in Belize.

The School is still at the disposal of the countries of the region as an international public good that they can use to strengthen the food inspection mechanisms of their nations.

The participating universities in this initiative are the University of Belize, the University of Costa Rica, the José Matías Delgado University of El Salvador, the Rafael Landívar University of Guatemala, the National Agriculture University of Honduras, the National Autonomous University of Nicaragua, the University of Panama and the ISA University in the Dominican Republic.

Additionally, there was active participation and support from the Ministries of Health and Agriculture of these countries and entities affiliated with them, throughout the entire process.

G. Central American Program for Integrated management of Coffee Rust

General objective:

- To assist in addressing climate change and its environmental effects through the adoption and application of measures for adapting, mitigating, and reducing disaster risks.

Specific objective:

- To increase the capacity of the region to design and implement policies, programs and measures for better adaptation, response capacity and resilience of the most vulnerable populations living in the coffee producing areas of Central America and the Dominican Republic, and who are exposed to the adverse effects of climate variability and change.

Expected results:

- Result 1 (R.1): The regional integration authorities and the scientific institutions have a greater number of tools and mechanisms to cope with the threats of climate variability and change in the coffee production sector of Central America and the Dominican Republic.
- Result 2 (R.2): Small and medium-sized coffee producers improve their capacity to resist the adverse, chronic or acute conditions resulting from climate change in focal areas of Guatemala, Honduras, El Salvador and Nicaragua. (Dominican Republic).

Actions under result 1:

- A1.R1 Implementation and consolidation of a Regional Early Warning Network devoted to coffee rust and threats to the subsistence production systems.
- A2.R1 Applied research, field validation, transfer of technology, and technical assistance to small and medium-sized coffee farmers.
- A3.R1 Formulation of regional policies and strategies for reactivation of coffee production and repositioning of the sector in the national priorities.
- A4.R1. Strengthening of the regional and national institutional framework for the implementation of public policies with schemes for public private participation.

Actions under result 2:

- A1.R2 Implementation of integrated local early warning networks to provide adequate information for decision-making on adaptation to variability and climate change, as well as on possible threats to coffee production and other subsistence systems.
- A2.R2 Transfer of technologies and income diversification activities, as well as adequate and timely response mechanisms to deal with threats identified in the coffee sector.
- A3.R2. Strengthening of institutional capacity at the local level to implement public policies.

Member countries	Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, Panama and the Dominican Republic.
Budget line	Delegation Agreement, "Development Cooperation Instrument (I*nstrumento de Cooperación para el Desarollo*)", DCI--- ALA/2015/365--- 178.
Title/CRIS No.	Central American Program for Integrated Management of Coffee Rust.
Mode of implementation	Indirect management with IICA.
Dates approval	27 January 2016.

Period of execution	60 months.
Partners who will participate in the implementation	IICA, SECAC, CIRAD, German Agency for International Cooperation (GIZ), Regional Cooperative Program for Technology Development and Modernization of the Coffee Industry (PROMECAFE), Coffee Institutes.

Next steps:

- Establishment of an Executing Unit at the IICA Delegation in Nicaragua.
- Establishment of the advisory committee (IICA, European Union (EU), SECAC, PROMECAFE).
- Establishment of the Technical Committee (IICA, CATIE, CIRAD, GIZ, SECAC, PROMECAFE, and representative of the small coffee growers' organizations throughout the region).
- Description of the project, total budgets, and logical framework sent to the IICA delegations and to coffee institutes in the seven countries. Basic information for the implementation of workshops on planning, programming of activities, defining roles and goals.
- Workshops for planning, programming of activities, definition of roles and goals.
  - Research and early warning systems (begins in year 1).
  - Policies (begins in year 1).
  - Baseline and actions within the territories (Baseline begins in year 1 and actions in year 2).
- Signing of agreements with counterparts:
  - IICA - CIRAD
  - IICA - CATIE
  - IICA - SECAC
  - IICA - GIZ
- Management training for effective and efficient implementation and budgetary execution.
- Beginning of activities, implementation of the project.

ACTIONS	EUROPEAN UNION FUNDS (THOUSANDS OF EUROS)
A0. R1 Baseline	104
A1. R1 Implementation Regional Early Warning Network	770
A2. R1 Applied research, validation, transfer and technical support for the CC	1448
A3. R1 Regional policy formulation	201
A4. R1 Capacity building	364
A1. R2 Implementation of early warning networks at the local level	437
A2. R2 Technology transfer	6823
A3. R2 Strengthening local capacities in PP	106
A4. R2 Coordination units	1439
Total	**11 734**

H. System of Rice Intensification (SRI) in the Americas

The rapid rate of climate change, together with a growing population and changing eating patterns threatens food security everywhere, especially in developing countries where millions of families depend on agriculture for their livelihood. Rice is a basic grain for millions of people throughout the world. This crop is facing major social, economic and environmental challenges that require an innovative, effective, multidimensional, and multidisciplinary intervention, such as SRI. This consists of cultivating irrigation rice in order to improve soil texture and oxygenate it instead of cultivating in flooded soils that are 100 % hypoxic, as is being done conventionally. Unlike random seeding, in SRI the seedlings are planted individually at greater distances and with a defined pattern. This system increases performance, while reducing production costs, water consumption and emissions of methane from the crop. The system originated in Madagascar in 1980 and was disseminated by Cornell University. It is currently used

in more than 50 countries and its approach has been adapted to other crops (wheat, sugar cane, corn, legumes and vegetables) and to the upland rice. SRI is being practiced by 9.5 million producers on more than 3.4 million hectares, primarily in Africa and Asia. However, there are no significant reports of its use in LAC, which means that it provides an innovative opportunity for many Latin American producers.

The benefits of SRI are very important in reducing the vulnerability of the production system to climate change by reducing the sensitivity of the crops to adverse climatic factors and increasing their resistance to pests and diseases. It promotes strong stalks that can withstand winds and hurricanes since more vigorous roots facilitate the search for water and nutrients in the soil. SRI increases yield by between 20 % and 100 %, reduces the quantity of seed required by 90 %, and of water required by 50 %. Technology development for the management of SRI is advanced and innovative. Although SRI has been used on a small scale in LAC, where technology can be replicated, innovation still has to be adapted to the local condition.

The objective of the proposal is to validate SRI in the Dominican Republic (DR) and Colombia in order to reduce the vulnerability of small rice farmers in light of the biophysical and socioeconomic impact of climate change. With the broad experience and commitment of the institutions, technical personnel, and specialized professionals, the project will enable farmers to develop skills to adapt better to climate change, to obtain social and economic benefits, and contribute to environmental preservation. The technical-operational strategy is based on three components: validation, mechanization and training/systematization.

Development of these components consists in validating technology in both countries through the implementation of demonstration plots, adapting the SRI principles to the local context, and training at least 100 researchers or technical personnel and at least 325 farmers. In addition, a strategy for dissemination and transfer of the SRI technology will be formulated for technical personnel and rice producers in both countries. Exchanges will be done among technical personnel in order to share their experiences and optimize the development of the project. The producers will be provided with markers and herbicides for use in community demonstrations, which will contribute to the development of human capital and infrastructure in both countries.

The project will lay the foundation for the successful dissemination of an innovative system with multidimensional benefits - social, economic and environmental.

The results expected at the end of the project are: 1) baseline available in the two countries from which to evaluate the effectiveness of SRI; 2) SRI validated in comparison with conventional production; 3) assessment of specialized machinery for seeding and weeding in LAC offering a solution for the high cost of labor, which is the greatest barrier to further disseminating SRI; 4) producers empowered in the social, economic and environmental benefits of SRI; 5) SRI practices adapted and documented for each country; 6) at least 100 technical personnel, researchers and extension workers trained in the principles and practices of SRI; 7) at least 325 producers know SRI; and 8) technical capability developed in two countries to monitor the dissemination of SRI. The total cost of the project is USD 430 600, of which a contribution of USD 200 000 was requested from FONTAGRO-IDB/Global Environment Facility (GEF); matching funds will be USD 230 600.

Executing agency:

- IICA.

Countries:

- Colombia.
- Costa Rica.
- Dominican Republic.

Source of funding:

- FONTAGRO.

Resources requested:

- USD 200 000.

Counterpart resources:

- USD 230 600.

Total estimated amount

- USD 430 600.

Execution period: 42 months.

Background and rationale:
Rice and Climate Change in the Americas: rice is of key importance in LAC countries for economic, cultural and food security reasons. In 2012, it was reported that more than 5.3 million hectares were under cultivation, mostly by small farmers. In the Dominican Republic, rice farming generates approximately 300 000 direct jobs and 800 000 indirect jobs, and occupies an area of 173 743 hectares. Average domestic consumption of white rice is 50 kg/year with an average price of USD 1 per kilo. In the case of Colombia, more than 20 000 producers cultivate 473 104 hectares, which indicates that 100 000 people earn a living directly from this grain.

In LAC, temperatures and climate variability, as well as frequency and intensity of extreme events are increasing. Rice production is very vulnerable, especially to droughts and floods, and forecasts indicate that there will be a reduction in yields of up to 6.4 %. On the other hand, conventional rice production requires a large amount of water, which is difficult to obtain in the required quantity and quality. Another expected biophysical impact is an increase in the types and frequency of pests and diseases, especially invasive species, that will affect the crop. Production is also affected by non-climatic factors, such as lower protections for rice in the Dominican Republic from 2016 under the DR-CAFTA Agreement. All these variables have potentially devastating consequences for most small farmers if they do not become more competitive with respect to rice imports.

SRI is a proven innovation that has been verified in more than 50 countries and practiced by 9.5 million farmers on more than 3.4 million hectares. SRI has been identified as an effective measure for adaptation of agriculture to climate change as it helps to reduce the vulnerability of the production system. Furthermore, SRI increases yield between 20 and 100 %, thus reducing the amount of seed required by 90 %, and the amount of water by up to 50 %. SRI is also practiced in unirrigated arable land and has been adapted to other crops such as wheat, sugarcane, corn, legumes and vegetables.

Unlike many of the technologies that are developed in research institutions and are then distributed to the farmers, SRI is a true agricultural innovation. It was developed on the basis of empirical observation of the practices of farmers in Madagascar. Instead of a predetermined technology package, SRI is carried out with flexible practices, but it is basically founded on four principles: 1) early transplanting of healthy seedlings that are between 8-12 days of age; 2) reduction of competition between seedlings (through low plant population: seedlings separated by a minimum of 25 cm); 3) reduced application of water that promotes soil aeration (alternating soaked soil with dry soil); and 4) addition of organic matter to improve the texture of soil and nourish the crop (application of dung, covered crops, etc.) The proven benefits of SRI include reduction of the sensitivity of the crops to adverse climatic factors, greater resistance to pests and diseases, strong stalks that resist strong winds, robust roots.

Objective of the project:

- To help reduce the vulnerability of rice farmers in light of the biophysical and socioeconomic impact of climate change through a reduction in the sensitivity of their production systems and improvement of adaptability, taking advantage of the proven innovation of SRI in Africa and Asia, as well as the incipient and promising efforts in LAC.

Purpose:

- To disseminate SRI principles and practices in order to improve efficiency in the use of water, soil, and other inputs, which will make it possible to diminish the sensitivity of the production system in light of climate change and improve the adaptation and profitability of farmers. This project will lay the foundation for successful dissemination of this innovation.

The specific objectives are to:

1. Validate SRI in LAC for rice producing families and adapt its principles to the local context by applying a rigorous methodology from the technical standpoint.
2. Identify an effective way to address the high labor costs in the SRI system through mechanization.
3. Increase the knowledge and capacities of researchers, technical personnel, and rice producers relating to the SRI system.

Identification of final beneficiaries

Direct beneficiaries:

- 100 researchers and extension workers have improved their knowledge of SRI and have access to a network of colleagues who work, cooperate, and publish on SRI, both within and outside of the hemisphere.
- 325 small and medium-sized rice producers in the DR and Colombia who share their knowledge, successes, and limitations regarding this production system.
- 1600 members of the producers' families.
- The manuals, videos and other documents benefited 1000 more people.

Indirect beneficiaries:

- Great progress will be achieved in order to ensure that this energy staple is maintained for 5000 rice consumers, and it is hoped that this will be guaranteed for millions within a decade, through knowledge expansion.

Components:

1. Validation of SRI technology in demonstration plots in the Dominican Republic and Colombia and adaptation of the principles to the local context. This component will begin with the development of a methodology for validation of SRI and the conventional plots, adjusted according to the country, area and construction of the baseline. The results obtained will be evaluated according to the SRI principles in different rice producing areas in the DR and Colombia through validations of the farmer's management on plots established on the family properties with technical advice provided by a crop research specialist, and the results will be shared with other producers and extension workers.

- At least three crop cycles will be carried out on each plot. A data collection protocol will be developed and implemented in order to monitor and evaluate the benefits of using SRI and facilitate comparison throughout the Region. The exchange of information and experiences will be promoted between the two participating countries via in-person encounters and by videoconference. These actions will make it possible to make adjustments to the SRI principles that are in keeping not only with the local agricultural conditions, but also with the sociocultural aspects governing the adoption of SRI. The results obtained could serve as basis for establishing research priorities for experimental development of aspects such as introduction to the participatory experimentation-action, weed control or utilization, seeding mechanization, preparation of beds for seeders, dosage and types of organic fertilizers, drip irrigation or spraying, direct seeding or seeding with biodegradable plastic technology. The results obtained from the SRI system will be compared with those of the conventional plots and the economic performance will be evaluated. The production cost structure will be analyzed and the cost / benefit ratio of implementing SRI will be determined.

2. Mechanization to reduce labor costs. The project will acquire only the required basic machinery as follows: a) to evaluate the use of machinery under the local conditions of those countries; and b) to demonstrate the profitability of its use versus the use of manual labor. Weed killers will be designed specifically for SRI in Asian countries. These will be used in the tests and support will also be given to the organized producers while the tests are being carried out. Once the project is finalized, this machinery will be transferred to the institutions within the consortium of each country.

3. Social appropriation and dissemination of knowledge. A strategy for dissemination and transfer of SRI technology will be formulated for technical personnel and rice producers in both countries. The SRI information and principles will be shared with a broad and diverse group of producers, technical personnel and researchers. Joint knowledge construction activities will be conducted (workshops, field trips, meetings, tours).

Activities and methodology:

Component 1: Validation of the SRI innovation on demonstration plots in the Dominican Republic and Colombia. In each participating country, leaders will be selected from among the farmers and they will be enlisted to establish the validation plots on their land, which will be set up based on the technical protocols of SRI. The plots will be established in representative regions of each country.

1.1 Define a protocol for establishing plots and raising the baseline: select the location for establishing the plots, bearing in mind the aspect of

representation and visibility, design a methodology for validation of SRI and conventional plots (according to country and area), define a standard protocol in order to determine the baseline and monitor socioeconomic and environmental variables.

1.2 Establish plots and collect data: establish plots for validation of SRI (ensuring at least three production cycles) together with control plots (conventional farming technique), adjust practices for the local agricultural conditions, and identify local research priorities to support adaptation of the innovation to the local needs (such as use of permanent beds, zero cultivation, drip irrigation, direct seeding). The plots will be established on the properties of some rice producers so that the validation is carried out in a participatory manner and responds to their realities, which will stimulate their interest and will ensure appropriation and adoption of the process, as well as the technical personnel of the institutions involved.

1.3 Determine the benefits of SRI: collect data in order to monitor and evaluate the benefits of SRI and enable comparisons in each region based on the established standard protocol, compare the SRI plots from an agricultural standpoint with conventional ones and determine the cost of conventional rice production versus the SRI system.

Component 2: Mechanization to reduce labor costs.

2.1 Obtain specialized machinery to implement SRI. Identify machinery and equipment to transplant rice plants and control weeds for demonstration purposes only. Evaluate the options for procuring equipment and machinery. Acquire the machinery.

2.2 Evaluate the machinery. Evaluate the functioning of the equipment and machinery in the field for the SRI method, on farmers' plots. Determine the management recommendations for the equipment and machinery used in SRI. Provide recommendations to the private sector and to researchers to ensure that the appropriate equipment exists in the region.

Component 3: Social appropriation of the knowledge and dissemination of the innovation. Various activities will be carried out with respect to social appropriation of knowledge, and will be done during the development of the other two components.

3.1 Hold dissemination events in the participating countries. Conduct field demonstrations and training workshops on the SRI method with technical personnel and rice producers in each country. Hold a technical event in each country for the general public.

3.2 Produce dissemination tools. Produce educational videos that cover different aspects of SRI. Produce a manual on cultivation using the SRI System for each country.

3.3 Systematize and disseminate the results of the project. Organize a project database for analysis. Produce a publication on the systematization of the SRI project in each participating country. Publish and publicize the progress of the project through Facebook, the SRI Google group, LAC, FONTAGRO, the Costa Rican Agricultural Sector Information System (INFOAGRO) National Agricultural and Forestry Research Council (CONIAF), Dominican Agricultural and Forestry Research Institute (IDIAF) and FEDEARROZ.

Expected results and products per component:

- Component 1:
  - Baseline available in the two countries on which to evaluate the effectiveness of SRI.
  - At least 4 demonstration plots available in each country in order to technically validate the SRI system in comparison with conventional farming.

- Component 2:
  - Assessment of specialized seeding and weeding machinery in the Americas.
  - Solution found for the greatest barrier to using SRI (labor cost).

- Component 3:
  - Producers empowered with respect to the social, economic and environmental benefits of the SRI system.
  - SRI practices adapted and documented in each country.
  - At least 100 technical personnel, researchers, and extension workers trained in the principles and practices of SRI by the end of the project.
  - At least 325 producers are aware of SRI.9. Technical capability developed in two countries to follow-up on the dissemination of SRI.

I. Medfly and Fruit Fly in Mexico

IICA's areas of work in Mexico are related to collaboration between producers and knowledge and technology generating centers, FF, agricultural health and food safety, inclusive agriculture, territorial management, resiliency, and efficient use of water.

Currently IICA executes 23 projects in Mexico, among them the Fruit Fly Operational Program, and has been supporting the National Agricultural Health, Safety and Food Service (SENASICA) for 21 years in the production of larvae from sterile flies and parasites, which helps to maintain areas free of or with low prevalence of flies throughout the country.

This work has supported the National Fruit Fly Campaign in ensuring that 51 % of the Mexican territory is free from this pest.

It also helps to maintain the plant health status of the country as free from the Mediterranean fly, through the Medfly Operational Program, with detection and control of outbreaks in the southern border states, which benefits Mexican fruit and vegetable-growing production (more than 200 species) and its trade in national and international markets.

In addition, the Regional Medfly Program has facilitated consolidation of the containment barrier and pest suppression in the infestation areas within Guatemala.

Through the Operational Technical and Administrative Support Programs for the Prevention of Entry and Spread of Exotic Pests and Diseases in Mexico and strengthening of the diagnostic capability of SENASICA, the operation of a network of 34 laboratories is being supported, among them 27 molecular biology labs to improve epidemiological surveillance and timely diagnosis of various diseases and pests, with the aim of keeping the country free of exotic diseases that endanger the country's agriculture and livestock.

The Medfly Program is recognized worldwide as one of the first ones to be developed in the American hemisphere for control of the Mediterranean fly, and the first program for control and eradication. It uses integrated management based on the sterile insect technique (TIE) with which it has managed to keep Mexico free from this pest since 1979.

The Mediterranean fly is among the ten most important economic pests and among the most devastating for agricultural production in the world. Its presence in the country would wipe out the possibility of exporting more than 250 species of fruits and vegetables such as mango, citrus and tomato.

The contribution of sterile flies that are produced at the plant currently operating in Chiapas is of vital importance for agricultural activity within the country and for exports to various parts of the world. Furthermore, for each peso invested in the Medfly Program over the last 35 years, the country has obtained 112 pesos in benefits.

Medfly Operational Program:

Introduction

The Medfly Program is based on the Federal Plant Health Law to prevent the introduction, establishment and spread of pests that affect vegetables, their products and by-products, and are causative agents in plant health problems. Its reference is "Official Mexican Standard (NOM)-076-FITO-1999, Preventive System and National Emergency Plan against the Exotic Fruit Flies". Its objective is to maintain the country free of the Mediterranean fly, through early detection of the entry of this pest and execution of emergency plans that guarantee its eradication, based on the NIMF-08.

In 2016, there were 248 registered entries of pest (69 outbreaks and 179 isolated detections) in the three operating centers bordering Guatemala (Soconusco, Comitán and Palenque), from the infestation areas in the south-east, north-east, and Northern Transversal Fringe of Guatemala, respectively. Through timely application of the emergency plans, 235 entries were eradicated; only 13 remained active in 2017.

In 2016, greater pressure from the pest was exerted towards Chiapas, from the infestation areas located in Guatemala, in comparison with the 20 entries recorded in 2015.

Following the strong infestation that occurred in 2007, which was characterized by the number of pest events (774) and its wide geographical distribution in the state of Chiapas and in the southern part of the state of Tabasco, the pressure from the pest toward Chiapas was reduced in 2008, due to the application of emergency plans, both in Chiapas and in Guatemala. In 2016, a similar situation to that of 2008 occurred, which could have been influenced by "El Niño", in which rains were limited and temperatures were high. This caused the duration of the biological cycles of the Mediterranean fly to be shortened, thus producing more generations in 2016. As a result, there was an increase in the pest population in the infestation zones in the south-east, north-east, and Northern Transversal Fringe in Guatemala. Thus, greater pressure was exerted toward the areas that were free of hosts.

Benefit or impact

The actions carried out jointly and coordinated with personnel from SENASICA and personal contracted under the Agreement between the Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA) and IICA in 2016, made it possible for the Medfly Program to fulfil the purpose of keeping the country free of the Mediterranean fly, through early detection of the entry of the pest and execution of emergency plans that guaranteed its eradication, based on the Protocol for eradication of transitory entries of the Mediterranean fly in free areas and the NIMF-08. Furthermore, these actions have contributed to the fact that the Regional Program is advancing toward consolidation of the containment barrier to protect the free areas in Mexico and Guatemala.

J. Meeting sanitary standards for export to Canada of cacao from Peru and Colombia

IICA currently sponsors a cacao project aimed at promoting income opportunities for women in the processing of cacao in Peru and Colombia. The activities are geared toward boosting the capacity for access to Canadian markets, including those linked to organic, direct and sustainable production systems.

For implementation of this project, the IICA Delegation in Canada works in collaboration with Canadian entities such as the Financial Alliance for Partnership for Sustainable Trade (FAST), Uniterra, a leading program in Canadian international development that is operated jointly by the World University Service of Canada (WUSC) and the Center for International Studies and Cooperation (CECI) and with Canadian and Peruvian cocoa and chocolate companies.

Canada is one of the largest consumers of chocolate. Average consumption is 6.4 kilograms per person per year, one kilogram more than the United States, which represents some 160 bars of chocolate per person per year. These figures make Canada the ninth largest consumer of chocolate worldwide.

Peruvian cocoa is recognized internationally as one of the best in the world. As the winner of several international awards, Peru is one of the principal countries of origin for cocoa and possesses 60 % of the varieties of this plant in the world.

At present, Peruvian cocoa is in high demand from some of the most exclusive chocolate manufacturers in Canada, Switzerland, Belgium and France. Furthermore, according to the International Cocoa Organization (ICCO), Peru is one of the few countries where fine cocoa is produced and exported, with excellent attributes in terms of flavour and aroma.

K. APP Program financed by the European Union in the Caribbean

Contribution Agreement of the European Union with an International Organization EDF/2012/310-015 and IICA for the execution of the action known as: Caribbean Action within the Framework of the 'Agriculture Policy Programme (APP) Focused on the Caribbean and the Pacific'.	
Nature	The object of this agreement is the contribution of the EU for the execution of the action known as: Caribbean Action within the Framework of the "Agriculture Policy Programme (APP) focused on the Caribbean and the Pacific."
Objective	Contribute to boosting regional (Caribbean and Pacific) and interregional capacities of the agricultural sectors for the eradication of poverty.

Contractor	IICA
Location of project	Trinidad and Tobago
Income from contract	EUR 8 600 000 CARICOM Component 1 EUR 2 517370 CARDI Component 2 EUR 2 703 163 Project Management Unit (PMU) EUR 830 500 IICA Component 3 EUR 1 986 350
Start date	15 March 2013
End date	31 December 2016

Relations with the European Union

For several years, IICA has participated in various programs co-financed by the EU. This collaboration with the European Union provides IICA with an opportunity to position itself as a strategic partner in LAC through its technical capability and its national, regional and hemispheric presence. Initially, IICA has collaborated with the European Union through grants, technical assistance, or tenders; however, since 2009, a process of evaluation of IICA by the EU began through a joint management audit called the "Four Pillar Assessment."

In the report "Four Pillar Assessment" of the EU, aspects were analyzed in terms of accounting, audit, system of internal audit and procedures of the Institute. The report indicates that IICA operates in accordance with internationally acceptable standards and is in a position to implement managerial tasks jointly with funds from the European Union.

This report credits the Institute as a partner to carry out contribution agreements with the EU. Thus, the IICA delegations are in a position to sign bilateral grant agreements with the delegations of the European Union.

Other important projects financed by the EU:

- PRIICA. IICA and the Central American Integration Agricultural Technology System (SICTA) initiated the execution of PRIICA, which is an initiative that has financial support from the European Union in the sum of USD 5 000 000 (five million dollars). Its objective is to improve the regional policy with respect to food security, especially for the most vulnerable groups, as well as promoting research and innovation of technologies in agricultural production. The partnership between IICA, the EU, SICTA, and the governments of the Region makes available to the countries technical and financial resources aimed at increasing food security levels and combating the high levels of poverty in the countries of the region. PRIICA is carried out in Central America with participation from the national agricultural research institutes of Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama.
- "Guaviare Forest" Project in Colombia in the amount of 1 200 000 €.
- Project "Support for the Strengthening of the francique mango chain in the Central Department" in Haiti in the amount of 1 500 000 €.
- Project "Support for strengthening the monitoring of food security in Haiti through the observatories " in the amount of 1 500 000 €.
- Project "Creation of sustainable employment opportunities through economic diversification in the banana producing parishes in Jamaica" in the amount of 234 500 €.
- European Space Agency. In 2009, IICA was selected by ENESA to participate in the European mini project "Remote Sensing as an Instrument to Manage Risks and Develop Agrarian Insurance in the Rural Sector" carried out by EDISOFT. This mini project is integrated into the JAGUAR project of the European Space Agency (ESA) which contracted Indra to carry out a characterization study of the Earth Observation sector in LAC. The objective of the JAGUAR project is to analyze the current situation within the remote sensing sector for the purpose of establishing a Strategic Plan of Action in this region for the period 2009-2014.
- Projects in Central America, Jamaica and in the countries of the Southern Common Market (MERCOSUR), for a total of USD 11.3 million, for research and innovation in agricultural value chain, strengthening of the capacity of producer organizations in the beekeeping sector, design and implementation of the MERCOSUR Virtual School, year 2011.

- Bidding with the European Union within the framework of the ECONORMAS-MERCOSUR Program. Amount 153 900 €, year 2012.
- Contribution Agreement between the European Union and IICA for the strengthening of the Sugar Industry Research and Development Institute (SIRDI) in Belize. Amount 3 055 444.66 €, year 2012.
- In negotiation, an additional project entitled "Toward a Knowledge-based Economy in Latin America and the Caribbean."
- In negotiation, implementation of the European Union Regional Agriculture Strategy for the Caribbean.

L. PRIICA Project financed by the European Union in Central America

PRIICA is an initiative promoted by the EU and IICA. This program helps to increase the availability of food and access to it, and to generate international public goods, through agricultural research in the products chain: potato, cassava, tomato, and avocado in Central America and Panama.

The main challenges that it faces are the following:

- Improve the living conditions of the beneficiaries, through the generation of income and consumption of the products-chain.
- Consolidate agricultural research based on the needs of the beneficiaries.
- Strengthen extension and transfer services in order to strengthen the adoption of technology, knowledge and practices.
- Diversify national innovation systems through the articulation of public-private partnerships.

All its actions are carried out by IICA, jointly with the national agricultural research institutes (INIA) and other stakeholders in the public and private sectors of the participating countries.

PRIICA is a program with funds amounting to 5.6 million Euros from the European Union and contributions from IICA.

Beneficiaries:
The designated beneficiaries of the program are small farmers and individual or organized producers located in marginal cultivation zones for cassava, avocado, tomato, and potato, as well as researchers in public and private sector consortia and organizations that form the links of each chain. These categories include farmers' associations, cooperatives, trade boards, rural promoters, and municipalities, among others.

With respect to institutions, the INIA stand out as the most important beneficiaries to which support is given from the institutional standpoint.

Likewise, there are the members of the national technology transfer systems which, in some cases, are directly linked to the INIA, but which in many cases are entities that belong to the Ministries and Secretariats of Agriculture. In other cases, rural development entities that function at the local level were identified, that is, they are seen as public sector recipients (transfer and extension), followed by the university extension services.

In short, it is estimated that the fundamental beneficiaries of the program will be 4800 producers in 24 local research and technological innovation consortia (CLIITA). This includes the beneficiaries of their grassroots organizations and even researchers at the national and regional levels.

M. Comprehensive Dairy Development Program (PIDEL) of Venezuela

PIDEL is a technology transfer program geared toward small and medium-sized dairy farmers. The program consists of applying integrated management to the production units, which gives the producer the sense of belonging and vision of a company on his/her farm.

There is an urgent need in Venezuela and the world to increase milk production, and this is behind the action of a group of researchers in the agricultural livestock sector, who with the support of public and private institutions, are putting their ideas and productive proposals into practice within the dairy sector. This is how PIDEL was born, as a national reference in the application of biotechnologies and innovation of productive models in order to develop the national dairy sector.

PIDEL is made up of professionals in various areas: veterinarians, agricultural engineers, experts, engineers in animal production, geneticists, informatics and systems engineers, graduates in administration and accounting, agricultural technicians, labourers and a number of producers throughout the country.

What DOES PIDEL offer?

To producers:

- Knowledge and technology development in the different areas of agricultural production.
- Improvement in key areas such as: management of registries, animal health, reproduction, nutrition, genetics, and environment.
- Human and social development on par with environmental enhancement through activities geared toward conserving watersheds, trees, and green areas in general.
- Training and comprehensive preparation in the area of the dairy production.

To students of the University of California in Los Angeles (UCLA):

- A window into knowledge and learning in the application of biotechnologies related directly to the agricultural sector.
- Possibilities for doing internships and enhancing their knowledge in the various productive areas, with the possibility in the future of entering the PIDEL organization and growing as professionals for a better Venezuela.

To Venezuela:

- Better nutrition for the entire population, especially for growing children, through the consumption of an important food such as milk.
- Technology development and preparation of a group of people linked to dairy production, which translates into human development and social improvements.
- Zoonotic Disease Prevention and Control.
- Dissemination of topics on the protection of the environment to children, young people and adults.

Where does PIDEL operate?

PIDEL commenced its activities in Lara state and currently addresses the needs of producers in different states around the country such as: Monagas, Anzoátegui, the southern area of Lake Maracaibo (Trujillo-Zulia-Mérida). In the upcoming months, PIDEL will initiate activities in the states of Bolivar, Yaracuy, and Carabobo.

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