Meeting of Ministers of Agriculture of the Americas 2015 and
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Technical document
Competitive, Inclusive, and Sustainable Productivity: Opportunity for the Americas

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COMPETITIVE, INCLUSIVE, AND SUSTAINABLE PRODUCTIVITY: OPPORTUNITY FOR THE AMERICAS

TECHNICAL DOCUMENT
Meeting of Ministers of Agriculture of the Americas 2015
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> *"The most powerful tool to end world hunger and poverty and boost shared prosperity is higher agricultural productivity. Some 78% of the world's poor live in rural areas and work mainly in farming, an activity that in the 21st century continues to be essential for economic development, and to feed a population that is expected to reach nine billion by 2050."*[1]

> *"Across Latin America and the Caribbean (LAC), a more productive and environmentally sustainable agriculture system holds great promise for achieving food security around the world — as well as for the region's development, for poverty alleviation and for social progress."*[2]

Foreword

Many of the technological developments of the first civilizations were designed to improve planting, growing and harvesting. Supplying food for human consumption has always been one of the main objectives of the continuous search for higher productivity in agriculture. In addition to guaranteeing the food security of a constantly increasing population, the agricultural sector has to meet the needs of other sectors of the economy; and for that, higher productivity is required.

For a long time, scientific and technological advances and the introduction of innovations made it possible to increase productivity ever more rapidly. It must be said, however, that in many cases those advances had undesirable consequences, such as the overexploitation of water and soil, the uncontrolled expansion of the agricultural frontier, and loss of biodiversity. A very obvious case in point was the Green Revolution, whose undeniable achievements in increasing productivity were marred by certain negative effects, such as contamination resulting from the use of large quantities of agrochemicals.

The possibilities of raising productivity now depend increasingly on the development of knowledge, innovations, research and, in particular, of major investments, the creation of enabling, science based policy environments and cooperation, in those areas. Furthermore, the availability of fewer natural resources for performing agricultural tasks is a problem that has been exacerbated by the effects of climate variability. Productivity, then, has to be sustainable.

[1] World Bank 2014. http://www.bancomundial.org/es/topic/agriculture/overview, January 14, 2015.
[2] IDB and GHI 2014.

From the economic and social viewpoint, productivity has expedited the generation of wealth from agricultural activities and their productive linkages with other sectors. However, highly productive farmers exist alongside a large group of producers who find it difficult to maintain a rate of production to match the demand, or even provide the income they need. Sustainable agricultural development, must therefore also be inclusive.

Productivity continues to be a condition for competitiveness, be it to incorporate all types of producers in value chains or to enable them to integrate successfully into both local and global markets.

Thus, achieving higher productivity is imperative to make the agricultural sector a linchpin of development and a source of well-being for all. It is an objective that calls for the effort of all the stakeholders linked to the agricultural sector, to enable the latter to fulfill the threefold purpose of guaranteeing the food supply, contributing to the sustainability of natural resources and promoting inclusive development in the countries of the Americas.

A number of studies have highlighted the potential of countries in the Americas to become the world's biggest supplier of agricultural products. If that potential is to be realized, however, agriculture will have to increase productivity across the board, closing the gaps that we see today within and across countries. It is here that international cooperation has an extremely important role to play, to complement national efforts.

With this document, our aim is to lay the foundation for coordinated multilateral action agreed upon at the highest political level, i.e., by the ministers of agriculture of the Americas. It was prepared jointly by specialists from Mexico's Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA), and the Inter-American Institute for Cooperation on Agriculture (IICA).

The document is designed to provide a framework of analysis for the deliberations of the ministers at their meeting in October of this year, and, before that, to garner the opinions, experiences and proposals of IICA's other member countries concerning the problems of agricultural productivity, as well as possible solutions, that reflect both the will to work together toward shared objectives, and the commitment to adopt measures in support of agricultural development and rural well-being through a common agenda.

We believe the ministers of agriculture will find the proposals submitted in this document useful, intended as they are to contribute to the achievement of sustainable agriculture and rural inclusion in the Americas, so that farmers can grow better, produce more and feed everyone.

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ABBREVIATIONS

AECID	Spanish Agency for International Development Cooperation
AVA	Agricultural value added
CAESPA	Center for Strategic Analysis for Agriculture (IICA)
CAF	Development Bank of Latin America
CBD	Convention on Biological Diversity
DC	Developing countries
ECLAC	Economic Commission for Latin America and the Caribbean
FAO	United Nations Food and Agriculture Organization
FDI	Foreign direct investment
Font	Technical Cooperation Fund (IICA)
G20	Group of 20
GDP	Gross domestic product
GHI	Global Harvest Initiative
GII	Global innovation Index
IABA	Inter-America Board of Agriculture
ICT	Information and communication technologies
IICA	Inter-American Institute for Cooperation on Agriculture
IDB	Inter-American Development Bank
IRRI	International Rice Research Institute
ISIC	International Standard for Industrial Classification
ISRIC	International Soil Reference and Information Centre
LAC	Latin America and the Caribbean
NAIS	National Agricultural Innovation Systems
NRCS	Natural Resources Conservation Service (USDA)
OECD	Organization for Economic Cooperation and Development
PF	Partial factor
PVS	Performance, Vision and Strategy
R&D	Research and Development
SAGARPA	Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food (Mexico)
TFP	Total factor productivity
USD	United States dollar
UN	United Nations

USDA	United States Department of Agriculture
WDI	World development indicators
WTO	World Trade Organization

COMPETITIVE, INCLUSIVE, AND SUSTAINABLE PRODUCTIVITY: OPPORTUNITY FOR THE AMERICAS

"The most powerful tool to end world hunger and poverty and boost shared prosperity is the improvement of agricultural productivity. Some 78% of the world's poor live in rural areas and mainly work in farming, an activity that in the 21st century continues to be essential for economic development and to feed a population that is expected to reach nine billion in 2050.[3]"

"Across Latin America and the Caribbean (LAC), a more productive and environmentally sustainable agriculture system holds great promise for achieving food security around the world — as well as for the region's development, for poverty alleviation and for social progress.[4]"

Objective

1. The basic purpose of this document, prepared jointly by the Inter-American Institute for Cooperation on Agriculture (IICA) and Mexico's Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA), is to contribute inputs for dialogue and the construction of an inter-American agenda aimed at improving the productivity of agriculture in the countries of the continent in an inclusive and sustainable way, and to enable IICA member countries to strengthen their post-2015 development agendas.

2. IICA recognizes the diversity of its member countries' development visions. The authors of this document are also mindful of the inalienable right of each country to implement its own policies, encourage its own producers, and develop its own agriculture, as independent nations and based on their principles and convictions. Furthermore, the observations and recommendations made in this document, based on a critical analysis of the evidence, are intended to provide stakeholders with the latest relevant knowledge on the subject.

Introduction

3. Throughout history, increased agricultural productivity has made it possible to supply the population with an abundance of increasingly cheaper food, thanks to which agriculture[5] has become a true engine of development and of economic growth, and a key factor in poverty reduction.

4. Over the last 60 years, world food production has grown mainly due to improvements in agricultural productivity, coupled, in many cases, with an increase in the arable land available. This has made it possible to supply sufficient food to meet the aggregate global

[3] World Bank 2014.
[4] IDB and GHI 2014.
[5] In this document, the word 'agriculture' is used to refer to agricultural activities in the broadest sense, i.e., crop farming, stock raising, forestry, and fish farming. Whenever it is used to refer to one of these activities in particular, it is done to make the problems and issues analyzed clearer.

demand, however hundreds of million people could not afford the daily minimum amount of foods for their families, either due to poverty or high food prices. Generally speaking, it has been accepted that the growth of productivity has been due mainly to an improvement in total factor productivity (TFP) (see Fuglie and Rada 2013).

5. Despite the progress achieved, concerns are now being raised about the global capacity to maintain the productivity growth rates observed in recent years. In fact, data and studies point to a clear, unsustainable trajectory wherein projected increases in crop yields are not keeping place with projected food demand (Ray, et al., 2013).

6. In the future humanity will face a serious food problem, one that is compounded by the major challenges posed by climate change, the loss of biodiversity and the ozone layer, and the pollution and acidification of oceans. Therefore, the present generations must construct new paradigms to provide for a more equitable and sustainable development of society within the limits permitted by terrestrial systems.

7. The slow growth of agricultural productivity could be a major obstacle to national development processes, especially to those countries where their economy heavily depends on agriculture, leading to significant differences in the level of per capita income, both within countries and across them. Higher agricultural productivity is essential for the development of the economy, because it allows countries to meet basic agricultural needs more quickly, thereby freeing up resources in the primary farming sector that can be channeled toward other economic sectors, including other links in the agricultural chain, and the manufacturing, mining, and services sectors (Saravia *et al.* 2013).

8. Within the framework of that scenario, the countries of the Americas have a unique role to perform, thanks to their agricultural potential, the abundance and diversity of their natural resources and, in particular, the wealth and quality of their human capital and institutions.

9. A recent study conducted by the Inter-American Development Bank (IDB) and the Global Harvest Initiative (GHI)[6] contains synthesis of information from a large number of studies on the subject of productivity It suggests that the Americas possess the natural, human, and cultural resources and institutions required to become the "global sustainable breadbasket," if major changes are introduced to facilitate innovation, promote investment, and reduce the inequality that exists in many regions of our continent.

Productivity: some basic concepts

10. In this document, the term "sustainable agricultural productivity" refers to the agricultural output achieved as a result of the use of total production factors (i.e., total factor productivity, or TFP) (see Box 1). Using this criterion, it is possible to understand the output achieved from all the factors (land, labor, capital and other material inputs) used in productive processes and the ratio to total agricultural production obtained in a given period. TFP is a better sustainability indicator than single factor productivity, such as yield per hectare, because TFP provides a better assessment of whether gains in production are

[6] IDB and GHI 2014.

driven by more inputs or by more efficient input use. For example, while yield growth could result from additions of fertilizer, labor, or capital, TFP would only grow if these additional inputs raised output more than input costs. As a result, TFP provides a broader assessment of success in producing more from less – less land, less chemical inputs, less labor, and less machinery. TFP growth is largely recognized as providing the strongest opportunity for reducing environmental externalities from agriculture. By increasing overall efficiency, TFP growth can reduce negative impacts, for example, through averting forest-to-cropland conversion and reducing greenhouse gas emissions per ton of meat and milk output. However, TFP growth does not explicitly measure environmental impacts, nor does it necessarily lead to environmental improvements. For example, the expansion of large-scale, confined hog feeding operations, a significant driver of TFP growth in this industry, has led to increases in waste concentration and water and air pollution. So, though growth in TFP is a good strategy for reducing environmental externalities, additional measures may be necessary to ensure this outcome."

Box 1. Productivity and efficiency

The broadest definition of a country's agricultural productivity is the ratio of aggregate agricultural production to the inputs used in the productive process, which is known as total factor productivity (TFP). Productivity increases when the rate of growth of aggregate agricultural production is higher than the rate of growth of the total factors used in the productive process, which includes changes in the use of resources such as land, water, labor, capital, raw materials, and energy.

Given the difficulties involved in calculating TFP, agricultural value added is often used as an indicator of productivity (measured in constant terms) per agricultural worker (see the World Bank's World Development Indicators). Other partial measures used as productivity indicators are land productivity (yield per hectare) and labor productivity, defined as the ratio of aggregate production to total labor used in the sector.

In the literature, a distinction is drawn between the two principal sources of growth of productivity (measured in terms of TFP). The first source is progress or **technological change**, which, in essence, means technological leaps or the expansion of the frontier of production, and which tends to be measured as the growth of TFP among a country's most efficient producers. The second source of productivity growth are changes in **technical efficiency**, measured in terms of the level of technology dissemination and adoption and the way in which less efficient producers move toward the frontier or their maximum production potential. This concept is particularly useful for estimating gaps in productivity, considered to be the difference between the TFP of the most efficient producers, and the TFP of the average of agricultural producers (Rada and Valdes 2012).

11. In addition to considering these factors jointly and in their totality, it is important to determine the partial contribution (PF) made by each individual factor in order to identify possible solutions involving either the development or strengthening of policies, or the application of instruments and the development of innovations to help enhance their use.

12. The most important factors that impact agricultural productivity are human capital, the use and allocation of production factors, the business environment in which the activity is

carried out, trade and the markets, and the capacity for innovation. If these factors are to be used in the best way possible, public policies must be in place to construct inclusive and sustainable productivity.

13. Given the complexity of determining TFP and the fact that many countries do not have up-to-date information on the subject, productivity is often estimated using certain indirect indicators, such as the market value of production or yield by unit area or animal unit. The productivity data to be found in this document is expressed with those indicators.

A quick look at agricultural productivity in the Americas[7]

14. Agriculture is more than crops, animals, and food. An economic activity that is key to the development and well-being of countries, it makes a major contribution to their economies and progress. In a groundbreaking study, IICA showed that, when all the productive linkages with agricultural activities are taken into account, the sector's contribution to the gross domestic product (GDP) is 8% in the case of the USA, and 34% in the case of Uruguay (IICA 2004).

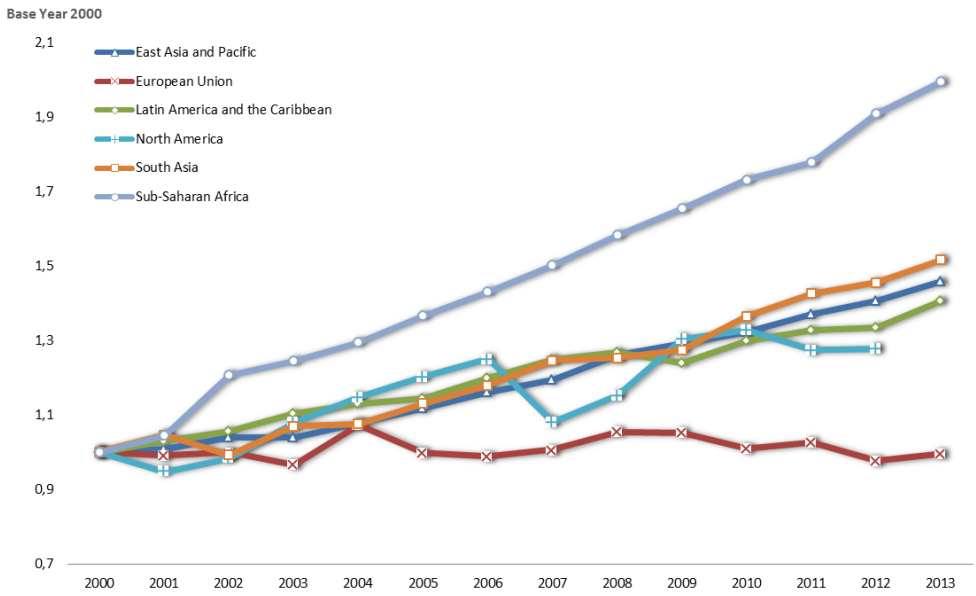
15. Figure 1 shows the trend in agricultural value added (see Box 2 for definition) in the Americas, and compares it with other regions of the world. This information highlights two facts. Firstly, that over the last ten years the trend in the agriculture of Latin America and the Caribbean (LAC), as a region, has been positive. However, the second significant fact is that growth has been slower than in other regions of the world, such as Asia and some parts of Africa, which are becoming major competitors for markets traditionally served by the LAC countries.

Box 2. Agricultural value added (AVA)

Agricultural value added (AVA) refers to net sector production based on total outputs minus intermediate inputs. It is calculated without deducting the cost of the depreciation of manufactured assets or the exhaustion and degradation of natural resources. Agriculture is included in divisions 01 to 03 of the Standard International Industrial Classification of All Economic Activities (ISIC), and includes forestry, hunting and fishing, in addition to the growing of harvests and raising of livestock. The ISIC is used to determine the origin of value added (WDI, World Bank).

[7] The description of agricultural productivity in this section is by no means intended to be exhaustive. In recent years, a large number of studies of agricultural productivity have been carried out in the region, some of the most important of which are as follows: ECLAC, FAO, and IICA 2012, 2013 and 2014; World Bank 2008; IDB 2010; GHI 2013; Saravia *et al.* 2013; Machicado *et al.* 2008; Días-Ávila *et al.* 2010 and Gollin 2010.

Figure 1. Evolution of agricultural value added (AVA) in different regions of the world.



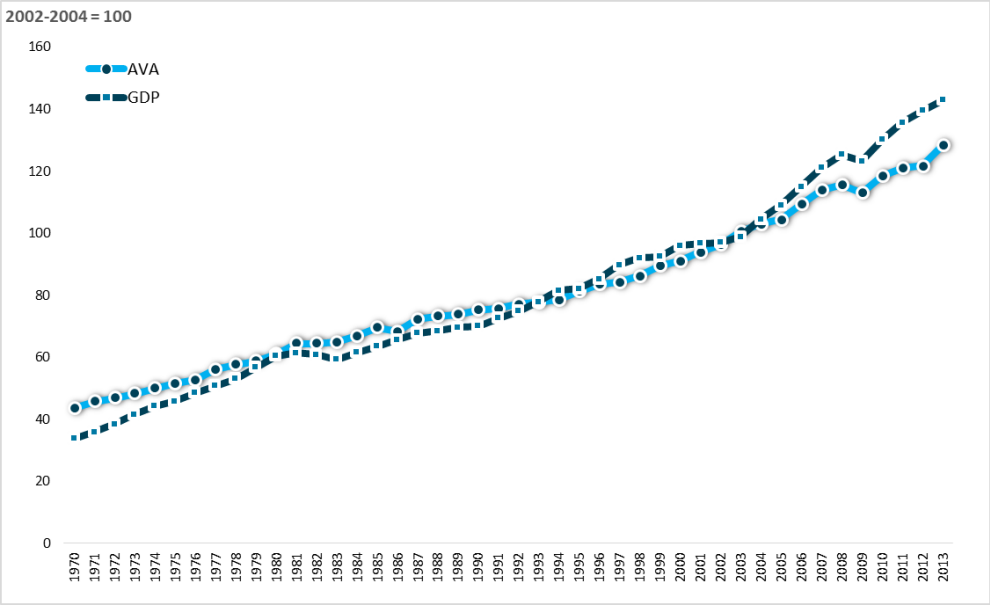
Source: IICA - CAESPA, with data from the World Bank (WDI 2015).

16. Also worthy of note is the fact that in the countries of the Americas average annual growth for agriculture was similar to the economy as a whole for many years, however starting in 2004, agriculture grew slower than the economy in general indicating that the sector in general is losing importance and dynamism (See Figure 2).

17. Studies on the state of agriculture in LAC carried out by ECLAC, FAO, and IICA (2012, 2013, 2014) show clearly that growth, expressed as agricultural value added (AVA) in constant 2005 USD varied significantly across countries and even within countries and crops, producing different impacts on income, living standards, and agricultural trade. While there are countries in the region whose levels of agricultural productivity are among the highest in the world, others have very low levels, even as low as those of countries in Sub-Saharan Africa. One aspect worth highlighting in Figure 3[8] is that in most LAC countries productivity growth is the principle source of output growth in agriculture sector. This is particularly true of Brazil, Guatemala, Uruguay, Colombia and Mexico, where agricultural productivity grew above the rate of the growth of production, indicating that these countries produced more with fewer resources.

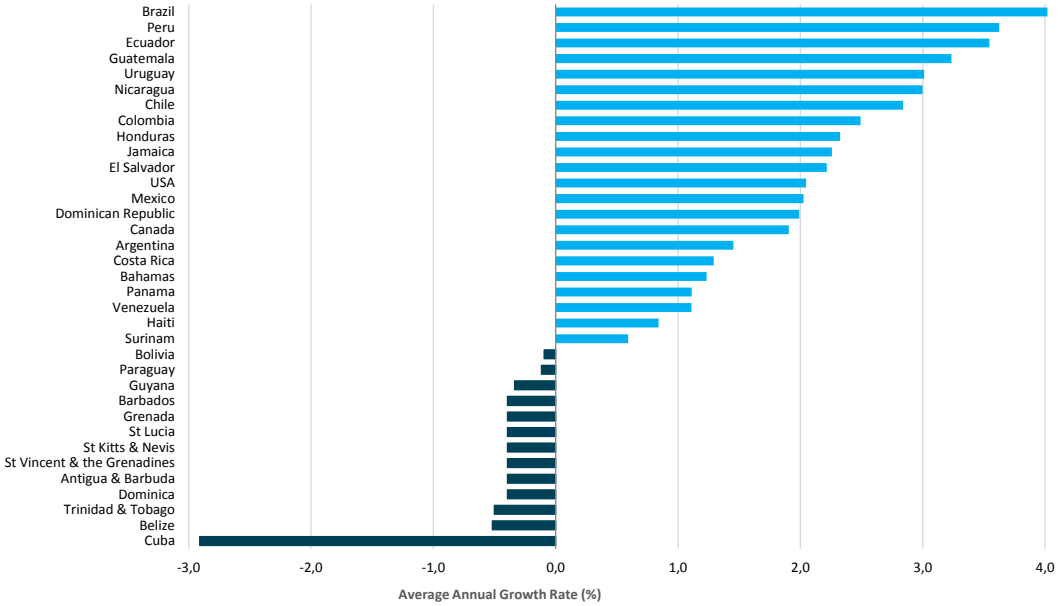
[8] The most recent calculations of TFP available are only up to 2010; hence, the comparison of AVA and TFP is for the period 2001-2010.

Figure 2. Growth of the agricultural sector and the economy as a whole in countries of the Americas



Source: IICA-CAESPA, with data from World Bank (WDI 2015).

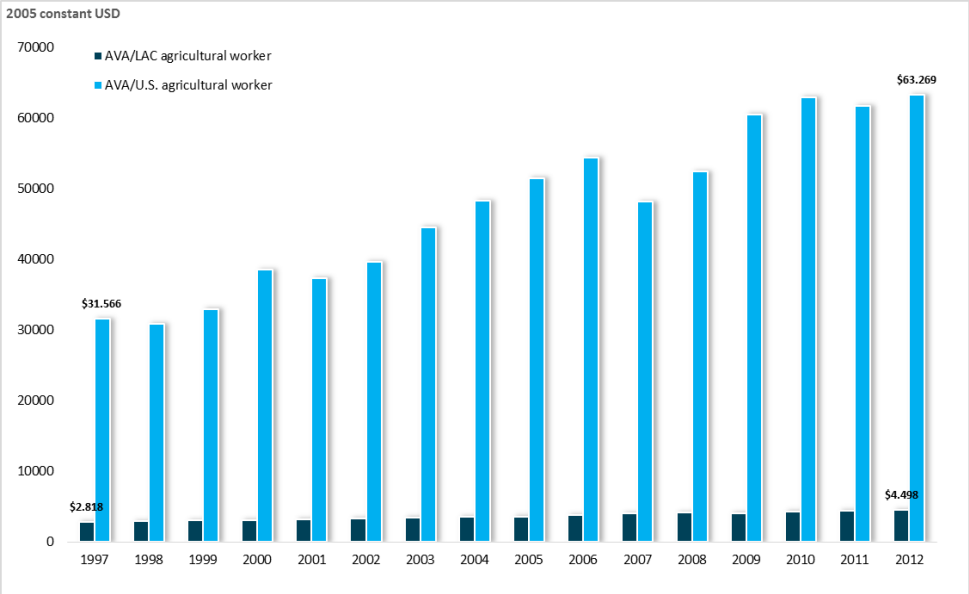
Figure 3. Growth in productivity (TFP) for agriculture in countries of the Americas in the period 2001-2010.



Source: ECLAC-IICA-FAO, 2015, in press.

18. In addition to the differences already mentioned, the fact that the gaps in agricultural productivity continue to widen is cause for concern. For example, Figure 4 shows that average per-worker AVA in Latin America is roughly one fourteenth of the figure in the U.S. In 2012, the value of agricultural productivity in the U.S. was USD 63,269 per agricultural worker, fourteen times higher than the average value in LAC, where the figure for the same year was USD 4498.[9] Over the years, the gap has widened instead of narrowing, since the rate of growth of productivity in the United States has always been higher than that of LAC (6.6% annually in contrast to 3.2% in the period 1997-2006, and 3.8% per year compared to 3.1% in the period 2003-2012).

Figure 4. Gaps in per-worker agricultural value added between the United States of America and the average for the Latin American and Caribbean countries.



Source: IICA-CAESPA, with data from World Bank (WDI 2015).

19. There are also major differences in these values across the Latin American countries themselves. For example, AVA per agricultural worker in Argentina (USD 9987) and Uruguay (USD 9064) contrasts sharply with the figure for Bolivia (USD 733). Figure 5 shows the gap in agricultural productivity across the LAC countries.[10]

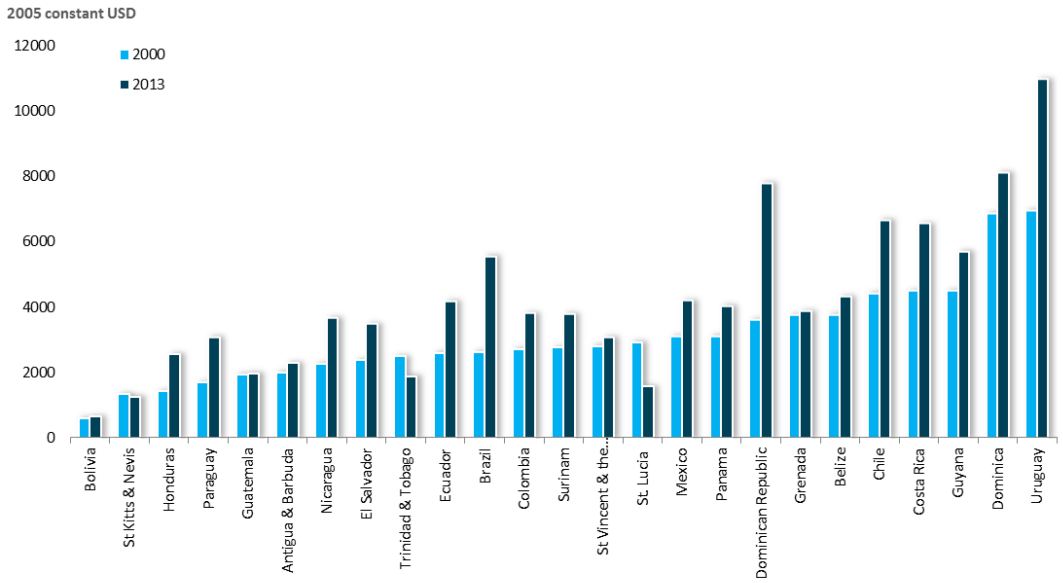
20. The AVA (expressed in 2005 constant USD) in e LAC countries have also grown at different rates in recent years, with Brazil and the Dominican Republic posting average annual growth of more than 5% (6.7% and 5.5%, respectively) for the decade 2004-2013. A second group of countries enjoyed annual growth of between 3% and 5%. These include

[9] The indicator through 2013 is not available for the U.S.

[10] As of 24 February 2015, the World Bank database (WDI) did not have up-to-date data for Argentina, Canada, Haiti, and Peru. The data for Venezuela, Jamaica, and Barbados is only up to 2012.

Surinam (4.8%), Nicaragua (4.3%), Trinidad and Tobago (4.2%), Venezuela (4.2%), El Salvador (4.1%), Jamaica (4.1%), Honduras (3.9%), Paraguay (3.6%), Uruguay (3.5%), Ecuador (3.4%), Barbados (3.3%) and Costa Rica (3.2%). A third group of countries recorded modest growth in productivity (from 0% to 2.9%), including Chile (2.8%), Grenada (2.7%), Mexico (2.2%), Colombia (1.9%), Guyana (1.8%), Dominica (1.3%), Guatemala (1.1%), and St. Vincent and the Grenadines (0.9%). The last group consists of countries whose agricultural productivity growth rates over the last ten years have been negative, such as Bolivia (-0.01%), Antigua and Barbuda (-0.6%), Panama (-0.8%), Belize (-3.2%), St. Lucia (-3.3%) and St. Kitts and Nevis (-4.6%).

Figure 5. Gaps in agriculture value added per worker between the Latin America and Caribbean countries.



Source: IICA-CAESPA, with data from the World Bank (WDI 2015).

21. Another aspect that has to be borne in mind when analyzing agricultural productivity in the Americas is how it varies according to the different types of agriculture practiced in the countries of the region, ranging from modern, large-scale commercial agriculture to subsistence farming, where family agriculture continues to account for more than 75% of production units and contributes between 20% and 40% of the crops produced in the countries of the region (ECLAC, FAO, and IICA 2014). The structure of the Latin American agriculture, has a clear reflection on existing productivity gaps where peasant-subsistence agriculture partially inserted to markets is associated with low technology incorporation, non-specialized labor and low productivity, contrasting with medium and large commercial agriculture associated with large capital investments and technology, qualify laborers, high negotiation capacities and elevated productivity. This situation affords an opportunity to find ways of increasing the productivity of all the types of agriculture that coexist in the same territories without exceeding the ecological limits of

sustainability, and complementarities among all the production systems. Hence, the biggest challenge in improving agricultural productivity lies in finding a way to achieve it in an inclusive and sustainable way, so that all the producers and sectors of our societies reap the benefits. This includes the possibility of finding alternative source of employment to those farmers which have limited potential to productivity growth.
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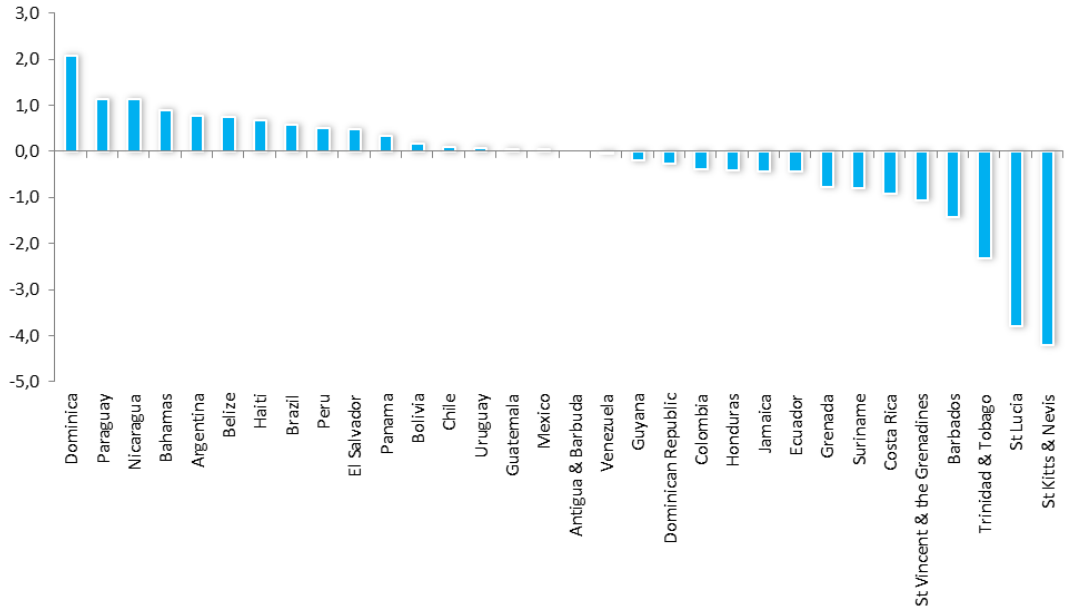
22. Over the last 20 years, production in the region has risen without a significant increase in the agricultural area. In fact, only three countries (Dominica, Nicaragua and Paraguay) have incorporated land, representing between one and two percent of their agricultural area each year, while six countries (Costa Rica and five Caribbean nations) have reduced their total farmland by between one and five percent for the period 1990-2009 (ECLAC, FAO, and IICA 2013; see Figure 6). This suggests a positive impact resulting from the use of new technologies, as well as an increase in the efficiency of both human capital, and investment and innovation processes.

Figure 6. Annual percentage variation in the agricultural area of countries in the Americas during the period 1990-2009



Source: IICA-CAESPA, with data from FAO (FAOSTAT 2015).

23. With regard to land use, it is interesting to observe that over the last 20 years the acreage planted with different crops has varied (Table 1). In particular, there has been a sizable increase in the acreage used to grow oilseeds in the Southern Region, while the Central American countries have seen an expansion in the acreage given over to the production of vegetables, fruits, roots, and tubers, due to changes in demand and the competitive advantages of each country. The future is however uncertain when climate change impacts are taken into consideration. It is expected that climate change will force a reconfiguration of productive areas across the hemisphere.

24. Regarding water, "…increasing the productivity of water in agriculture is essential to reduce the pressure on water resources, curb environmental degradation and improve food security…" (Beekman, et al., 2014).

Table 1. Annual variation in the area harvested in the Americas in the period 1993-2013.

	Oilseeds	Cereals	Fruits	Vegetables	Roots and tubers
Central America	0.35%	-0.40%	1..88%	2.13%	2.26%
South America	5.07%	0.65%	0.53%	1.30%	0.09%
North America	0.81%	-0.61%	-0.56%	-1.35%	-1.06%
Caribbean	-0.94%	1.50%	-0.39%	3.08%	1.28%

Source: IICA (CAESPA) based on FAOSTAT data, 2015.

25. The region's agriculture faces obstacles that, if left unattended, may not only affect the growth rate in the future, but even undermine the success already achieved with regard to productivity and, especially, national development in the region. The main obstacles and challenges that will have to be addressed in the short and medium terms include the continued implementation of structural reforms across the entire economy, reforms designed to boost innovation and investment levels, reduce inequality, improve human capital, ensure the sustainability of resources such as soil and water, enhance energy use, halt the loss of biodiversity, deal with the impact of climate change and advance the business environment in which agriculture operates, including the transparency and efficiency of trade.

26. However, when we look to the future, we cannot be anything but optimistic about the possibility of the region becoming a "global breadbasket," as the IDB and the GHI (2014) have suggested, as it possesses (albeit important differences among the countries that conform the American Hemisphere) abundant water, energy, biodiversity, human capital and land (it is one of the few regions of the world that can still expand its agricultural frontier without affecting forests and jungles), and relatively stable political and economic conditions.

27. In the following pages a brief analysis of the main factors that affect the productivity of the agricultural sector are briefly discussed, starting the role of human capital, followed by the importance of natural resources, where the impact of water and soil, land tenure and the importance of biodiversity are reviewed. Following this there is an analysis on the importance of the business environment, innovation as a catalytic element to increase productivity and a final chapter with six general recommendations to support the dialogue of the Ministers of Agriculture of IICA´s member countries with the hope to agree on a common agenda to increase agricultural productive in a sustainable and inclusive fashion.

Human capital

28. One of the factors traditionally believed to have the biggest effect on the productivity of a given country or a sector is human capital, due to its impact on the use of conventional

resources such as land, labor and capital, and its contribution to the improvement of a country's capacity to innovate and to develop or adapt to technologies, resulting in a bigger social return (de la Fuente 2011, Pritchett 2001).

29. The human capital that takes part in agriculture can be viewed from various perspectives, ranging from the merely physical standpoint (the size of the population of a country or the number of workers working in a sector) to analyses focused on the different forms of knowledge and the population's knowledge, which is very difficult to quantify (Schuh and Angeli-Schuh 1989).

30. For the purposes of this document, human capital is considered to be as the set of knowledge, skills, competencies and attributes embodied in individuals that facilitates the creation of personal, social, and economic well-being (OECD 2011). Furthermore, it is recognized that human capital has to do not only with (formal or informal) education, but also with elements that directly affect the capacity of human beings to do a job, such as health and nutrition. These are extremely important in agricultural activities, since there are very high levels of malnutrition in rural regions, and medical services are more limited, which affects the productivity of agriculture.

31. Specialists in this field, affirm that educating the human capital working in agriculture has a positive impact on productivity. Being better educated enables producers to be better agents of change, because education boosts their decision-making capacity, increases their capacity to innovate , and helps them to make better decisions regarding the purchase of inputs. Being better educated also equips them to negotiate, reduces the asymmetry between the producer and other agents in the value chain, fosters the adoption of technology and improves producers' capacity to deal with risk. In short, better-educated producers are able to allocate their resources more efficiently and make better decisions; and they become a channel for the dissemination of innovations and technology, thereby influencing the other producers with whom they come into contact.

32. Agricultural producers must apply a combination of specific technical knowledge related to the agricultural sector (agronomic, climatic, technological and market expertise) in order to decide what to produce, in what sequence to do so, and how to organize processes on the farm. They also have to apply management and business skills (accounting, project and financial analysis, administrative organization) to ensure the economic viability of the operation. (Dirven 2002).

33. In agriculture, the introduction of new technologies is usually accompanied by low rates of success in the initial stages, followed by greater success due mainly to the adoption of the technologies by producers who comprehend them, understand the risks and opportunities involved in their use, and disseminate their benefits. Education fosters these processes.

34. Although a better education results in higher productivity, there are cases in the agricultural sector in which education does not have the expected positive effects (see introduction to Reimers and Klasen 2013). One of the reasons for education's failure to have a positive impact on agriculture is the fact that a job in the sector is regarded as employment of last resort; better-educated people switch from farming to more attractive sectors, leaving their

less educated peers behind in agriculture. Another reason for the apparently low impact of education on agricultural productivity in some countries, is the poor quality of education systems, especially in rural areas. This makes it impossible to significantly enhance producer's capabilities, since the capabilities that the systems develop are very general and do not match the productive, ecological or social conditions of producers. It has also been suggested that the benefit of education in agriculture is more limited in the poorest households (Reimers and Klasen 2013) and in very traditional social conditions, such as those in which women are prohibited from developing or heads of household make all the decisions.

35. The question of education and its relationship with agriculture is multifaceted. On the one hand, there is the training of professionals who will devote themselves to agriculture and, on the other, education for producers and rural dwellers, which has to do with levels of schooling and the development of skills and capabilities required for work in agriculture. The formation of highly qualified personnel for agriculture is and will continue to be critical for sustainable productivity in the countries in the Americas, not only for their role in science and innovation but also for their role in extension services and in the operation of commercial farms. Therefore, productivity in the sector calls for investment in formal education, in technical education, and skills and capacity development for workers, producers and extension professionals.

36. It is also important to recognize that education for agriculture has to be approached with a vision much broader than the traditional one of primary production, in order to include matters such as value added, sustainability, business development, logistics, marketing, quality and safety, social management, the gender approach, and equity and leadership, to name but a few. Raising agricultural productivity should therefore be accompanied by a real revolution of education for the countryside, where the use of the new information and communication technologies will play a very relevant role.

37. Table 2 presents a simple analysis of the years of schooling of rural and urban populations. It shows the mean levels of schooling of various groups of heads of household in the countries of the Americas for which accurate data is available, and the changes that had occurred ten years later. The figures in the table confirm what has long been known: that educational levels are lower among heads of household living in rural territories, whose most important economic activity is agriculture. Unfortunately, the data do not permit us to evaluate the quality or relevance of the education, or, in particular, whether it is effective in helping to make producers more productive, more organized, and more aware of the need to conserve natural resources.

Table 2. Mean years of schooling of heads of household in selected countries of the Americas in 2000 and 2010.*

Country	Zone	Type of household and year			
		Total	Sal agric.	Non-sal agric.	100% fam. ag.
		2000	2000	2000	2000
Bolivia	National	7,1	5,4	9,8	4,2
	Urban	8,8	6,4	10,1	5,9
	Rural	4,3	4,5	9,0	3,6
Brazil	National	4,6	2,2	5,7	2,4
	Urban	6,3	2,3	7,0	3,1
	Rural	2,5	2,1	4,3	2,0
Chile	National	7,2	6,1	8,1	5,3
	Urban	10,0	7,4	10,9	7,4
	Rural	5,5	5,5	7,3	4,7
Colombia	National	6,2	4,0	7,8	3,4
	Urban	7,8	4,6	9,3	4,3
	Rural	3,8	3,5	7,0	2,7
Costa Rica	National	6,6	4,5	7,5	4,5
	Urban	8,7	6,0	9,4	5,3
	Rural	5,7	4,3	7,3	4,0
El Salvador	National	4,8	2,4	6,3	2,4
	Urban	6,7	3,2	8,5	3,5
	Rural	2,6	2,0	4,7	1,8
Honduras	National	4,7	2,7	6,9	2,6
	Urban	6,6	4,0	7,8	3,6
	Rural	2,8	2,2	5,1	2,3
Nicaragua	National	4,2	2,4	6,1	2,5
	Urban	5,8	2,9	7,0	4,0
	Rural	2,4	1,9	4,8	1,6
Panama	National	7,6	5,6	9,0	4,7
	Urban	10,0	6,8	10,7	6,8
	Rural	5,5	4,8	8,4	3,8
Paraguay	National	6,2	5,5	7,7	4,1
	Urban	7,8	6,8	8,8	4,9
	Rural	4,5	3,9	6,9	3,7
Dominican Republic	National	6,3	5,1	8,2	3,3
	Urban	8,1	8,8	9,3	3,9
	Rural	4,3	3,2	6,9	2,8

Country	Zone	Type of household and year			
		Total	Sal agric.	Non-sal agric.	100% fam. ag.
		2010	2010	2010	2010
Bolivia	National	7,9	4,9	10,8	4,1
	Urban	9,6	6,0	10,9	4,7
	Rural	4,8	4,5	10,2	4,1
Brazil	National	7,1	3,6	8,4	3,4
	Urban	7,7	4,0	8,5	4,5
	Rural	3,6	3,3	5,8	2,8
Chile	National	10,0	7,2	10,9	7,2
	Urban	10,5	8,2	11,1	8,3
	Rural	6,8	6,5	8,6	6,1
Colombia	National	7,5	4,2	9,8	3,9
	Urban	8,5	5,7	10,0	5,0
	Rural	4,3	4,0	6,9	3,4
Costa Rica	National	8,2	5,1	9,1	5,7
	Urban	9,3	6,7	9,6	8,3
	Rural	6,5	4,9	7,8	5,0
El Salvador	National	6,2	3,2	8,4	2,6
	Urban	7,7	4,0	9,2	3,6
	Rural	3,4	3,0	5,4	2,3
Honduras	National	6,3	4,5	8,5	4,2
	Urban	8,3	7,3	9,1	5,7
	Rural	4,6	4,2	6,4	4,0
Nicaragua	National	5,8	2,4	8,1	2,8
	Urban	7,2	4,3	8,4	4,3
	Rural	3,4	1,9	6,2	2,5
Panama	National	9,1	5,2	11,2	4,5
	Urban	10,8	8,0	11,7	7,3
	Rural	6,0	4,8	8,7	4,1
Paraguay	National	7,7	5,5	9,7	5,3
	Urban	9,2	6,6	10,1	6,4
	Rural	5,9	5,3	8,3	5,1
Dominican Republic	National	7,5	4,0	9,2	3,9
	Urban	8,8	6,2	9,7	4,9
	Rural	5,1	3,6	7,3	3,4

Source: Agricultural Development Unit (ECLAC), published in ECLAC, FAO, IICA 2013. The Outlook for Agriculture and Rural Development in the Americas: A Perspective on Latin America and the Caribbean. 2014

* This table does not include an analysis by ethnic group or income level. Based on the data that exists, however, it is fair to assume that indigenous peoples and ethnic groups have the lowest levels of education in the region. This underscores the importance of closing social gaps and affording all the inhabitants of our countries the same access to basic education.

38. In the case of formal education, a far-reaching overhaul of the system is required. Countries will need to review their curricula and education programs; devise programs to disseminate and raise awareness of the importance of receiving training in agriculture; incorporate cutting-edge areas of knowledge; strengthen education in the basic, humanistic, and economic sciences; and enhance students' practical skills, and construct solid values of service, honesty and respect for the traditional values of society. The ministries of agriculture should take the lead in this task, under the aegis of the State.

39. Another aspect of human capital that must be taken into account is the cost of the labor used on farms, an issue that has two opposing sides that are difficult to reconcile. The first concerns the net value of the salaries earned by workers employed in agriculture, which are clearly lower than those of people working in non-agricultural activities. The second is related to the impact that an increase in the salaries of agricultural employees would have on the activity. The work of Fuglie *et al.* (2007) shows that in the United States, as a result of the real increase in the salaries of farm workers, farm owners are hiring fewer people, while at the same time increasing their use of technologies and other innovations, and more inputs. This has permitted that country's agricultural sector to continue to increase production without the need for more labor.

40. As consequence of these realities and to the increased migration of workers from the rural areas to the cities, there are many regions of the hemisphere in which farm operations are encountering difficulties to to find workers for the farms, which affects the productivity and the competitiveness of the agricultural sector. s.

41. No analysis of the importance of human capital for agricultural productivity is complete without considering four important issues that are mentioned only briefly in this document but warrant more in-depth examination: a) child employment, b) young people involved in the sector, c) women producers, and d) education for smallholders over 50 years of age.

42. Child labor is a complex, highly sensitive problem in agriculture. Governments, the private sector, and civil society need to continue to work together to ensure that the numbers decrease and the international conventions on child labor are respected. This calls for improvements in the quality and coverage of educational programs, the establishment of more social protection programs and more transparent operation of those already in place, as well as higher remuneration for adult workers. Child labor in the countryside is closely related to household poverty, the lack of schools in the country side, to culture and tradition of rural dwellers, and to the fact that many parents cannot afford to send their children to school due to demand for several household chores such as tending livestock, collecting fodder and fire-woods, etc. Changing the situation will be no easy matter. A continuous, arduous, and permanent effort will be required.

43. The second issue has to do with the integration of young people into agriculture and the creation of a generational change that not only enables young people to be involved in the sector, but also includes a renewed vision of agriculture capable of tackling the challenges of the future. In recent years, there has been greater interest in promoting the development of youth in the agricultural sector of the Americas. It is estimated that young people (15-30 years of age) account for nearly 25% of the continent's total population, and that nearly 47% of young people in rural areas live in poverty (Minute from the youth meeting, IICA 2014), which suggests that unemployment in rural areas is high. In many cases the same agricultural policies could hinder the youth and the younger generations to take farming. Agricultural policies such as input subsidies, output price support, income support to farmers, tend to keep inefficient farmers farming and tend to create entry barriers for younger people through raising the value of fixed assets such as land. Thu removing the distortion in agriculture and exposing farming to market signals could make agriculture an attractive profession for a younger generation. It is needed to develop an agriculture that is economically attractive, with higher value added and with the use of state of the art technologies in order to make it attractive to the younger generation.

44. Investing in young people could transform agriculture and agrifood systems, but for that to be achievable, the image of agricultural work would have to be changed, and further investment made in education, training, and infrastructure. A recent study by ECLAC, AECID, and the CAF (2014) proposes a series of interventions designed to improve the integration of young members of the workforce into the economy, including the strengthening of public policies for employment and education. The issue of youth is so important that it is one of the priority areas of the Post-2015 Development Agenda.

45. The third important issue related to the improvement of the human resources involved in agriculture concerns women, a key productive agent for agriculture and for adding value to the products of rural areas. Over the last 20 years, the importance of their role has increased, and a gradual process of feminization has taken place in the countryside, accentuated in many countries by high rates of male migration to the cities or overseas.

46. That demographic transformation has been accompanied by many studies on the contribution of women to agriculture, their needs, and possible ways of empowering them as economic actors. Great strides have been made as a result of all this, but much remains to be done (policy-making, preparation of instruments, design of business models and implementation of training programs, among others) to achieve equality for women in every sense, including equal access to capital assets.

47. The fourth point related to human resources has to do with the age of farmers. The average age of most of the people involved in agriculture in the countries of the Americas is over 50. This poses a threat to productivity, although insufficient information is available on the subject to be able to estimate the impact of an ageing labor force on agricultural productivity. A study conducted by ECLAC, FAO, and IICA (2013) suggested that rural households with lower levels of poverty in Latin America had younger heads of household. Therefore, it is suggested that the ministries of agriculture contribute to the understanding of this dynamic and to generational renewal.

48. A thorough knowledge of the subject is required to ensure the sustained and sustainable growth of agricultural productivity, and future success will depend on producers' capacity to innovate and solve the new problems that are bound to arise in a more volatile world context. Producers, especially smallholders and family farmers, must be given the tools and knowledge they need to enable them to undertake a sustainable intensification of agriculture; and resources invested in the training a new generation of farmers and agricultural professionals. Reliable statistics on education in the rural sector will be needed for that task, especially on formal education, technical training, and skills development for producers.

Soil, water, energy, and biodiversity: pillars of agricultural productivity

49. Natural resources (water, soil and biodiversity), as well as energy, are the backbone of agriculture. Agriculture could not exist without them, and productivity is directly linked to their availability and use.

50. Regarding water; in collaboration with the Argentine Ministry of Agriculture, IICA undertook an analysis of the situation of water in agriculture for the Seventeenth Regular Meeting of the Inter-American Board of Agriculture (IABA) and the Meeting of Ministers of Agriculture of the Americas, held in Buenos Aires, Argentina, in 2013. The document produced provided a detailed summary of the state of water resources in the region, their use in agriculture, the challenges related to their management and the areas in which opportunities existed for developing an Inter-American agenda designed to improve water allocation and the integrated use of water in agriculture.

51. As the question of water was dealt with in depth at that meeting, and the status of the resource and its importance for the productivity of agriculture have not changed significantly since then, the present document includes only the recommendations on the subject made at that forum, and once again emphasizes the importance of the countries of the Americas continuing to work on their implementation (Box 3).

Box 3. Recommendations for improving the use of water in agriculture that IICA presented to the Meeting of Ministers of Agriculture held in Buenos Aires, Argentina, in October 2013.

Recommendation 1: Promote the institutional strengthening of the ministries of agriculture to improve the use of water in agriculture and integrated natural resource management.
Recommendation 2: Promote integrated water management to achieve sustainability in agriculture and address the challenges of climate change.
Recommendation 3: Strengthen innovation to improve the productivity of water resources in agriculture.
Recommendation 4: Strengthen the training of human resources in the new paradigms of agriculture.

Source: Beekman *et al.* 2014. Water to feed the land. IICA.

52. Soil is the basic resource required for agricultural development and sustainability, since it provides the substratum for the production of food, feed, and other agricultural products. Soil is also vital for the planet's stability, as it plays a very important role in the water cycle and in the cycles of carbon and other nutrients, and is the habitat of microorganisms and other life forms estimated to make up more than one fourth of the world's biodiversity.

53. Soil is considered a nonrenewable, finite resource. Most experts agree that it takes at least 100 years for an inch of soil to form, with the precise length of time varying according to the climatic conditions, the previous health of the soil, and vegetation, among other factors (NRCS n.d.). According to ISRIC - World Soil Information (2015), soil also is a fragile resource (ISRIC 2015). Data from this organization suggests that, despite all the knowledge that exists and the advances made in soil management technologies and innovations, around 17% of the earth's surface shows serious signs of degradation (other data suggest that close to 40% of soils used for agriculture are either degraded or seriously degraded and that soil is being lost to a rate of 10 to 40 times the rate at which can be formed; Time, 2012), caused largely by poor agricultural practices, overgrazing primarily by livestock, deforestation, and incorrect land use, all of which reduce nutrient content, cause agricultural soil to be lost increasing desertification, and alter the physicochemical properties of the soil (increase in salinization and acidification), with the use of pesticides and other chemical inputs reducing the number of organisms and microorganisms (Box 4).

Box 4. Soil degradation

Soil degradation is a global phenomenon that reduces the soil's capacity to provide sustainable direct and indirect environmental services.

Degradation is defined as the loss of the biological and economic productivity of arable land due to the effect of a combination of agents of change (deforestation, livestock practices, inefficient treatment of waste) that affect soil's physical or chemical properties (mainly, depth, organic matter content, pH, salinity and fertility). It is linked to a complex system of extreme phenomena, such as change in soil use and climate.

54. Owing to the burgeoning population and the expansion of urban areas, soil degradation is now affecting marginal areas not suited to agriculture, thus putting the soil in the areas concerned under greater pressure and further degradation.

55. Erosion affects crop productivity, since it alters the physical and chemical properties of the soil, such as its ability to retain water. Studies carried out show that corn productivity can be up to 21% less in highly eroded soils (Mokma and Sietz 1992), and that this is due mainly to the soil's inability to retain water (Arriaga and Lowrey 2003). This demonstrates and confirms the urgent need to develop programs for the integrated management of natural resources, since managing one resource without taking account of the rest does not solve the problem and, in many instances, causes greater negative effects.

56. It is estimated that more than half of the 576 million hectares of arable land that exist in LAC have been degraded to varying degrees as consequence of human activity. This highlights the urgent need to prevent further soil deterioration, and to rehabilitate soils that can still be restored.

57. So great is the importance of soil that the United Nations declared 2015 the *International Year of Soils*. Furthermore, the need to strengthen international cooperation has led to the creation of the Global Soil Partnership, whose five pillars of action are as follows:

    a. "Promote sustainable management of soil resources for soil protection, conservation and sustainable productivity.
    b. Encourage investment, technical cooperation, policy, education awareness and extension in soil.
    c. Promote targeted soil research and development focusing on identified gaps and priorities and synergies with related productive, environmental and social development actions.
    d. Enhance the quantity and quality of soil data and information: data collection (generation), analysis, validation, reporting, monitoring and integration with other disciplines.
    e. Harmonization of methods, measurements and indicators for the sustainable management and protection of soil resources". (Global Soil Partnership 2015).

58. Equally important to soil management and conservation, are the forms of land tenure and governance in place. A joint ECLAC-FAO-IICA study carried out in 2013 includes an analysis of the land tenure situation in LAC and a series of suggestions with regard to public policies for tackling the new, and not so new, challenges in that area. There is a very close relationship between security in land tenure, investment and improvements in productivity (Lawry, et al., 2014)

59. The institutions mentioned recognize that various dynamics exist with regard to land ownership and the size of production units, and they identified certain important aspects and trends that have to be taken into account in order to develop policies and policy instruments, respecting the social, ideological and political principles of countries (See Box 5). In this effort, is important to include and review the laws that regulate land leasing as a mechanism to construct a new agrarian structure, and especially in those cases where land values are high and few producers have access to it.

Box 5. Relevant issues of importance for improving land governance and tenure in agriculture.

- In the case of land tenure, there is a group of countries in which the ownership of agricultural land has been consolidated, giving rise to a smaller number of production units. On the other hand, in another group of countries the number of production units have increased, while total acreage has decreased.
- In the case of the Caribbean countries, it is important to note that the vast majority of land is still owned by the government.
- In many countries in the region, land ownership is reemerging as a priority issue.
- Further work on land tenure security is needed, as nearly 50% of the region's producers do not have titles to their land (Valdez and Lopez 1999).
- The implementation of transparent, equitable mechanisms that afford access to land is a task that remains pending.
- The need to address issues of land grabbing by other nations.
- The question of the recognition of rights of indigenous and native peoples is gathering renewed impetus.
- There is a growing trend toward the internationalization of businesses, which puts pressure on forms of land tenure.
- Agriculture in the region faces greater competition for land from other activities, such as mining and industry.
- The Americas will continue to undergo a process of urban development, which calls for the development of innovative, new policies and instruments to address the concept of what "rural" means. The line between "rural" and "urban" is getting thinner all the time, though very marginalized regions still exist that have not benefited from development (particularly communities of native peoples and ethnic groups).

Source: ECLAC, FAO and IICA 2013.

60. One constant observed throughout the ECLAC-FAO-IICA study carried out in 2013 is the lack of up-to-date agricultural censuses. This is unquestionably a serious constraint to decision-making with regard to land tenure, investments, and infrastructure. The countries clearly need to redouble their efforts to keep their agricultural censuses up to date across the region.

61. Work on the subject of land tenure, legal security and related aspects, including land markets, continues to be a focus for the countries of the Americas. In 2012, 96 countries and more than 30 international organizations approved the Voluntary Guidelines on the Responsible Governance of Tenure (FAO 2012), designed to guarantee equitable access to land, fisheries and forests. These guidelines, which enjoy wide support from public sectors, private enterprises, and international forums, are an important source of guidance that countries in the continent should take into account in implementing best practices on the issue and laying the foundation for competitive agriculture and, in particular, for inclusive agriculture.

Box 6. Some recommendations for the design and the implementation of public policies on land tenure and governance in agriculture.

1. Develop new economic measures that take natural resources and their finite nature into consideration.
2. Continue to promote transparent and equitable mechanisms for affording access to land for agriculture.
3. Make further progress with the legalization and titling of farms.
4. Strengthen and develop institutions, and promote modern regulatory frameworks for environmental conservation and land use planning.
5. Develop and implement policies and capabilities for regulating the purchase of land, especially when large amounts and other nations are involved, and to regulate trans-boundary movements.
6. Implement programs and projects to attract young people to agriculture, with special emphasis on the development of instruments aimed at affording them access to land, innovation, technology, and other production inputs.

62. In summary, improve productivity in agriculture requires of strengthening each country efforts to define a new agrarian structure, considering not only property rights and regulations for land leasing, but also labor and social mobility policies.

63. Energy has always been of essential importance for agriculture; in fact, agriculture is a process of converting energy into food by means of photosynthesis, with plants using solar energy, water, and soil nutrients to generate the wide range of agricultural products with which we are all familiar.

64. Over the course of human history, the sources of energy used in agriculture have multiplied. In the beginning, only solar energy and human strength were involved. The development of farming based on the use of modern methods, on the other hand, has led to the utilization of sources with a high caloric content, such as petroleum-based products (Box 7).

Box 7. Ways in which agriculture uses energy.

Agriculture consumes energy in two ways: directly and indirectly. Direct energy consumption occurs in activities related directly to the growing of crops, the water supply, the operation of equipment and machinery, processing, and the adding of value to, and transportation, of foodstuffs. Indirect energy consumption occurs as a result of the use of inputs for primary production, particularly fertilizers and pesticides, whose production involves the use of a large amount of energy. Such indirect uses can be very significant; for example, it is estimated that nitrogen fertilizers can account for up to 50% of the total energy used in food production (Woods *et al.* 2010).

65. It is estimated that, in most countries of the Americas, primary agricultural production uses between three and eight percent of all energy (Table 3). However, when the analysis includes all the energy used throughout the chain for food production and consumption, the total energy consumed ranges from 14% to 16% of the total (Canning *et al.* 2010).

Table 3. Energy used in agriculture and forestry in the countries of Latin America as a percentage of total energy used.

	2002	2003	2004	2005	2006	2007	2008	2009
Argentina	5,5	6,0	6,8	7,0	6,0	5,4	5,6	6,3
Brazil	5,0	5,1	4,9	4,9	4,8	4,8	5,1	5,0
Canada	1,8	1,8	1,8	1,8	1,8	1,9	1,9	1,7
Colombia	6,1	5,9	6,3	6,1	5,5	5,2	5,2	7,1
Costa Rica	4,6	4,5	1,9	1,3	2,5	2,1	1,9	1,9
Cuba	2,4	2,2	2,6	2,8	2,8	2,8	2,9	2,5
Ecuador	0,1	0,1	0,1	0,2	0,1	1,3	1,2	1,1
El Salvador	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2
USA	1,0	0,9	1,1	1,1	1,1	1,0	1,0	1,0
Mexico	2,7	2,9	2,8	3,0	2,9	2,9	3,0	3,3
Nicaragua	0,7	0,7	0,8	0,9	0,9	0,9	0,7	0,7
Panama	1,1	1,6	1,3	1,3	1,4	0,6	0,8	0,5
Peru	5,1	5,0	5,1	4,2	4,1	3,2	3,1	2,7
Dominican Republic	1,5	1,2	1,1	1,3	1,2	2,8	3,2	2,6
Uruguay	1,0	1,0	1,1	1,2	1,3	1,1	1,1	1,1
Venezuela (Bolivarian Republic of)	0,5	0,2	0,3	1,0	0,2	0,1	0,1	0,1

Source: IICA (CAESPA) with data from FAO (FAOSTAT 2015).

66. It is generally accepted that there is a positive correlation between the use of energy, agricultural production, and food consumption. However, this is not always clear, (see the review made by Woods *et al.* 2010), and in some instances, excessive use of energy can have an even bigger negative impact on productivity. The positive relationship with regard to the use of energy is more evident in the developing than the developed countries. In the case of the latter, changes in energy use do not automatically mean higher productivity; the

changes are due more to changes in the composition of the basket of products demanded by consumers than improvements in the productivity of a given crop.

67. Table 4 shows a summary of the estimated use of fertilizers in agricultural production in the Americas as a whole, and in the LAC countries. Figure 7 shows the use of fertilizers in various selected countries.

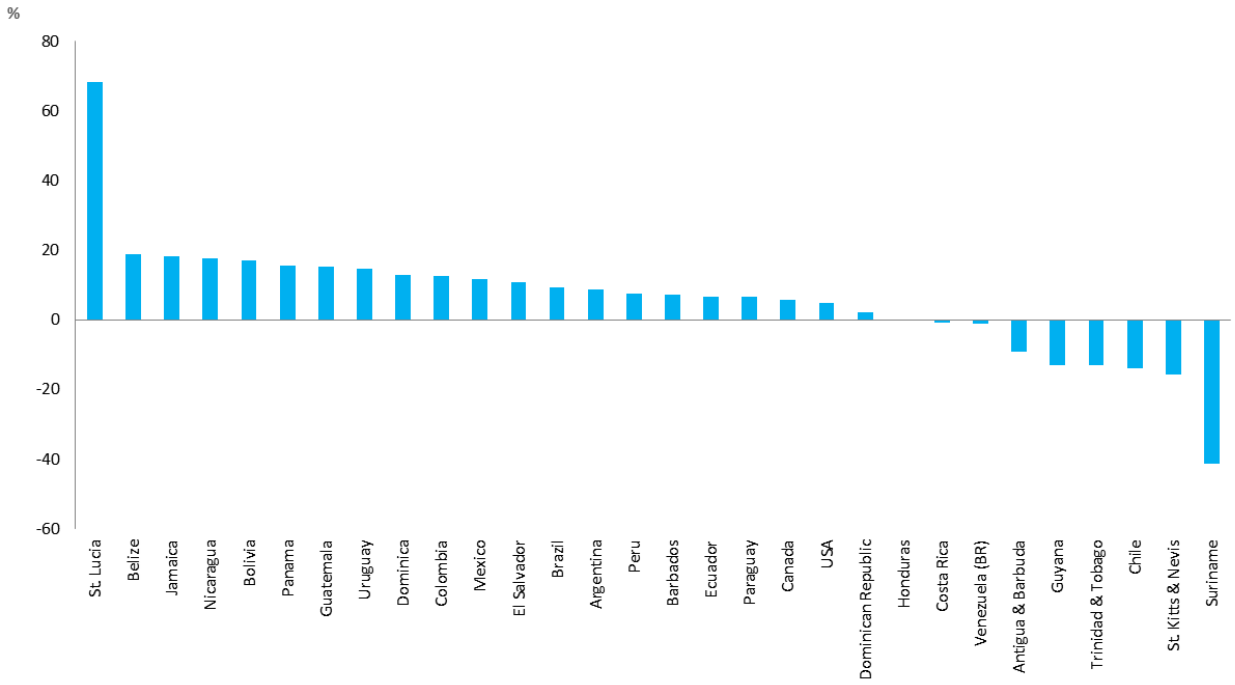
Table 4. Nutrient use in the Americas (tonnes of nutrients), and average yearly growth (%) during the period 2008-2012.

Region	Average (2008-2012)			Growth rate (2008-2012)		
	Phosphate fertilizers	Nitrogen fertilizers	Potassium fertilizers	Phosphate fertilizers	Nitrogen fertilizers	Potassium fertilizers
The Americas	9609647	21524816	9346462	7,4	6,0	6,2
LAC	5266691	8037289	5154197	9,5	10,5	6,8
Andean	449486	1261045	466753	9,6	4,9	6,9
Caribbean	55544	140205	47484	0,4	2,7	5,9
Central	110925	419316	118691	13,8	11,0	4,4
Mexico	169126	1230346	208265	7,3	10,7	15,3
Southern	4481610	4986377	4313004	9,6	12,2	6,5

Source: IICA (CAESPA) with data from FAO (FAOSTAT 2015).

68. Several conclusions can be drawn from this data. Firstly, that, as is to be expected, chemical fertilizers are used widely in all the countries of the Americas. The quantities applied vary widely, and that their use is increasing with time which would have unintended environmental impacts. All this calls for reflection on why this is occurring, and underscores the need for farmers to learn how to use such products more efficiently. There is evidence to generate concern on the use of fertilizers as it can have serious consequences in contaminating aquifers and water basins. When the use of energy is calculated, taking into account both the volume of products used and the amount of energy contained in each input, the need for innovative action on this issue is obvious.

Figure 7. Average annual growth in fertilizer consumption by hectare of arable land in various countries of the Americas (2008-2012).



Source: IICA-CAESPA, with data from the World Bank (WDI 2015).

69. Fossil fuels are currently the most important source of energy used in agriculture, leading to a high correlation between oil and food prices, presumably as a consequence of a positive relationship between the price of oil and production costs. This close relationship between the use of fossil energies and food production not only poses a risk for agriculture, due to the finite nature of fossil fuels and possible higher prices in the long term (which could make their use in food production unsustainable), but is also responsible for large amounts of anthropogenic greenhouse gas emissions.

70. Oil prices fell sharply between the last quarter of 2014 and April 2015, a development that is bound to affect agriculture in some way. The precise impact will depend on two factors: a) the productive structure and the technology used in agriculture, which will determine the weight of inputs in production costs; and b) the margin and the speed with which international prices are transmitted to local markets, which in turn will depend both on the level of trade opening and dependence on energy imports.[11]

71. In addition, in the short-term, the fall in oil and gas prices could reduce the demand for agricultural feedstock products used in biofuels, particularly corn, sugarcane and oilseeds impacting income of the producers of these commodities. However, this could be avoided

[11] According to World Bank studies (World Bank 2015), a one percent reduction in the price of energy could lead to falls in agricultural prices of between 0.11% and 0.25%.

through public policies that encourage bio-based products or the payment of subsidies to the sectors affected. However as oil and gas prices fluctuate, and long-term opportunities exist for agriculture-based bio products, especially in advanced biofuels, biochemical and bio composites.

72. Mindful of the risks of the close relationship that exists between the use of fossil fuels and agriculture work is under way to develop alternatives, in order to take better advantage of other energy sources. For example, great progress has been achieved with the use of solar and wind energy, methane and biofuels, which, coupled with the utilization of new production systems, will result in more efficient use of energy resources and less impact on the environment.

73. To achieve these transformations, account must be taken of the importance of a country's energy policy to the entire development process. An example of how the energy policy affects the way in which agriculture is carried out can be seen in the policies governing the use of ethanol implemented in some countries, such as the U.S., where the obligation to include a certain volume of ethanol-based fuel in the final fuel mix has transformed corn-producing areas, ethanol use, and grain prices, directly impacting access to these products by food importing countries. Another example of a public policy that affects energy use is one designed to subsidize prices or keep them low for the sector, which becomes a negative incentive to investment and innovation.

74. In short, the biggest current challenge as far as energy use is concerned is the need to modify the existing relationship between fossil energy and agricultural productivity. Agriculture's present highly intensive use of fossil energy in production has to give way to less intensive use, promoting the utilization of renewable energy sources throughout the chain, while at the same time continuing to improve the production and self-management of energy in production units, either using agricultural by-products or tapping wind and solar energy and the use of bio-digestion systems.

75. Biodiversity, in particular agro-biodiversity, is one of the most important inputs for the productivity of agriculture and perhaps one of the least understood in economic terms (Box 8).

Box 8. Role of biodiversity in agriculture

Biodiversity encompasses the entire diversity of the planet's living organisms and the interactions among them. The Convention on Biological Diversity (CBD 1992) recognizes three levels of biodiversity: ecosystems, species, and genetic resources. The biodiversity of greatest importance for food production is agricultural biodiversity (or agro-biodiversity), which includes the diversity of agricultural ecosystems, the diversity of domesticated species and other species associated with them (for example, pollinators, microbes, and other soil organisms, crop wild relatives, etc.), and genetic diversity (races and varieties).

Some of the main contributions that agro-biodiversity makes to agricultural activities are as follows:

- It helps to conserve soil structure and fertility, and facilitates the retention and supply of water and nutrients to plants.
- It provides a reserve of plants for insects, birds and pollinating mammals, essential for production.
- It contributes with ecosystem services for the control and regulation of pests and diseases.
- It is the most important source of raw material for the genetic improvement of crops.
- It contributes directly to the production of food.
- It contributes to the provision of energy (firewood, charcoal, biogas, hydroelectricity).
- It is an important source of new discoveries of bio-inputs and the development of the new "bio-economy."
- It allows production systems to be adapted to climate change, and increases their resiliency to extreme weather events.

76. Another aspect of the complex relationship between agriculture and biodiversity that must be mentioned, is the impact that agriculture has had on biodiversity. In recent decades, this has been mostly negative, due to the excessive use of pesticides and chemical fertilizers, over-utilization of the soil, deforestation, poor water management, and the huge expansion of mono-cropping, leading to the genetic erosion of agro-biodiversity. In light of this situation, the countries need to better, harness the use of biodiversity in agriculture, and equip stakeholders with more knowledge, in order to create virtuous circles of agricultural productivity and biodiversity of the countries of the Americas (Scherer and McNeely 2008). This would reduce agriculture's negative impact on natural ecosystems, increase yields and improves adaptation to the new climatological conditions that will be accentuated by climate change.

77. Additionally to these challenges, agriculture has to deal with the impacts of climate change. It is generally accepted that climate change will negatively impact agricultural productivity (IPCC, 2007, Lobell et al, 2011; Nelson et al., 2009, 2010). These effects are expected to be manifested in a multitude of variables from rainfall distribution and temperature changes to soil fertility and land availability. To adapt agriculture to these changes farmers would need to have access to viable and competitive crop and livestock varieties that can tolerate climate variability and countries should, among other things: a) establish and support climate-resilient infrastructure; b) strengthen agricultural innovation systems; c) improve risk-management mechanisms; d) produce up to date weather-based cropping calendars and

e) establish community based early warning systems. Transforming agriculture and adapting it to these new paradigms calls for a science-based sustainable intensification of production despite the challenges posed by climate change, in such a way as to reduce agriculture's vulnerability, obtain higher yields per hectare and per unit of water, prevent deforestation, and rehabilitate degraded land so that it can be used for production (Box 9).

Box 9: Some recommendations to improve the utilization of agrobiodiversity:

- Increase investment and create a facilitating environment for research and innovation.
- Collect and improve the large number of native crops that are underutilized as to take advantage of their tolerance to pest, diseases, drought and other marginal conditions.
- Diversify production systems as a mechanism to improve adaptability and resiliency.
- Identify, evaluate and disseminate local and traditional knowledge.

The business environment

78. Agricultural entrepreneurs in the rural milieu face major challenges that range from obtaining inputs at competitive prices to securing credit, hiring labor, organizing production and implementing regulatory standards and procedures to establish businesses, among many other tasks. In general, being an agricultural entrepreneur not only means having the capacity to contend with the challenges of Nature, but also meeting the challenges of the business and policy environment in agriculture.

79. Of importance for a sustainable productivity increase in many countries of the region is the expansion of the capital base which includes both private and private sources and importantly better decision making process from the farmers themselves.

80. The rule of law is fundamental for the development of inclusive productivity. An inefficient legal system has an adverse effect on the efficiency of contracts, the security of investments and property rights.

81. The first prerequisite for creating a favorable business climate is to have a healthy, stable macroeconomic context that offers farmers and all agents involved in the production chain the incentives and assurances needed to increase productive efficiency (IDB 2015). Macroeconomic instability reduces growth and makes it more uncertain to obtain proper returns on investments (WTO 2014, Ventura-Días *et al.* 1999).

82. An important element of the macroeconomic context is the opportunity for safe investment with fewer risks, particularly when it comes to attracting foreign direct investment (FDI), since this plays an important role in establishing links between the agricultural sector and global value chains, the transfer of technology and the dissemination of knowledge. One positive collateral effect is that the application of food safety and quality standards spreads

rapidly, with more sophisticated coordination of the stages of production, marketing and consumption, thus favoring the transfer of information, knowledge and technologies to producers in the countries participating in the supply chains (WTO 2014).

83. The effects of FDI on the market structure and domestic competition are sometimes perceived as being negative in the short term, because they threaten to displace national businesses, particularly if foreign companies have a higher level of performance, efficiency and knowledge than local businesses. However, in the medium and long term, competition may force a more efficient distribution of resources, promote the adoption or imitation of new technologies and knowledge and foster the emergence of mutually beneficial partnerships between foreign and domestic businesses, resulting in improved national output. Consequently, the growth of FDI tends to be greater in the knowledge and skills-intensive sectors (IDB 2015). In sum, the positive effects of FDI depend on a country's initial level of development (Box 10).

Box 10. FDI in the hemisphere's agriculture

The recent trend in FDI has been characterized not only by a greater participation of developing countries as recipients and sources of the investment (WTO 2014), but also by the growing importance of FDI for the development of agriculture in LAC, although FDI in the agricultural sector still accounts for a very small part of the total in percentage terms.

According to 2012 figures, developing countries absorbed more than 50% of total FDI at the global level, a more than 30% increase in the values recorded in 2000. At the same time, the participation of developing countries as a source of investment has also increased, rising from 7% at the end of the 1980s to 35% in 2012.

Although FDI has become an important driver of agriculture in some LAC countries, particularly in activities related to agricultural exports, the flow of FDI to the agricultural sector remains very limited. It is reported that less than one percent of total FDI (USD 87 billion out of a total of USD 1.2 trillion) went to the food, beverages and tobacco sectors, while only five billion US dollars (2008 figures) (Bioversity *et al.* 2012) was targeted at the primary agricultural sector. Increasing FDI in the agricultural sector is an essential task, particularly considering the effects of trade and FDI on productivity, which will be even greater as the technological gap between national and foreign firms is reduced (IDB 2015).

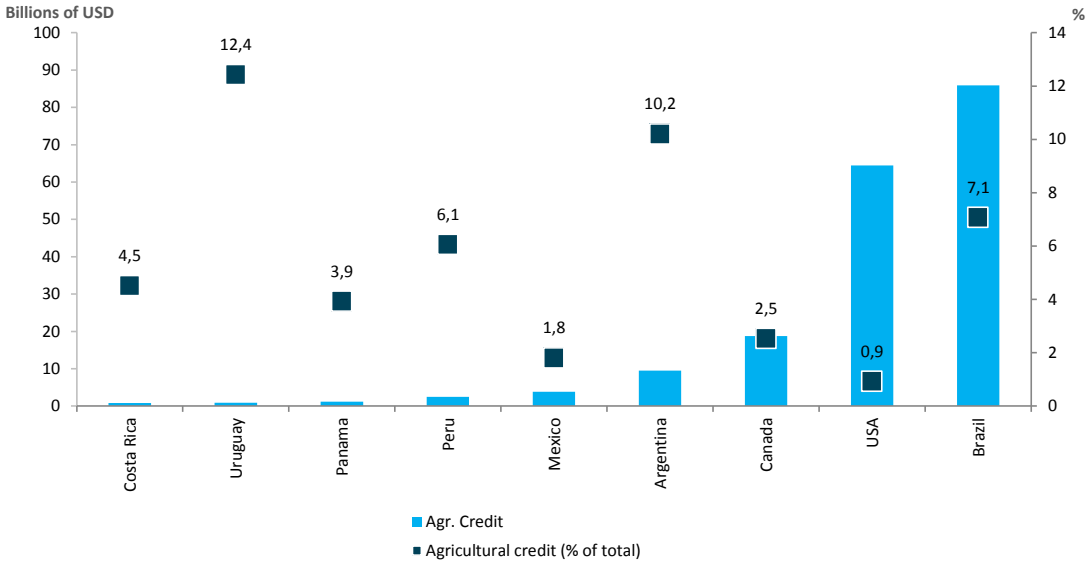
To attract FI for agriculture requires very balanced norms that prevent the concentration of the property of the land and other productive assets in foreign hands, and also the development of new and novel management tools for these resources.

84. To create an appropriate business environment for agriculture, financing mechanisms need to be made more inclusive. In general, agriculture is the sector that faces the biggest constraints in accessing loans and financing. This is partly due to the very nature of farming as a high-risk activity, but is also due in large measure to structural factors (farm size, for example), producers' per capita incomes (particularly medium- and small-scale farmers), the absence of rural financial infrastructure and the lack of assets to serve as collateral to secure loans or financing. All this makes the sector somewhat unattractive to banks and lending institutions, creating a circle of negative feedback that results in low levels of

investment in the countryside. It is needed to look for and evolve to non-conventional guarantees for credits, collective and differentiated insurance for each stage of the productive process with a long term vision.

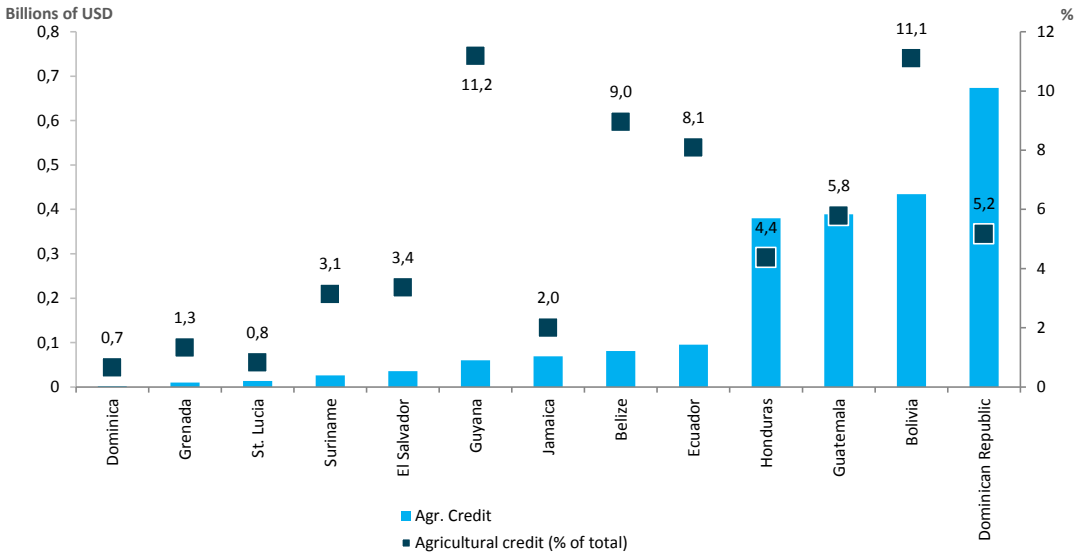
85. Rural credit plays a vital role in improving the distribution of benefits derived from research and development (R&D), and especially ensuring that technology reaches small- and medium-scale producers. Figure 8 shows a comparison of agricultural credit in countries of the region whose loan portfolio in agriculture exceeds one billion US dollars. Figure 9 shows the same comparison, but for countries whose loan portfolio is less than one billion US dollars. From these figures, it is clear that agriculture receives low amounts of credit, even in the countries that grant the most.

Figure 8. Agricultural credit in relation to total credit in countries of the Americas with an agricultural loan portfolio that exceeds one billion US dollars per year



Source: IICA-CAESPA, with data from FAO (FAOSTAT 2015).

Figure 9. Agricultural credit in relation to total credit in countries of the Americas with an agricultural loan portfolio of less than one billion US dollars per year



Source: IICA-CAESPA, with data from FAO (FAOSTAT 2015).

86. In a 2008 document, the World Bank made a number of recommendations for improving the availability of agricultural credit, including the following:

a. Reform state-owned agricultural banks.
b. Promote the development of microfinance institutions.
c. Modernize the architecture of rural financial service institutions.
d. Expand the scope of rural financial services.
e. Develop alternative financial intermediaries.

87. An example of the importance of credit for agricultural development is to be found in Brazil, where credit has been channeled primarily to small-scale farmers since the 1990s, mainly to finance crops and livestock production, the construction of infrastructure, the purchase of equipment and the marketing of primary products. Since the reforms of 1994, government subsidies have accounted for nearly one-third of all loans granted to Brazilian agriculture, while prior to that the government supplied nearly all the credit required by the sector.

88. Changes in credit architecture cannot be conceived separately from the establishment of comprehensive risk management programs. The importance of this protection mechanism has been endorsed -among many other initiatives- by the recently enacted U.S. Farm Bill, which places strong emphasis on the mechanism as a means to bolster the competitiveness of agriculture. Over the last nine years, IICA has promoted a permanent dialogue among its member countries with the aim of establishing agricultural insurance programs and instruments in response to the mandates issued by the IABA in 2005.

89. Inequitable access to assets and the means of production has negative effects on productivity and productive efficiency. This, in turn, creates a vicious circle that further widens productivity and income gaps among countries, regions, urban and rural areas, and producers. Just as this principle applies to poverty, because of its intergenerational nature, the greater the inequity today, the greater the inequity will be in the future (Chetty *et al.*, cited by Rupasingha 2014).

90. Other aspects involved in building a favorable environment for competitiveness include the need for companies to operate on a formal basis and with as little red tape as possible in each country. Much of the comparative data on the ease of establishing a business (normally measured as the number of days and procedures required for that purpose) in the countries of the Americas reveals that regulations and procedures are widely dispersed, which generally places excessive burdens on producers and entrepreneurs. Although much work remains to be done on this issue, several countries of the continent have already made considerable progress (Primarily Chile, Mexico and Brazil) in this regard and their efforts may provide lessons for other nations.

91. In the case of primary agriculture, this matter is of special significance, since farms do not operate in the same way as other types of businesses. This sector requires the design of policies and policy instruments that allow for greater transparency in land acquisition, more effective land titling processes, legal security for landowners, rational taxation mechanisms in response to the risks inherent to this activity and labor regulations based on the characteristics and needs of agriculture.

92. To develop competitive businesses it is also necessary to have a solid and modern infrastructure. In the case of agriculture, specific investment is required in transport and logistic infrastructure (roads, railways and waterways), storage and cold-storage systems and networks, research and technology and in rural financial infrastructure. In the case of the livestock industry, additional investments are needed in traceability and refrigeration, which are essential for competitiveness.

93. With respect to investment in transportation and means of communication, several areas must be addressed. In the first place, it is necessary to continue paving roads in rural areas, since this not only brings producers closer to markets, but also permits better development in rural territories. Recent evidence in Brazil shows that paving the roads in the savannah region helped to improve farmers' productivity (Rada and Valdes 2012).

94. However, the aforementioned investments are not the only ones needed; it is also urgent to invest in the renewal of railways, in the improvement of ports and docks, and in the modernization of the commercial vehicle fleet. It is particularly important to invest in improving the availability and quality of services and procedures to make trade of agricultural products more efficient.

95. Historically, the countries have attached importance to developing the physical infrastructure of markets, investing large sums in the installation and operation of wholesale centers and municipal markets. Unfortunately, during the last 10-20 years those facilities have been neglected and many of them are now in a deplorable condition and

operate with practices and principles that are inadequate to guarantee safe foods or competitive and transparent prices for the great majority of the population, especially rural dwellers. Therefore, there is an urgent need to review the role of those markets in order to ensure the competitiveness of agriculture and the region's food security. It is also necessary to improve their operating levels so that they meet current standards.

96. Another aspect of the business environment that is essential for the inclusive development of agricultural productivity is the way that markets operate, their transparency and efficiency.

97. In practice, most countries experience some form of market concentration, which impedes free competition, fosters corruption, increases transaction costs for businesses and hinders the efficient allocation of factors of production. These markets include the telecommunications, transport and energy markets, electricity services, the banks and, closer to agriculture, the fertilizer market and the market for the development of the dairy industry.

98. Among these markets, one that requires particular attention is the so-called "land market." Inequitable land distribution is associated with low levels of productivity and agricultural efficiency (Erickson and Vollrath 2004). Vollrath (2007) shows how a reduction of one standard deviation in the Gini coefficient in land distribution increases agricultural productivity by 8.5%. These observations have major implications for LAC, as the region with the worst land distribution (Gini coefficient of 0.81), compared with other regions and economic blocs such as Africa, the Middle East and North Africa (0.66), Eastern Europe (0.62), South Asia (0.59), OECD (0.56), East Asia (0.51) and Sub-Saharan Africa (0.40). A more equitable distribution of land results in a more efficient use of labor, due in part to lower management costs (Vollrath 2007).

99. The concentration of land ownership is also associated with underdeveloped financial markets. The absence or limited number of markets for managing risk and access to credit discourages the sale of land and leads to the concentration of land tenure. This, in turn, prompts agricultural workers to transfer their production risks to the landowners, given the absence of market instruments for that purpose, which merely reinforces the level of concentration. At the same time, the greater the concentration of land ownership, the smaller the number of potential clients for credit and insurance instruments, a factor that holds back the development of financial markets (Erickson and Vollrath 2004).

100. A favorable business environment cannot be conceived without appropriate mechanisms to facilitate the integration of economies into regional and global markets. The next chapter briefly explains the importance of trade for agricultural productivity; however, it is important to consider that economic liberalization helps to ensure that cutting-edge technologies and inputs are made available more quickly to producers and that external competition forces them to use the factors of production more efficiently.

101. Citizen security and migration are two aspects that should not be overlooked when reflecting on sustainable and inclusive productivity in agriculture, because they have a profound impact on it.

102. It is no secret that in many parts of the Americas, the rural sector in general, and the agricultural sector in particular, are faced with high levels of violence. This discourages investment, leads to the abandonment of farms and causes family and cultural disintegration. In several regions, the future of agriculture is seriously threatened by this phenomenon; only if the current trend is reversed and a state of peace and legality established, will investment and the inhabitants return to these areas.

103. Agriculture is one of the sectors most affected by migration, since it both generates emigration and receives migrants. In order to ensure sustainable and inclusive agricultural productivity, immigration reforms are needed across the continent. A study conducted by the Economic Research Service (ERS) of the U.S. Department of Agriculture (USDA) shows that nearly 50% of America's hired agricultural laborers are unauthorized immigrants (Zahniser *et al.* 2012). There are experiences in other regions of the hemisphere whose show the importance of migratory process, where immigrants have been able to increase the agricultural productivity in those areas in which they locate. Addressing the immigration problem throughout the Americas is an essential requirement for a competitive continent.

104. Another important impact of migration on agriculture are those related with remittances, and although their direct impact on agricultural productivity has not been studied in depth, the resources that these remittances provide to the rural areas are important to keep the families involved in agriculture.

105. Consumers could be regarded as the final and, arguably, the most important link in the market chain, since they are the ones who use the products originating from agriculture. Unfortunately, there is very little information on how consumers affect agricultural productivity. A recent study by the government of the United Kingdom (Peacock *et al.* 2013) confirms that having effective laws that protect and promote consumers' rights fosters innovation and improves productivity and competition, allowing consumers to make better decisions about what they eat. Therefore, it is important that all countries establish efficient, transparent consumer protection laws.

106. From a simpler perspective, agriculture must respond to three major trends in consumer demand, given that the vast majority of the population now lives in cities.
    - The first of these trends involves paying greater attention to the way in which agrifood systems produce food, because society now demands to know more about how and where food is produced, and has greater environmental and social awareness (traceability).
    - The second trend that will affect agriculture has to do with consumers' expectations about the food they eat, since they are more concerned about the quality and safety of foods and their impact on human health and wellbeing.
    - Finally, the third trend, is the expectation of foods that are easier and quicker to prepare, and that meet the needs created by the faster pace of urban life.

Agricultural trade and its relationship with agricultural productivity

107. International trade serves as a channel for the dissemination of technology and innovation, either through imports of intermediate products and capital equipment or the lessons learned from exporting to industrialized countries (Laborda *et al.* 2011). The effect of international trade on productivity depends on the complementarity of economies.

108. In the case of imports, their effect on productivity depends on whether they complement the domestic production process (such as capital goods and intermediate goods) or compete with domestic production. Imports play an essential role in the modernization of productive processes, since the provision of better inputs and modern machinery contributes to technological improvement.

109. On the export side, it is clear that countries that adopt currency devaluation policies increase their competitiveness but mask the countries´ inherent structural inefficiencies. Despite this, the devaluation of local currencies stimulates exports, thereby increasing the installed capacity of the exporting sector. This relationship between the devaluation of the local currency and technical efficiency is more evident in countries whose external sectors play an important role in the local economy (net exporters) (Araujo *et al.* 2014).

110. Another effect of open trade on productivity occurs through international competition in domestic markets (Ventura-Días 1999). External competition in domestic and international markets forces businesses to innovate in order to avoid being displaced from the market (WTO 2014).

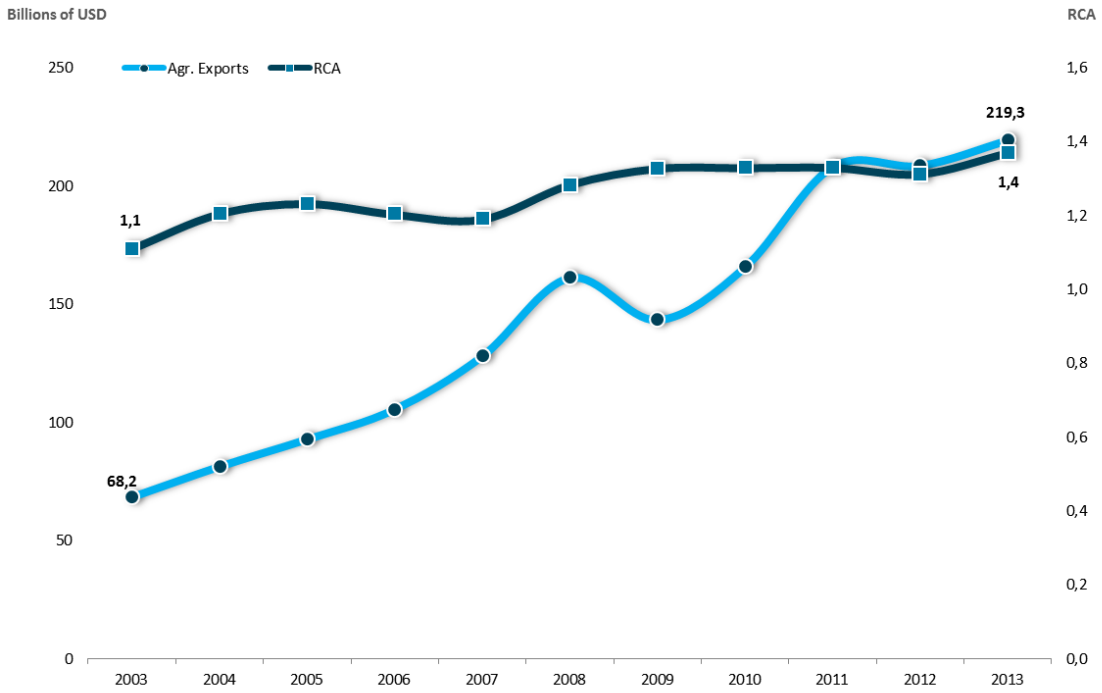
111. Although most agricultural production is consumed in domestic markets, international trade in food is a highly dynamic activity with major repercussions on local economies. Although world agriculture only accounts for an estimated 9% of international trade, it is a business worth nearly USD 1,5 trillion in exports in absolute numbers (WTO 2013), of which 83% corresponds to food and the rest to other types of agricultural products, such as live animals, etc.

112. Agricultural trade is important for countries because it contributes to incomes, employment and to improving the purchasing power of all agents throughout the chain. An IICA study on the real contribution of agriculture to the economy (IICA 2004), estimated that an increase of one USD in primary agricultural exports has an important effect on the remuneration of the factors of production (labor, capital and land), ranging from USD 1.421 in Canada to USD 3.34 in Argentina. The same study showed that in Costa Rica, one additional USD in coffee exports generated an additional increase of USD 1.18 in family incomes.

113. In 2013, the LAC region exported USD 219 billion in agrifood products, an increase of 221% over 2003 (USD 68 billion) and an average annual growth rate of 11.8 %. Despite such dynamic growth, if we compare the performance of the region's agrifood exports with those of the rest of the world, it is clear that LAC lost dynamism (in other words, other regions grew more rapidly and gained market share) during the 2008-2012 period. As

Figure 10 shows, the index of revealed comparative advantage[12] increased from 1.18 % in 2003 to 1.32 % in 2008, subsequently falling to 1.23 % in 2012, and to increase again to close to 1.4 in 2013, the year in which signs of recovery began to be observed (Figure 10).

Figure 10. Value of exports and index of revealed comparative advantage, 2003-2013



Source: IICA-CAESPA, with data from United Nations (COMTRADE 2015).

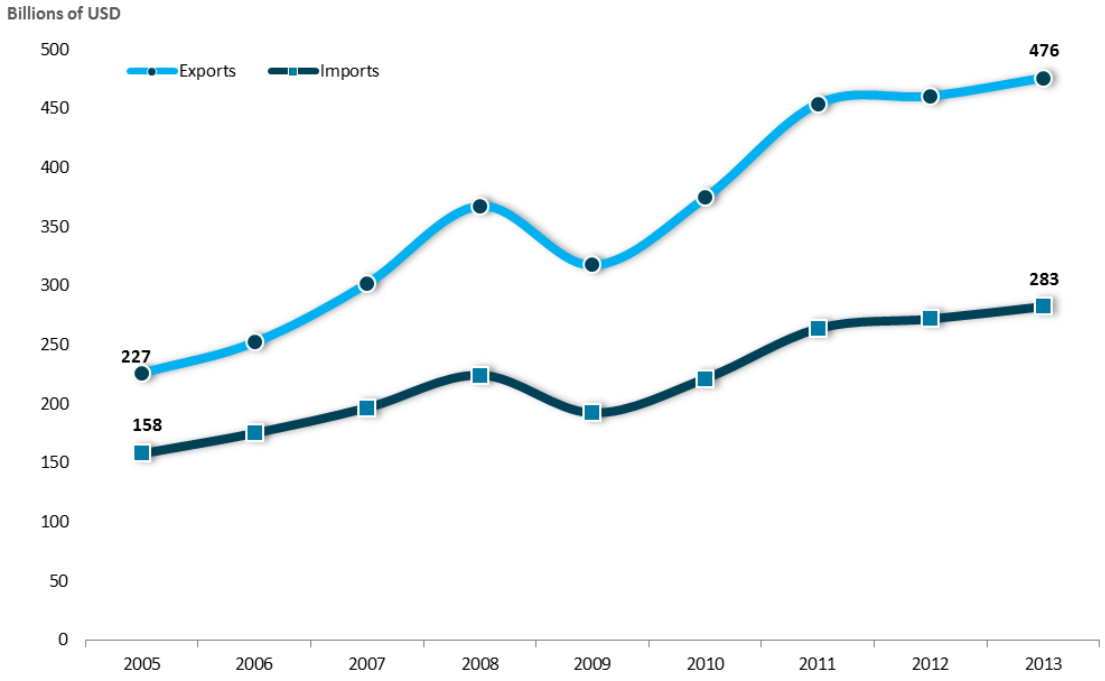
114. Countries in the Americas have the potential to become leaders in supplying agrifood products to global markets, thanks to the expected population and income growth and to the mis-match of global distribution of this growth and the natural and agricultural production base of those countries that will experience the higher changes in population and income. In doing so, the countries of the region must continue to insist that the poorest developing countries continue to implement sound agricultural policies which will help their agricultural sectors to compete globally and cope with special circumstances.

115. At present, the Americas is a very dynamic region as far as the international food trade is concerned. The performance of the continent's agrifood exports and imports is shown in Figure 11. It is undoubtedly the most dynamic region of the world in terms of the number of trade agreements signed or under negotiation, which will provide new opportunities for expanding trade in the region's agricultural products. However, it is important that the

[12] The index of revealed comparative advantage measures the evolution of agrifood trade with respect to a country's other products, taking the rest of the world as a reference. An indicator greater than zero shows that the country has a positive comparative advantage. If it increases over time, it is a sign that the sector has shown greater dynamism than the rest of the world and, therefore, has gained market share at the global level, which means that the sector is more competitive (see Arias and Segura 2001).

countries of the Americas make a concerted effort to conclude the Doha Round and implement the Bali Agreements. In the region there is a group of countries that are considered net food importers that are highly vulnerable for food security, and for which it is also important (albeit different reasons) to advance in issues of international trade.

Figure 11. Performance of agricultural exports and imports in the Americas (in billions of USD)



Source: IICA-CAESPA, with data from WTO (2015).

116. Most national production is consumed in domestic markets. According to IICA (2004), based on a sample of ten countries in the Americas, just over 10% of the gross value of expanded agricultural production was exported; the rest was sold on the domestic market. However, the growth of international demand, combined with the competition faced by exporters in international markets, the quality of human capital, innovation processes and FDI flows, has meant that, in the last ten years, the growth of LAC's agricultural exports has doubled, and even tripled, the growth experienced in domestic markets (with certain exceptions, such as tobacco, vegetables, roots and oranges, etc.)

117. The income growth that the middle classes in the LAC countries will experience in the years ahead is expected to bring about a significant expansion in the region's domestic markets. If they are to take advantage of the growth of domestic markets, national producers must satisfy the increasingly rigorous demands of consumers in those markets. Therefore, as well as increasing productive efficiency to match the costs of international competitors, countries will also have to raise standards of quality, health, safety, etc. This is

important, because in LAC countries such as Argentina, Mexico, Costa Rica, Colombia and Guatemala, among others, multinationals are responsible for over 60% of trade in foodstuffs, and require their suppliers to comply with very rigorous private standards (Reardon and Berdegue 2002).

Innovation as a catalyst for productivity

118. Innovation is an element that acts as a catalyst for growth and positive change (Box 11) and it allows for the creation of a science based enabling environment. Promoting this process is vital for increasing and intensifying production and productivity, improving incomes, reducing poverty and inequality, lessening the environmental impact of the agrifood sector, responding to natural disasters, increasing access to new technologies, adapting to climate change and, consequently, achieving food security and improving the quality of life for all our citizens.

Box 11. What do we mean by innovation?

"Innovation is the implementation of something new or improved (whether technology or otherwise) in products (goods or services), processes, marketing or organizational methods. In other words, it means applying ideas, knowledge or practices that are new to a particular context for the purpose of creating positive change that will provide a way to meet needs, take on challenges or seize opportunities. Such novelties and useful changes could be substantial (a big change or improvement) or cumulative (small changes that together produce a significant improvement)" (IICA, 2014, adapted from OECD, 2005). In the case of agriculture, it could be the introduction of a new processing technique by an agroindustrial company.

In the agrifood sector, innovation encompasses best practices and new technologies, healthy and safe products, improved infrastructure and support services for production and marketing, technology transfer and knowledge sharing in value chains, training and extension services, access to credit and a science-based legal and policy framework.

119. The importance of innovation in agriculture was ratified in the 2011 Declaration of Ministers of Agriculture of the Americas (San Jose, Costa Rica) in which the countries of the Americas reaffirmed their commitment to promote the transformation of agricultural research institutions into national agricultural innovation systems, encourage cooperation among countries, institutions and stakeholders, and to foster innovation as a key tool for improving agricultural productivity in order to ensure food security in the continent.

120. The Global Innovation Index (GII)[13] ranks the innovation capabilities and results of 143 countries. In 2014, the United States was ranked sixth, while Canada occupied twelfth place. Over the last four years, these two countries have consistently figured among the top

[13] The GII consists of 81 indicators related to institutional framework, human capital, research, infrastructure, level of sophistication of markets and businesses, as well as the impacts of knowledge, technology and creativity. The index refers to any innovation process, not only to the agricultural sector.

ten nations in the GII. The highest-ranking country in the Caribbean Region was Barbados (47th), while Chile ranked highest among the Southern Region countries (46th). Panama led the way in the Central Region (52nd), and Colombia ranked highest in the Andean region (68th) (Cornell *et al.* 2014).

121. The differences between the north and the south of the continent were also reflected in the 2014 SCImago Journal and Country Rank (SJR Indicator),[14] in which the U.S. occupied first place in the production of scientific documents for agriculture and the biological sciences, while Canada ranked eleventh of the 219 countries included. In fifth place was Brazil, followed some distance behind by Mexico (20th), Argentina (22nd), Chile (36th) and Colombia (43rd). In Central America, Panama ranked highest (68th), while Cuba led the Caribbean (69th). In addition, with the exception of Brazil, Mexico and Argentina, the rest of the LAC countries have an h-index[15] of less than 100, while the figure for the U.S. is 478 and for Canada, 263 (SCImago 2014).

122. In LAC, investment in science, technology, research and development is very limited; only countries like Brazil and Mexico invest significant - but insufficient - amounts in these areas, a factor that substantially affects their productivity (ECLAC 2012). The Latin American countries are characterized by low levels of investment in R&D, which accounts for barely 0.75 % of GDP, insufficient for the region's production needs. In Central America, these figures are below 0.50 % of GDP (IICA 2014).

123. One way of fostering innovation is through the development and consolidation of national agricultural innovation systems (NAIS). These networks include institutions, businesses, organizations and individuals that request and offer knowledge and technologies, and focus on the use of new products, processes, forms of organization and rules, and mechanisms through which they interact (World Bank 2006). NAIS integrate the generation, dissemination and management of knowledge and are continuously evolving dynamic systems. Their outstanding feature is that they include a large number of stakeholders, not only from the public sector, which has the key role of developing the policy, infrastructure and regulatory framework for fostering innovation and promoting interaction between different stakeholders, but also from the private sector and civil society (OECD 2013).

124. One way to improve the agricultural innovation process for a more productive agriculture is by attracting the private sector and by public-private partnerships. These partnerships should produce mutual benefits and will allow for sharing of resources and expertise, promote science based process and good practices as well as the promotion of locally adapted innovation (IOB, 2013; OECD, 2014)

125. An important aspect of innovation systems is the vital role played by extension services in affording farmers, their organizations and other agents, access to knowledge, technologies and information. Recently, governments have reduced their involvement in extension services, which has encouraged the emergence of intermediaries and private suppliers.

[14] A portal that includes the journals and country scientific indicators developed from information contained in the Scopus® database (Elsevier B.V.).
[15] The h-index is the number of articles cited.

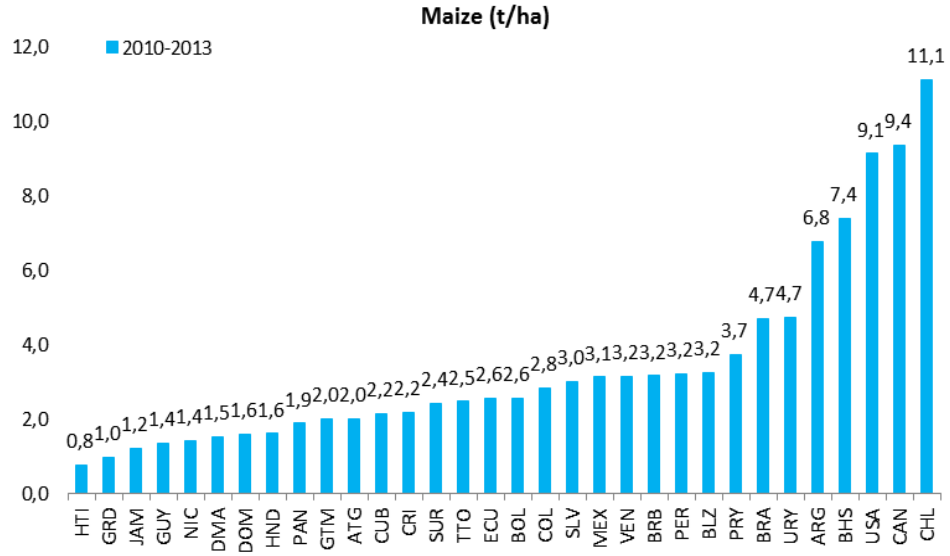
However, these changes have not had the desired impact, especially among small-scale producers or those least able to pay for services. Therefore, it is necessary to rethink how to implement extension processes, recognizing the important role that extension agents have in promoting change and improving the dynamism of productive systems. Alternatively, service providers and input suppliers may play an important role in the provision of knowledge, especially for the small scale producers, however in order for this to become a reality there is a need to improve the business climate and the policies and programs to enable small holders to engage in the markets for inputs and services.

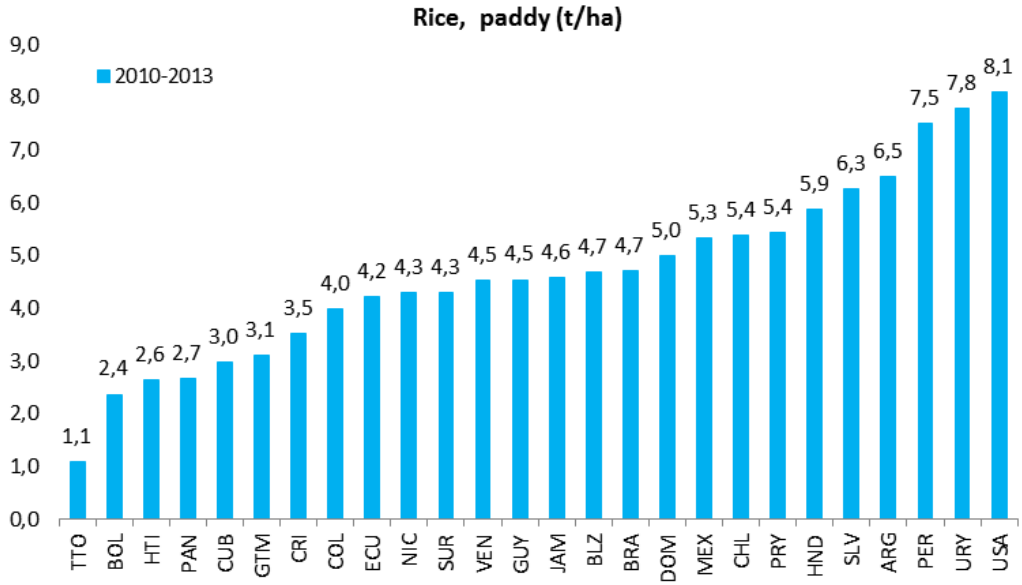
126. It is generally accepted that the use of information and communication technologies (ICTs) has a positive impact on agricultural productivity, through management, extension, information and knowledge instruments. One example of these efforts is the "e agriclutre.org" platform, which is a worldwide community oriented to facilitated the dialogue to share the use of ITC in the development of a sustainable agriculture.

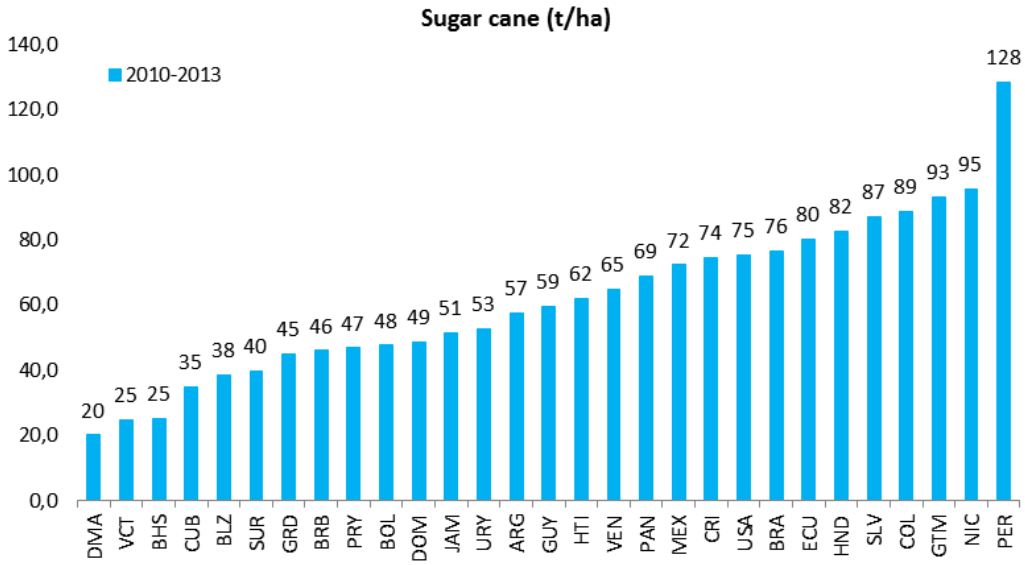
127. However, the application of ICTs in the region's agriculture is limited and their use is conditioned by various factors, such as the cost of equipment and systems, their high rate of obsolescence, infrastructure constraints, lack of competition and transparency in the telecommunication markets and problems of connectivity in rural areas. Another factor that affects the incorporation of ICTs into agriculture is resistance on the part of agricultural producers, especially older farmers (Chavarría 2012).

128. The institutional changes needed to consolidate a culture of innovation in the countries of the Americas call for a long and continuous effort, but a potentially feasible way to improve the productivity of agriculture in LAC is by bridging the production gaps that exist between the most advanced and least advanced producers (Figures 12 and 13). Achieving this goal is not only an issue of availability of technologies, but it also requires continued efforts in innovation, resources and appropriate public policies.

Figure 12. Maize, rice and sugar yields in the countries of the Americas (in t/ha).

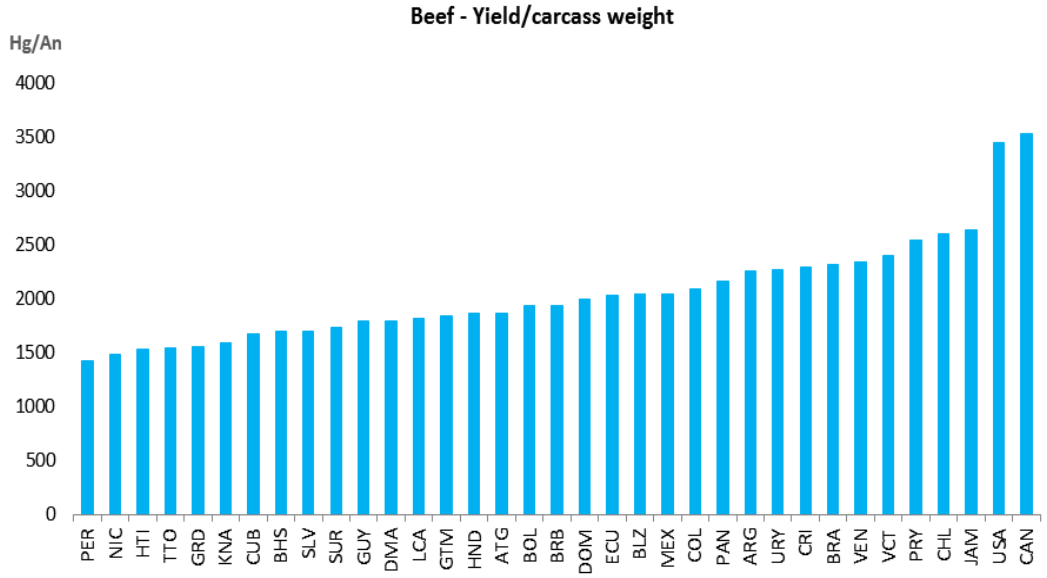


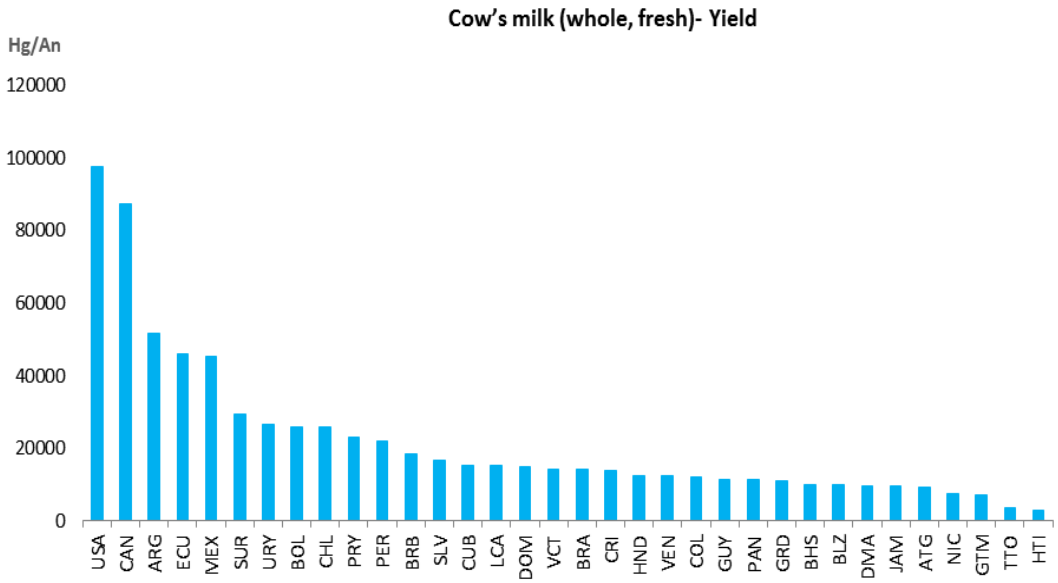


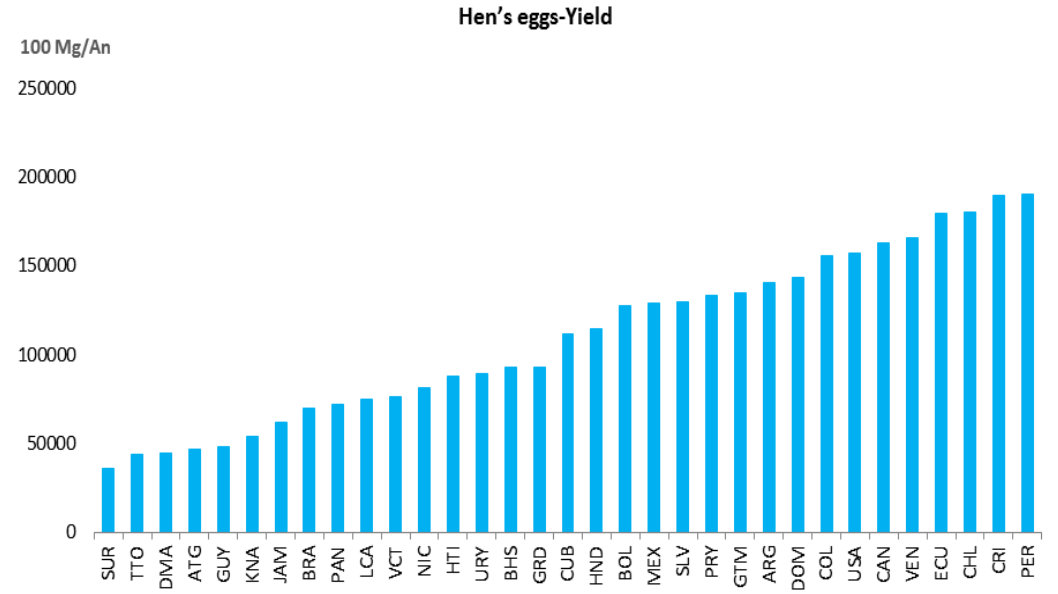


Source: IICA-CAESPA, with data from FAO (FAOSTAT 2015).

Figure 13. Yields of animal-based products in countries of the Americas.







Source: IICA-CAESPA, with data from FAO (FAOSTAT 2015).

129. A wide array of technologies and innovations is available to close the abovementioned production gaps, which are already in use or could be placed at the disposal of producers in the countries of the Americas with relatively little effort (Box 12).

Box 12. IICA Technical Cooperation Fund

In order to find new solutions to the problems of agriculture, for the last four years IICA has been operating the Technical Cooperation Fund (FonTC) as a competitive mechanism to promote innovation. Some of the results obtained from projects generated by this fund include: a) a series of instruments and methodologies designed to support the development of public policies on health and safety; b) an estimate of the contribution made by stock raising to food security and an increase in the incomes of smallholders in three countries; and, c) various instruments that are enabling producers and countries to take better advantage of advances in biotechnology. Furthermore, the application of new approaches made it possible to support efforts to improve the capacity of producers and exporters to understand and implement new international trade regulations, and to enhance the capacity of ministries of agriculture to meet the challenges of climate change, among other actions.

130. One such technology is the use of biotechnology which, with its varied and numerous techniques, can be very useful for increasing agricultural productivity. For example, the application of such techniques has resulted in the development of varieties that are more resistant to drought, salinity, pests and diseases (Chan *et al.* 2010). Biotechnology is an important element which, when linked to policies, markets and stakeholders (producers, regulators and consumers), provides tools to boost the productivity of agriculture (Box 13). However, despite the benefits of the safe and judicious use of agricultural biotechnology, many countries in the Americas lack enabling, science-based policies and oversight to facilitate their use, a challenge that must be addressed in order to facilitate the continued availability of these technologies to address global changes, as well as to support a regional "global sustainable breadbasket" in the Americas.

Box 13. Impacts of biotechnology on agriculture in the Americas.

Biotechnology has undoubtedly had a major impact on agriculture. Maize, like other cereals and oilseeds, is a good case in point. Around 1900, productivity of yellow maize across the world reached 1.5 t/ha; 40 years later, with the introduction of hybrids, this increased to 3.5 t/ha. By 1975, productivity had increased to 6 t/ha, as a result of the Green Revolution. Subsequently, the use of other biotechnology techniques (e.g., tissue culture and marker-assisted selection), and genetic engineering (recombinant DNA technologies), made it possible to boost maize yields during different periods, reaching field values of between 18 and 22 t/ha, with potential production rates estimated at between 42 and 64 t/ha. In the case of rice, the use of traditional improvement techniques, supported by biotechnology, has resulted in the generation of more than 840 varieties, which have been released in 77 countries (IRRI 2015).

131. Another innovation that has had a positive impact on productivity and natural resource conservation is the practice known as conservation tillage. Derpsch *et al.* (2010) offers a detailed description of the progress and expansion of this production system, estimated to

be in use on more than 120 million hectares around the world, nearly 50% of them in South America.

132. Another example is precision agriculture, which combines the use of traditional agronomic and market knowledge with the utilization of data in real time. This enables producers to make specific decisions based on the conditions of their farms and crops, thereby boosting productivity, reducing the impact on the environment and natural resources, and improving the sustainability of the operation. Technologies of this kind can be used by all types of producers (Bongiovani, et al., 2006).

133. In the case of livestock production, important knowledge and innovations are available for improving productivity on farms and reducing environmental impact. Advances in the use of molecular biology have led to the development of new and better vaccines and medicines, faster, more accurate detection of parasites and diseases, and the identification of markers that help speed up genetic improvement in animals. Major progress has also been made with nutrition, making it possible to improve the use of feed rations, reduce the production of methane and other gases produced by enteric fermentation, and even alter the population and function of bacteria that live in animals' digestive tracts. Progress continues to be made in our knowledge of the mechanisms that regulate animal growth rate and body composition. Reproductive management techniques now make it possible to improve both the fecundity and fertility of farm animals.

134. As in the case of crops, there is a development known as precision livestock farming, which is currently applied mainly on dairy and pig farms, and includes the use of real-time information on the condition of animals and their productive levels, existing resources and the environment. This system allows for specific interventions for each animal in order to maximize its productivity.

135. Animal welfare is another vital issue for achieving sustainable productivity in livestock farming. Research confirms that stress in all its manifestations affects animals' productive capacity and the quality of the products obtained from them (Moberg and Mench, 2000). In addition, consumers are increasingly demanding certification of the wellbeing and humane treatment of animals, given their growing awareness of the production systems used in agriculture.

136. Pests and diseases have substantial negative effects on agricultural productivity, not only because of their direct impact on crops, livestock and fisheries, but also because of the end result for producers' health and livelihoods. While the global costs of pests and diseases to agriculture are difficult to quantify precisely, due to the variability of commodity prices, the geographic distribution of pests and diseases, their intensity, and the costs of inputs to combat them, their effects on productivity, health and incomes can be devastating (Box 14). Two cases in point are the outbreak of coffee leaf rust that has hit the Central American region and the avian flu outbreak that affected Mexico's poultry sector a few years ago, as well as poultry production in the Midwest of the US recently which have had a serious impact on productivity and the wider economy.

Box 14. IICA's contribution to advances in plant and animal health

Among many other actions, IICA has supported the development of modern national animal and plant health systems through the application of the Performance, Vision and Strategy (PVS) tool to national plant and animal protection organizations. Applied in more than 12 countries in the Americas, it has led to better-equipped national systems with improved capacity. Another example of the importance of international cooperation in this area is IICA's efforts, with support from the USDA, to facilitate the effective participation of the LAC countries in international organizations, particularly in the CODEX Alimentarius.

Working together for the inclusive and sustained productivity of agriculture in the Americas

137. Boosting agricultural productivity must be a national, regional and hemispheric-wide objective. If achieved, all segments of the population will benefit, and inequality in the region will be reduced. However, higher productivity must be achieved in an inclusive manner, through the integrated management of natural resources and without increasing the adverse impact of agriculture on the environment and biodiversity.

138. Achieving this goal requires long-term and joint efforts with the involvement of all State institutions, the private sector and civil society. It calls not only for the ministries of agriculture to oversee programs designed to ensure the sustainable improvement of agriculture under the aegis of the State, but also for the implementation of actions and policies agreed with other ministries and agencies. Agricultural development strategies must inherently acknowledge the link between increasing agricultural productivity and the overall growth in the wider economy of countries in the Americas.

139. Increasing the productivity of agriculture cannot be only a national effort. Meeting the challenges and tapping the new opportunities requires the combined efforts of all countries, since cooperation and the dissemination of knowledge, good practices and experiences are essential, especially for the provision of public goods.

140. Recognizing the complexity of this task, the multiplicity of potential interventions needed at all levels and the varied political, economic, ecological, cultural and social circumstances and conditions of the countries of the Americas, the following general recommendations are offered to improve agricultural productivity across the continent:

141. ***Recommendation 1:*** Strengthen the State's guiding role in agriculture through the development and application of strategic science-based policies and policy instruments that foster productivity, investment, innovation, infrastructure, the promotion of science and food health and safety. Among the areas of action that could be considered are the following:
    a. Revitalize public investment for the provision of public goods in and for agriculture, to this end each country should make precise commitments of the investment they are willing to make in agriculture.

b. Modernize institutions and promote institutional change, continuing with the implementation of structural reforms.
c. Strengthen public policies that foster innovation processes, particularly in small-scale and family farming.
d. Promote and organize the development of markets for agricultural and non-agricultural rural products and services, including land markets.
e. Develop strategic policy documents that identify goals and approaches for sustainable agricultural development, including, as applicable, the role of agricultural biotechnologies.

142. ***Recommendation 2:*** Implement a modern agricultural education process that serves all the stakeholders in the system. This calls for the following actions:
a. Modernize professional education in agriculture.
b. Continue to promote improvements in the quality and coverage of rural education, including substantial improvements in and upgrading of teachers' skills, and the expansion of infrastructure.
c. Establish capacity-building programs for agricultural workers through certified training programs.
d. Strengthen the business and organizational capabilities of agricultural and rural producers.
e. Establish solid training programs for new farmers, targeted at young people.
f. Establish programs to improve producers' capacity to implement and participate in productive projects.
g. Establish and foster nutrition education programs at all levels aimed at reducing existing levels of obesity and malnutrition in the Americas, cutting food losses and waste.
h. Enhance the agricultural and rural entrepreneurial spirit in the students at technical and agricultural colleges, supported in credit and investment for innovation programs.

143. ***Recommendation 3:*** Continue investing in the creation of a culture of agricultural innovation by strengthening innovation systems and processes, paying particular attention to the following aspects:
a. Develop public policy instruments to promote public and private investment, including mechanisms to facilitate the close coordination of the two sectors.
b. Promote more efficient and sustainable use of natural resources.
c. Strengthen the links between technological research and development centers and the private and public sectors, in order to increase and improve the integration of value chains.
d. Identify, evaluate and take advantage of local and ancestral knowledge.
e. Strengthen research systems linked to productivity and to each country's strategic priorities.
f. Promote the creation of inter-institutional and interregional networks that facilitate the flow of knowledge among stakeholders in the value chains.
g. Strengthen and invest in extension services are these are a key element for production systems.

144. ***Recommendation 4:*** Consolidate the region's leadership in international trade of agricultural products.

a. Continue to work toward improvement of the world trade system and on the implementation of agreements already established.
b. Strengthen the continent's leadership in worldwide mechanisms such as CODEX and other international agreements with an impact on trade.
c. Continue working toward the implementation of appropriate systems for the protection of intellectual property rights and the protection of investments.
d. Continue to establish and implement health, safety and trade policies based on scientific decision-making, including considerations of regulatory cooperation vis-à-vis recognition and harmonization.
e. Work towards greater inter-American trade integration.

145. ***Recommendation 5:*** Foster an entrepreneurial, business-oriented culture.

a. Support the business and organizational development of agricultural and rural producers to improve their negotiating capacity and take advantage of economies of scale.
b. Increase opportunities for accessing production assets, financing and integrated risk management, giving priority to women agricultural producers.
c. Support the implementation and expansion of social responsibility programs.
d. Strengthen the inclusion of small-scale and family producers in value chains.
e. Simplify formalities and improve the business environment for agricultural enterprises.

146. ***Recommendation 6:*** Strengthen international cooperation for the development of productive, sustainable and inclusive agriculture.

a. Instruct international and regional organizations to include in their cooperation programs an agenda for the sustainable intensification of agriculture.
b. Work in a coordinated manner to close existing productivity gaps.
c. Help in the articulation of nutrition and health programs with those of the agricultural sector, helping to strength the national plans of food and nutritional security. Strengthen cooperation among organizations involved in conducting analyses, studies and proposals for the sustainable and inclusive development of productivity.
d. Work with countries on the design of policies and programs to achieve productive, sustainable and inclusive agriculture.

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