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WATER FOR AGRICULTURE IN THE AMERICAS

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Water, Innovation and Productivity Series

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ACKNOWLEDGEMENTS

This book is dedicated to agricultural technicians and producers, and, most importantly, to all personnel responsible for agricultural irrigation systems across the continent.

We hope that the book will serve not only as a source of information, but also as a tool for raising awareness of the need to use water in a wiser, more rational manner; as we all know, this critical natural resource is running out.

FOREWORD

Water, food for the land

There is absolutely no doubt that water is linked to agriculture and civilization; from early civilization, all cultures have developed around water. Our societies today, and in the future, depend on the manner in which we are able to resolve the problems associated with an insufficient and unreliable water supply, on the scarcity and unequal distribution of this resource and on pollution of the groundwater and surface waters.

The volume of water available on earth is 1386 millon cubic kilometers. However, only one percent of this is fresh water. Agriculture, by consuming two-thirds of the amount of available freshwater, is the sector that consumes the largest quantity. However, population growth, urbanization, agricultural expansion, deforestation, bad agricultural practices and pollution of water sources have made freshwater in general, and agricultural water in particular, a scarce and in-demand resource, and have transformed it into a strategic topic for food security.

Agricultural water is a public good. Its efficient use prevents waste and contributes to increasing productivity and food supply, to improving the living conditions of the rural population and reducing the poverty levels and marginalization of millions of rural families.

Conserving this public good and utilizing it in a more efficient manner is everyone's responsibility, be they governments, farmers, economic sectors, consumers, international organizations and civil society organizations.

Through this publication, the Inter-American Institute for Cooperation on Agriculture (IICA) presents an overview of agricultural water on the American continent. The region possesses 46 % of the world's water supply and one of the highest levels of rainfall, although these resources are distributed very unequally. In addition to these contrasts both at the regional level and within the countries, there is very little use of agricultural irrigation, i.e. in only 13 % of arable land. Therefore, in light of the serious challenges that food production will face in the coming decades, it is imperative to boost irrigated land and the efficient use of agricultural water in order to increase productivity.

IICA, which is responsible for promoting competitive, sustainable and inclusive agriculture at the hemispheric level, has identified a number of strategies and guidelines to strengthen integrated and sustainable use of water resources throughout the Americas. The ministers of agriculture throughout the Americas have defined a series of guidelines and directives that have been strictly adhered to by IICA in order to determine and promote a hemispheric water agenda. This was reflected in the 2010-2020 Strategic Plan and in the 2010-2014 and 2014-2018 Medium-term Plans, in which the strategies, programs and actions were defined for driving this water agenda.

This support from the highest authorities within the member countries of IICA was also reflected in the Declaration of Ministers of Agriculture Argentina 2013, as well as in the ministerial dialogue which included discussions and sharing of opinions on a series of documents and studies associated with integrated management of water resources, among which are: Water to feed the land and Innovation and water management for sustainable development of agriculture.

This new book contains the central topics related to this agenda. It details the main actions and water projects pursued by IICA since 2010, as well as the principal irrigation projects in which the Institute has participated throughout the Americas. It concludes with a chapter that points out the major challenges facing the water agenda for the Americas in the future. I am confident that this work will be of great use to those dealing with agricultural water at the hemispheric level.

Dr. Víctor M. Villalobos
Director General
IICA

01

STRATEGIC IMPORTANCE OF WATER

Water is an essential element of life. Some 70 % of the earth's surface is covered with water. It is essential to the origin and evolution of all living organisms and has been, and always will be a fundamental element for humankind and other living species. All cultures, including the most ancient, developed around water. In large measure, the present, and even more so, the future of our societies, are closely linked and depend on the manner in which society and governments resolve the problem (since all of us are equally responsible) of a growing scarcity and unavailability of freshwater, which has become a strategic and central problem for humanity since the end of the XX century.

With the demographic growth of the middle of the last century, and with increased urbanization and industrialization, the supply of freshwater for a dynamic and developing society has become a central topic. Of the total volume of water available on the planet, around 1386 km^3, only 1 % is freshwater. 97 % of this water is in the oceans and seas, and 2 % is frozen. Agriculture utilizes two-thirds of available freshwater for agriculture. Given the uncontrolled and often unplanned growth that has occurred in most of the urban and rural sectors over the past decades, freshwater has become a strategic topic, not only for food security, but also for national security.

Water is an essential element for combatting poverty and hunger. It is also essential to increasing food production, achieving sustainability and improving living conditions throughout the society, both in the rural areas and in the cities.

Since the 1980s, but particularly since 1990, international organizations such as the United Nations Organization (UN), the United Nations Food and Agriculture Organization (FAO), the World Health Organization (WHO), the Organization for Economic Cooperation and Development (OECD) and the World Bank, as well as other regional organizations such as the Inter-American Institute for Cooperation on Agriculture (IICA), have promoted various initiatives and projects to resolve this fundamental problem.

The conclusions that they reached and which form the basis for these initiatives and programs are well known: water, especially freshwater, is a resource that is increasingly scarce, necessary and valuable. There is a growing shortage and misuse of freshwater. In addition to misuse, contamination caused by urban and industrial waste, as well as agriculture and agroindustry, have caused the quality of water to deteriorate, and has resulted in serious damage to the groundwater resulting from overuse. Contamination and over-use of these water tables, as well as an increase in salinization, have affected both the water used for agriculture, and the water used in the cities. Under these conditions, guaranteed sustainable development of humanity is difficult. Over the past decades, competition between agriculture, industry and urban services for water has become acute, and is expected to increase. For this reason, conflicts regarding the use of water between the rural and urban populations, and between the main productive sectors, has also intensified and will continue to increase.

In light of this situation, and since the end of the last century, the world has turned its attention to the water used in agriculture. Agricultural water has become a strategic public good in two respects. Firstly, efficient use of agricultural water would prevent the unfortunate waste of an enormous amount, and would serve to improve consumption habits in the non agricultural sectors. Secondly, efficient use of water in agriculture would result in greater productivity and food supply, which is also a strategic aspect in light of the food needs of a growing world population, and vast regions where hunger and malnutrition are pressing problems that need to be urgently resolved.

For this reason, since the beginning of the last century, governments and international financial bodies have devoted large sums of money to creating, expanding and improving irrigation infrastructure. During the 1980s, some 30 % of agricultural loans from the World Bank were allocated for putting irrigation systems in place, while the aid organizations invested more than USD 2 billion in irrigation projects. Given its strategic importance for the countries, and the amount of resources required, the governments have assumed this cost and are subsidizing the majority of their operation and maintenance. (FAO 1993:233).

In spite of this, the levels of inefficiency, waste and contamination of irrigation water continue to be very high, with serious consequences for the population and agricultural yields. Additionally, as pointed out by FAO, in the ever-increasing competition for a scarce good such as water, agriculture can no longer compete with the cities and industries that can pay more for it and obtain greater benefits per unit utilized.

However, many countries have reduced their use of water in agriculture, and have increased the amount destined for the cities and industry. Farmers are having to pay more and more for the water they need, due to reduction or elimination of government subsidies resulting from the fiscal crisis and the economic model that is practiced in the majority of countries since the 1980s.

The State is primarily responsible for ensuring food security, which is increasingly linked to water security. Most of the food produced is obtained from irrigated land, while one-fifth of fishery products are grown in freshwater.

Within this context, irrigation systems and irrigated agriculture have become more important. Higher food production and greater agricultural productivity, through more efficient use of water, contribute to advancing toward achieving food security and translate into greater income for farmers and better living conditions for rural families.

For this reason, public policies in the agriculture sector over the past decades have placed emphasis on the topic of water, with a view to moving toward sustainable use of this strategic resource.

Availability of water

Freshwater results from precipitation caused by the evaporation of water from oceans and seas. As part of the water cycle, 110 000 km^3 of water results from rain, of which 70 000 evaporates. The remaining 40 000 km^3 is distributed unequally among the different regions of the world, and two-thirds of this amount is lost. Comparatively speaking, Latin America is the region with the largest quantity of available water. In 1950, each inhabitant in Latin America had on average that 105 000 m^3 of water available to him/her. Demographic growth and poor usage of this resource, combined with pollution, deforestation, urbanization and lower replenishment levels of the water table, have caused a drastic reduction in the quantity of water. An estimate conducted by the FAO shows that around 1980, this was already at half, and that in 2000, the water level was barely a quarter of what it had been 50 years earlier.

The regions with the lowest quantities of water are North Africa and Asia. In these regions the availability of water per inhabitant towards the middle of the last century was 20 600 m^3 and 9600 m^3; in 2000, this had been reduced to 5100 m^3 and 3300 m^3, respectively. Europe is the region that has experienced the least amount of change, albeit comparatively, given that because of its high demographic concentration, it has the least amount of water available. In the second half of the XX Century, this was reduced from 5900 m^3 to 4100 m^3 (FAO 1993:237, table 6). Most of the problems occur in Asia, Africa and Latin America, given the high level of demographic growth.

With respect to consumption, Asia was, in 2000, the region that consumed the highest amount of water, amounting to 60 % (4000 km^3), followed by North America, (15 %), Europe (13 %). Africa (less than 7 %) and Latin America (less than 5 %).

Over the past decades, water availability has been slowly decreasing, as a result of population growth, misuse, and unequal distribution of this resource. It is felt that, when water availability is less than 1000 m^3 per person, this becomes a critical situation that impedes economic development. Towards the end of the last century, the countries that found themselves in this situation were located in North Africa, the Middle East and Sub-Saharan Africa. The following level is considered to be marginal scarcity and corresponds to countries with less than 2000 m^3 per inhabitant per year.

The estimate at the end of this century was that 40 countries would be in this category, with the majority in North Africa and the Middle East. These two regions are the ones with the greatest risk of scarcity of this liquid. (FAO 1993:236-237).

Pollution and over-use of water tables that has occurred over the last decades has worsened the reduction in water resources, which in many cases proportionally affects the poorest social classes, especially in the large cities where this scarce liquid is the least available, which forces them to pay higher prices for water than those that benefit from the public water supply. In some cases, they spend up to 20 % of their family income on water, and have to restrict its use, which causes a vicious cycle with respect to hygiene, health and illnesses.

Water usage

Agriculture utilizes 70 % of the freshwater that is extracted annually throughout the world. The rest is destined for domestic and industrial use. Throughout the XX Century, water consumption worldwide increased ten-fold. However, with the industrial, technological and urban development that has taken place over the last century, water usage for agricultural purposes has diminished proportionally in a very significant way. From a consumption of 90 % at the beginning of the century, it has fallen to 62 % at the close of the century, while the volume of available water has increased, moving from 5 % to 35 % during this period of time. Agriculture and industry consume more water than the amount used by the populations in the cities. Industrial water is largely recycled, but the major problem is the contamination that builds up from chemical products and heavy metals, which causes environmental disasters and has affected health, often causing fatal illnesses in the human, animal and plant populations (FAO 1993:240-244).

As can be observed in Table No. 1, in 2007, 69 % of the freshwater extracted in the world was used for agricultural purposes. Africa and Asia were the regions where agriculture consumed the greatest percentage (82 % and 81 %, respectively), while Europe was the continent that used the least amount of water in agriculture, with only 22 % usage of the water extracted. The Americas, on the other hand, utilized a little more than half of the water extracted for agricultural activities.

TABLE 1. Water extraction per sector before 2007.

(1) Total extraction per sector
(2) Total extraction of water
(3) Total extraction of freshwater
(4) Extraction of freshwater as a %

	(1)						(2)	(3)	(4)
	Municipal		Industrial		Agricultural				
	km³/yr	%	km³/yr	%	km³/yr	%	km³/yr	km³/yr	%
World	462	12	734	19	2722	69	3918	3763	9
Africa	27	13	11	5	174	82	213	199	5
North Africa	9	10	6	6	79	84	94	82	176
Sub-Saharan Africa	18	15	6	5	95	80	120	117	3
Ameica	130	15	288	34	430	51	847	843	4
North America	74	14	252	48	497	38	524	520	10
Central America and the Caribbean	8	28	2	9	17	63	27	27	4
South-America	36	17	26	12	154	71	216	216	2
Asia	228	9	244	10	2035	81	2507	2373	20
Middle East	25	9	20	7	231	84	276	268	55
Central Asia	7	5	10	7	128	89	145	136	56
South-East Asia	196	9	214	10	1676	80	2086	1969	18
Europe	72	22	188	57	73	22	333	332	5
Western and Central Europe	53	22	128	54	58	24	239	237	11
Eastern Europe	20	21	60	64	15	16	95	95	2
Oceania	5	26	3	15	11	60	18	17	2
Australia and New Zealand	5	26	3	15	11	60	18	17	2
Other Pacific islands	0.03	33	0.01	11	0.05	56	0.1	0.1	0.1

Source: FAO (United Nations Food and Agriculture Organization, Italy). 2007. AQUASTAT (online, database). Rome, Italy.

Ten years later, this situation has changed somewhat. The percentage of extracted water used in agriculture continues to be 69 %, while the percentage used by Africa and Asia remains stable. However, Europe slightly increased its use from 22 % to 25.5 %, while America decreased its consumption from 51 % to 48.2 °%, as illustrated in the table below.

TABLE 2. Water resources and extraction worldwide in 2016.

(1) Total internal renewable water resources (km³/year)
(2) Total water extraction (sum of all the sectors, km³/year)
(3) Agricultural use
(4) Industrial use
(5) Municipal use
(6) % of total extraction with respect to water resources

REGION	(1)	(2)	(3)	%	(4)	%	(5)	%	(6)
Africa	3931.0	227.1	184.6	81.6	9.4	4.1	32.2	14.2	5.8
Asia	11 864.6	2557.3	2069.4	80.9	253.1	9.9	234.0	9.2	21.6
Latin America	13 769.7	309.5	223.4	72.4	34.3	11.1	50.9	16.5	2.2
Caribbean	98.0	21.9	12.1	57.2	4.7	22.5	4.3	20.5	22.4
North America	5668.0	530.2	179.8	34.0	281.5	53.2	68.0	12.8	9.4
Oceania	902.3	25.8	16.2	64.9	3.7	14.9	5.1	20.4	2.9
Europe	6576.4	330.6	84.0	25.5	179.2	54.3	66.6	20.2	5.0
TOTAL	42 810.0	4002.4	2769.5	69.2	766.0	19.1	461.0	11.5	9.3

Source: FAO (United Nations Food and Agriculture Organization, Italy). 2016. AQUASTAT (online, database). Rome, Italy). Consulted on 19 Jul. 2016, 20:25. Available at http://www.fao.org/nr/water/aquastat/main/index.stm.

Water provides four main economic benefits to societies. The first one is the private usage experienced by the persons who drink it or use it for cooking or in their hygiene, as well as industry, which uses it as input and for cleaning. The second is its use in

eliminating urban, agricultural and agricultural waste. The third is the recreational use of seas, lakes and rivers for sports and aquatic activities. The last one is its use as a habitat for fish and flora, which represent an economic activity for different groups of human beings.

Water and health

There is a close relationship between water and health. It has been demonstrated that access to drinking water for hygiene and food has direct positive effects on health. A lack of water and use of dirty and contaminated water, on the other hand, has a negative effect on health and causes illnesses to varying degrees. Among the principal diseases related to water are those caused by bacterial infections transmitted by microorganisms and bacteria that is present in water (typhoid, dysentery, cholera, infectious hepatitis and gastroenteritis), as well as those caused by infections linked to a lack of hygiene on the skin and in the eyes (trachoma, scabies, leprosy, conjunctivitis and ulcers). These diseases cause hundreds of thousands of deaths each year, especially in the poorer countries, as is well known, since there is a close relationship between poverty and disease.

It is estimated that in the developing countries, 80 % of diseases originate from consumption of non-potable water and from poor sanitary conditions among the population. It is also estimated that 20 % of diseases could be prevented with improved water supply, health services, and hygiene. Based on data from the World Health Organization (WHO), diarrheal illnesses are the second most frequent causes of death in children under 5 worldwide. In 2013, it was estimated that some 1700 million diarrheal illnesses occurred because of a lack of drinking water and hygiene, leading to the death of 760 000 children under 5 annually.

In that year, it was estimated that 780 million people worldwide did not have access to drinking water, and that 2500 million did not have access to appropriate sanitation systems. In the poorest countries, children under 3 suffer three episodes of diarrhea per year, which affects their development, health, and performance. The leading cause of these diarrheal symptoms is water polluted by human or animal feaces (WHO 2013).

By the end of 2015, this situation had improved relatively, although figures for disease and deaths continued to be high. A WHO report shows that one in ten people becomes ill every year from eating contaminated food, resulting in 420 000 deaths (125 000 children under 5). The regions most affected by this public health problem are Africa and Southeast Asia.

According to that report, in 2015 diarrheal diseases affected 550 million people and resulted in 230 000 deaths. That included 220 million children who became ill, with 96 000 dying. Among the principal risk factors for these illnesses are food preparation with polluted water, lack of hygiene, bad agricultural practices and an absence of legislation governing food safety or its application (WHO 2015).

In the case of Latin America and the Caribbean (LAC), the cholera epidemic that affected the region in 1991 was closely related to deterioration in the water supply, in sanitation, and in the health services as a result of the economic crisis of the previous decade. The epidemic resulted in job losses and affected tourism, agriculture, fisheries and exports (WWAP 2016:87).

Water and industry

One of the most important uses of water is in industry, given its impact on the economic development of countries and the creation of jobs. It is estimated that 22 % of the water in the world is directed toward industry, amounting to 59 % in the countries with high incomes and to only 10 % in countries with average and low incomes. It is also calculated that the annual volume of water used in industry will move from 752 million km^3 in 1995 to 1170 km^3 in 2025. However, the industrial sector is one of the main pollutants of groundwater resources. In the developing countries, 70 % of the liquid effluents from industry are poured into rivers, lakes and seas without any treatment to eliminate the polluting residues (Jiménez and Galizia 2012:26).

Water and energy

One of the most important uses of water is for hydraulic energy generation. It is estimated that in 65 countries, more than half of the energy consumed is hydroelectric,

in 32 countries it is more than 80 %, and in 13 it is almost 100 %. Despite the progress in supplying all homes with electricity, one third of the world's population still does not have access to it. Hydraulic energy constitutes one the best options for energy generation given its high yield, which is above 90 %, because does not produce contamination and can be linked to irrigation, the supply of water for drinking and industrial purposes, and recreational activities (Jiménez and Galizia 2012:26-27).

Water and employment

Water, throughout its various cycles and in its different intermediate uses, is an important factor for generating and supporting employment, both directly and indirectly. The sectors that depend most on water are those that use it in large quantities as input for their activities and/or production processes. It is estimated that 95 % of the jobs in agriculture, 30 % in the industrial sector, and 10 % in the services sector depend in large measure on water. In 2014, it was estimated that around 1350 million jobs (42 % of the total active workforce worldwide) depended on water. The sectors that depend moderately on water are those that do not require large volumes in order to carry out their activities, but for which water is a necessary component in some of their processes. It is estimated that 5 % of the jobs in the agriculture sector, 60 % of jobs in the industrial sector, and 30 % of jobs in the services sector are in this latter category with respect to the use of water. It has been determined 1150 million jobs (36 % of the total active workforce worldwide) depend moderately on water. It is estimated therefore that 78 % of jobs in the workforce worldwide depend on water (WWAP 2016:37-38).

Water in agriculture

Since ancestral times, irrigation has been an essential factor in the growth of agriculture and food production. The surface area in irrigated agriculture grew considerably between 1800 and 1990. In the XIX Century, it grew six-fold, and up to 1990 almost five-fold. Most of the irrigation infrastructure was located in developing countries, i.e., primarily in China, India and Pakistan, which accounted for 45 % of irrigated land in the world. Between 1900 and 1960, the rate of growth of irrigated land was one percent annually, accelerating thereafter at annual growth rates of 2.3 % between 1972 and 1975. However, following this period, growth began to diminish gradually to levels below one percent in the following years. That reduction in the expansion of irrigated land, when combined with demographic growth, resulted in a significant decline in the amount of irrigated land per inhabitant.

Among the reasons for this decline is the growing cost of irrigation works, since the best lands and groundwater sources have already been used up, at a time when grain prices on the international market are falling. After the 1970s, the cost of major irrigation projects in China, India, Pakistan, and the Southeast Asian countries ranged from USD 1 500 per hectare to more than USD 20 000, while the medium-sized projects ranged between USD 2 400 per hectare in Asia and USD 2 700 in Africa. Another aspect of this issue is the fact that financing of irrigation projects by the international organizations was cut in half in the 1980s, when compared with the previous decade (FAO 1993:284-289).

This difficult situation is compounded by the depletion of the watersheds and the deterioration of the irrigation lands due to industrial and urban contamination, lack of maintenance of canals and bad irrigation practices that induce flooding, salinization and erosion. Around 1990, FAO estimated that more than one-tenth of irrigated agricultural land was seriously affected by salinity and that 1.5 million hectares were being lost per year as a result. It was calculated that the percentage of salinity that was affecting the agricultural irrigation lands was 10 % in Mexico, 11 % in India, 21 % in Pakistan, 23 % in China and 28 % in the United States.

The high costs of maintenance and repair of systems for irrigation and drainage of salt water, as well as the inadequate financial resources of the majority of the farmers who benefit from irrigation, have led to the deterioration of irrigation infrastructure and to governments having to decide the best ways of allocating resources to solve the problem, without being able to charge the users for guaranteeing an adequate supply of water.

Since that decade, it had become clear that, despite these difficulties, that solving the problem through significant investment in the creation, modernization and expansion of irrigation infrastructure, as well as its maintenance and repair, was necessary. To

this end, it was important to include the users of water in the planning, management, and operation of irrigation systems, since it has been demonstrated that this approach improves access to information, monitoring, responsibility and efficiency.

At the same time, several countries began to the transfer irrigation operations to the farmers' associations (FAO 1993:289-293).

Toward the end of the 20th century, it was a given that major grants for irrigation systems had come to an end. The public policies on irrigation had been guided progressively towards regulation and standardization of systems, towards being a public good in which the general interest is greater than the individual interest, and with growing participation by the organizations of producers and water users in the design and operation.

The link between food and agriculture is essential. Grains and livestock need water in large quantities in order to develop. Nevertheless, it is estimated that only 20 % of annual water usage in agriculture, which amounts to 7130 km^3, comes from blue water, that is, from rivers, lakes, and irrigation groundwater. Despite this, irrigated agriculture has a critical role to play, since it accounts for more than 40 % of the world's food production (WWAP 2012b:46).

The challenge

Water, as pointed out by the UN and the World Bank, is at the center of social and economic development. According to these agencies, the world will not be capable of overcoming the challenges of the 21st century if it does not improve the management of its water resources and ensure access to water and sanitation services. Water insecurity can have devastating effects on economies and endanger the well-being of entire populations, especially in the poorest and most vulnerable groups.

Climate change alters the water cycles and water is once again unpredictable. A World Bank report suggests that a 4-degree Celsius increase in temperatures would increase the pressure on water in various areas around the world. Nearly one billion people living in the monsoon areas, and 500 million who live in the deltas, would be

especially vulnerable. The poorer nations, which are those that contribute the least to creating this problem, would be the most seriously affected. The same document shows that by 2025, 1800 million people will live in areas with chronic water shortages (World Bank 2016:1-2).

Agriculture is one of the sectors that is most vulnerable to climate change. Agriculture absolutely depends on water, which means that changes in rainfall patterns and intensity, droughts and floods significantly impact crop production. Therefore, integrated water management is required in order to increase economic and social well-being a in more equitable and sustainable way (IICA 2014:32).

Water management requires the appropriate governance arrangements that transfer the issues regarding water from the fringes of government towards the center of society. At the national and local levels, both adequate funding of infrastructure as well as the appropriate governance mechanisms are required in order to protect the groundwater resources and ensure sustainable development and equitable distribution of the profits derived from water.

There are major uncertainties concerning the amount of water that is required to meet the demand for food, energy and other human activities, as well as maintain the ecosystems. These uncertainties are worsened by the impact of climate change on available groundwater resources. Climate change directly affects both water and its uses. Measures to mitigate it have focused on reducing the consumption of energy and carbon emissions, while adaptation means planning and preparation for increasing hydrologic variability and extreme meteorological phenomena such as floods, droughts, and storms (WWAP 2012b:2). Predicting future water demand for agriculture is uncertain, since it depends on the demand for food, which in turn depends on the number of people who need to be fed and how much food they consume. Climate change, efficiency in crop production, as well as varieties of land and crops, etc. should also be considered. The main challenge, as indicated by the UN, is not to produce 70 % more food over the next 40 years, which is the estimate for world food requirement in 2050, but to increase food availability by 70 % for the people who need it. This implies reducing food losses in storage and throughout the value chain, as well as technological innovations to improve the productivity of crops and tolerance to drought, better use

of fertilizers, new pesticides, and non-chemical substances in order to protect crops, reduce postharvest losses and move toward sustainable production of livestock and edible marine species (WWAP 2012b:3).

At present, groundwater provides almost 50 % of the drinking water consumed throughout the world. In the past 50 years, the groundwater catchment rate has tripled, which has resulted in increased food production and rural development. Nevertheless, many of these resources are not renewable. In several regions, their exploitation has reached its limits, which poses the challenge of sustainability and lowering the levels of pollution through adequate management of water resources.

Another pressing problem is desertification. It is estimated that 2 billion hectares are critically degraded worldwide, which affects 1.5 billion people. Desertification affects food insecurity, malnutrition, and poverty among the population living in the affected areas.

According to the UN, a central aspect in moving forward toward a solution to these problems is better water management. An end must be brought to the fragmentation of institutions responsible for it, which are still focused on offering solutions related to water supply and technology, whereas the focus must be on the approach needed to manage the processes and people in an integrated way, aligning water management with all the sectors, policies and institutions (WWAP 2012a:4-5).

02

STRATEGIES AND GENERAL ORIENTATIONS OF INTERNATIONAL ORGANIZATIONS

The International Conference on Water and the Environment (ICWE) was held in January, 1992 in Dublin, Ireland by mandate of the United Nations, with participation from 114 countries, 28 United Nations organizations and agencies, 14 intergovernmental organizations and 38 non-governmental organizations.

This conference recognized that access to fresh water at an affordable price is a basic human right, and that scarcity and misuse of fresh water pose a serious and growing threat to sustainable development and protection of the environment. It also concluded that human health and welfare, food security, industrial development and conservation of ecosystems are essential to humanity and would be seriously threatened if not managed more effectively.

To resolve this situation, the Conference issued the Dublin Statement on Water and Sustainable Development, which defined the following guiding principles:

1. Since water is a finite and vulnerable resource, essential for sustaining human life and the environment, effective management of water resources requires a

holistic approach, linking social and economic development with the protection of natural ecosystems. This also includes linking land and water from water catchment areas or ground water aquifers.
2. Water development and management must be based on a participatory approach that involves users, planners and policy-makers at all levels.
3. Women play a central role in the provision, management and safeguarding of water.
4. Water has an economic value for all of its competing uses and should be recognized as an economic good.

The first three principles were accepted without objection. However, the fourth was subject to intense debate since many considered that water is a natural good that everyone should have the right to access, as is the case with air, and rejected that there should be an associated cost for access to it.

Based on these principles, a series of recommendations were issued and an action formula on water developed with the following objectives:

Alleviation of poverty and disease. The Conference recommended that priority be given to the development and management of water resources, provision of food, water and sanitation.

Protection against natural disasters. The Conference noted that climate change would increase the risk and magnitude of the natural disasters caused by droughts and floods, which would take a huge toll on human lives and economic resources. Attention, should therefore be given to developing a disaster preparedness policy based on efforts to protect water resources, as well as programs and basic user data collection systems.

Water conservation and reuse. Furthermore, the Conference recommended using more efficient irrigation practices for substantial freshwater savings, and recycling water for industrial use with the added benefit of reducing pollution, given that up to 60 % of water was lost as a result of irrigation schemes, 50 % of industrial water was lost, and 36 % of the urban water supply was lost. Better management of water in agriculture, industry and domestic water supplies would significantly benefit the sustainability of national water supply systems.

Sustainable urban development. The Conference stated that freshwater supplies in most of the world's major cities now faced a critical situation caused by depletion and waste in the past decades, thereby leading to an increased dependence on distant water resources and growing costs for users who previously had no access to water. Future supplies must, therefore, be based on appropriate water charges and discharge controls.

Agricultural water. Ensuring food supplies for a growing world population, while saving and rationing the use of agricultural water is one of the major challenges faced by many countries. The conference highlighted that water-saving technology and management methods were required for more efficient use of water used for agriculture as well as methods and incentives for rural populations to adopt these new approaches.

Protecting aquatic ecosystems. Misuse and contamination of water resources has altered many aquatic ecosystems and affected activities that essential for environmental and natural resources conservation, while negatively affecting rural groups that rely on fishing, agriculture and grazing activities, thereby requiring integrated management of river basins.

Resolving water conflicts. Another priority item addressed by the Conference was the need to address conflicts arising from water use in transboundary regions, since river or lake basins are the most appropriate geographic areas for integrated planning and management of water resources shared by transboundary countries.

In addition to these issues, the Conference emphasized the need to develop appropriate data systems to measure and assess water cycle components and modifications as a result of climate change. Trained staff in water research and analysis techniques, as well as individuals responsible for the development of public water-related policies is also needed (ICWE Secretariat 1992).

The aforementioned principles and recommendations were analyzed and included in the United Nations Conference on Environment and Development (UNCED) held in Río de Janeiro in June 1992. Chapter 18, Section II of Agenda 21 of the Rio Declaration, Protection of the Quality and Supply of Freshwater Resources: Application of Integrated Approaches to the Development, Management and Use of

Water Resources stated that climate change and atmospheric pollution threatened ecosystems and could also impact the availability of fresh water resources. It also emphasized the fact that human activities could not surpass nature's capacity to absorb water, and that innovative technologies were required to fight against water-related diseases and optimize water resources.

The Rio Earth Summit highlighted the fact that planning and integrated management were necessary to cope with overall depletion and deterioration of water resources, and that development plans must also address aspects such as water supply and sanitation, agriculture, industry, human development, hydroelectric power, aquaculture, transportation and recreation and not overlook conservation and efficient use of water resources.

The Summit established that States must launch national water management programs aimed at utilization, quality, protection and improvement. It also pointed to the need to promote research, data storage, modeling and sharing of topics related to water, in addition to clear rules for the disposal and storage of industrial waste and for rational use of pesticides and fertilizers.

The Summit also recommended rehabilitation of ecosystems, review of international and national legislation and improvement in education relating to personal hygiene in schools. Given the rise in urban growth, The Rio Summit stated that each person should drink 40 liters of water per day, that residual industrial and city wastewater should be eliminated, and that 75 % of solid urban waste should be recycled or disposed of.

The Summit called for rational use of water in agriculture, adoption of new technologies aimed at more effective use of water, prevention of groundwater pollution from salt water and studies to assess the impact of climate change on freshwater (United Nations, 1992).

It was concluded that access to water supply services has a cost, particularly in cities and for industry, which is mostly subsidized by governments. The low price of subsidized water has often led to failure in recognizing its economic value and, as a result, wastefulness, a situation which is considered to be more serious now than in

past decades, particularly in areas where water is scarce and cannot meet the demands of a growing population (United Nations 1992).

Consequently, both meetings recommended a new approach whereby freshwater would be regarded as a finite and vulnerable resource and water-related issues addressed by governments as an integral part of a country's economic and national policy, with sectoral plans and program.

It was also emphasized that measures adopted by countries and international organizations to support water management policies were interrelated and interdependent, since surface water and ground water flows have no national boundaries. Therefore, water collection, pollution and overexploitation in a country directly affects the water supplied to surrounding regions and neighboring countries.

Furthermore, public water policies lacked a holistic approach, since government agencies responsible for irrigation in most countries were not the same agency responsible management of the water. Another agency was responsible for generating hydroelectric power, and yet another for the environment.

This resulted in a lack of coordination and a breakdown in water resource management that led to conflict in neighboring countries. Dams were built and water pumped from rivers and streams to supply water to neighboring countries and overexploitation of water in border areas affected, not to mention the problems caused by climate change and its impact on the world's water system.

As a result, it was decided that water-related issues should be addressed holistically. Public water policies were based on this comprehensive perspective and governments had to coordinate with other state agencies regarding water-related issues that affected other sectors (FAO 1993:246-250).

Based on the statements and commitments made at the United Nations Conference on Environment and Development and the Rio Summit, other international meetings revisited water issues as part of their agenda. In 1994, the Ministerial Conference on Drinking Water and Environmental Sanitation held in Noordwijk committed to

strengthening sanitation and excreta disposal systems in urban and rural areas as part of its plan of action. The following year, two other meetings also addressed water: the UN Fourth World Conference on Women in Beijing and the World Summit for Social Development in Copenhagen. The Beijing Declaration and Platform for Action specifically endeavored to:

> *Ensure the availability of and universal access to safe drinking water and sanitation and put in place effective public distribution systems as soon as possible.*

At the same time, the second commitment of the World Summit for Social Development in Copenhagen committed to:

> *Focus… efforts and policies to address the root causes of poverty and to provide for the basic needs of all. These efforts should include… safe drinking water and sanitation* (United Nations, 1995).

In 1996, the World Food Summit held in Rome referred to water issues in its Action Plan, stating that it was necessary to:

> *Combat environmental threats to food security, in particular, drought and desertification, pests, erosion of biological diversity, and degradation of land and aquatic-based natural resources, restore and rehabilitate the natural resource base, including water and watersheds, in depleted and overexploited areas to achieve greater production.*

The Second Commitment of the United Nations Conference on Human Settlements (Habitat II), held in Istanbul, stated:

> *We shall also promote healthy living environments, especially through the provision of adequate quantities of safe water and effective management of waste* (FAO 1996, United Nations 1996).

As a result, the World Water Council was created in 1996. The World Water Council is a global agency composed of governments, private companies and nongovernmental organizations that address and issue high-level recommendations on water-related issues. The Preamble of its By-Laws underscores the need to better streamline and coordinate efforts to address water management:

> *Management of the world's water is fragmented among the nations of the world, hundreds of thousands of local governments and countless non-governmental and private organizations as well as many international bodies:*
>
> The mission of the World Water Council is:
>
> *To promote awareness, increase political commitment and trigger action on critical water issues at all levels at all levels, including at the highest level of government with the objective of facilitating conservation, development, planning, management, and efficient use of water in all of its dimensions and provide sustainable ecological benefit of all life on earth.*
>
> The objectives of the World Water Council are listed below:
>
> - Identify critical water issues of local, regional and global importance on the basis of ongoing assessments of the state of water.
> - Raise awareness about critical water issues at all levels of decision-making, including the general public.
> - Bring together stakeholders and promote the implementation of effective water-related policies and strategies worldwide.
> - Provide advice and relevant information to institutions and decision-makers on the development and implementation of policies and strategies for sustainable water resources management with due respect for the environment and social and gender equity.
> - Contribute to the resolution of issues related to transboundary waters (WWC n. d.).

The First World Water Forum met from March 21-22, 1997 in Marrakech, Morocco, and was attended by 135 ministers representing the majority of the world's countries. Following two days of deliberations, the Declaration of Marrakech was prepared, which stated:

The Forum calls on governments, international organizations, NGOs and the peoples of the World to work together in a renewed partnership to put into practice the Mar del Plata and Dublin Principles, and Chapter 18 of the Rio Summit to initiate a "Blue Revolution" to ensure sustainability of the Earth's water resources.

In particular, the Forum recommends action to recognize basic human need for access to clean water and sanitation, to establish an effective mechanism for management of shared water, to support and preserve ecosystems, to encourage the efficient use of water, to address gender equity issues in water use and to encourage partnership between the members of Civil Society and Governments (WFC 1997).

The Forum also instructed the World Water Council to carry out a study, consultations and analysis in order to incorporate the Vision for Water, Life and the Environment for the 21st Century.

Thus, in the United Nations. Millennium Declaration, which was signed in New York from 6 to 8 September 2000, the world leaders defined the values, principles and objectives of the international agenda for the 21st century and set time frames for the implementation of the actions agreed upon. In this Declaration, the leaders declared that the principal challenge was to make globalization a positive force, in which the benefits were distributed equitably, and thereby establish a more peaceful, prosperous and fair world. The Millennium Declaration called for the promotion of policies and global measures and defined freedom, equality, solidarity, tolerance, respect for nature and shared responsibility as the six fundamental values in 21st century international relations.

Chapter IV of the Millennium Declaration, entitled Protecting our common environment, ratified the commitment of all countries to adopt an ethics of conservation and protection of the environment, and reaffirmed their support for the commitments stated in Agenda 21 of the United Nations Conference on Environment and Development. With respect to water, the Millennium Declaration undertook the commitment to:

To stop the unsustainable exploitation of water resources by developing water management strategies at the regional, national and local levels, which promote both equitable access and adequate supplies (United Nations 2000).

The Second World Water Forum was held in The Hague in March 2000. The Ministerial Conference was attended by 114 ministers and officials from 130 countries. The World Water Vision Report, which was prepared after two years of work in which more than 15 000 people participated, was presented at that Forum:

Build consensus to design management plans that prevent more water crises. Our Vision is a world in which all people have access to safe and sufficient water resources to meet their needs, including food, in ways that maintain the integrity of freshwater ecosystems. The Vision exercise's ultimate purpose is to generate global awareness of the water crisis that women and men face and of the possible solutions for addressing it. This awareness will lead to the development of new policies and legislative and institutional frameworks. The world's freshwater resources will be managed in an integrated manner at all levels, from the individual to the international, to serve the interests of humankind and planet earth—effectively, efficiently, and equitably (WWC n. d.:2).

In that report it was concluded that the way in which water was managed had led to a crisis. More than 1 billion people lacked access to drinking water. More than 3000 million did not have access to health services. Many countries did not have sufficient water to produce their food. With population growth and greater demand for water, many others would be in that situation.

In order to ensure the sustainability of water, a holistic vision should be adopted to balance its use among the different competitors for water resources: cities, agriculture, industry, energy and the environment. Sustainable management of groundwater resources requires a process of decision-making that is systemic, integrated, and recognizes the interdependence of three areas. Firstly, that decisions regarding the use of land were affecting water and vice versa. Secondly, that economic and social decisions regarding the future, which were sectoral and fragmented in nature, were affecting hydrology and ecosystems. Thirdly, that decisions at the international, national, and local levels were closely related (WWC n. d.:3).

From that perspective, the three basic objectives for integrated management of water resources were:

1. *Empowering women, men, and communities to decide on the level of access to safe water and hygienic living conditions and on the types of water-using economic activities that they desire-and to organise to obtain it.*

2. *Producing more food and creating more sustainable livelihoods per unit of water applied (more crops and jobs per drop), and ensuring access for all to food required for healthy and productive lives.*

3. *Managing water use to conserve the quantity and quality of freshwater and terrestrial ecosystems that provide services to humans and all living things.*

In order to achieve these objectives five actions were required:

i. Involve all users in the integrated management of water resources.
ii. Move toward fixed costs for the water services destined for all human uses of water.
iii. Increase public funding for research and innovation.
iv. Recognize the need for cooperation in the integrated management of water resources in the international watersheds.
v. Achieve a massive increase in public and private investment in water (WWC n. d.:4-5).

The greatest challenge for the integrated management of water resources related to institutions, since corruption, institutional fragmentation, duplication of efforts, poor investment of resources, and authoritarian and centralized practices increased the cost of its utilization. The report concluded that:

> *The real revolution in water resource management will come when stakeholders have the power to manage their own resources.*

In the Ministerial Declaration of The Hague, agreement was reached that the common objective was to guarantee water security in the 21st century. This objective meant guaranteeing protection and improvement of fresh water, coasts, and related ecosystems; promoting sustainable development; promoting access by each person to sufficient drinking water at an accessible price that would enable him/her to lead a productive and healthy life and ensuring that vulnerable groups were protected from the risks of a shortage of fresh water (WFC 2000).

The Ministerial Declaration identified the following as the greatest challenges: meeting the basic fresh water needs of the entire population, especially women; guaranteeing food security; protecting ecosystems; sharing groundwater resources through cooperation and synergy among water users at all levels; managing risks; assessing water in economic, social, environmental, and cultural terms by moving toward price setting for water services and toward a government and administration that are careful with water (WWC 2000).

These were the general principles that guided the actions of governments and international organizations over the following years. In March 2003, the Third World Water Forum was held in Kyoto, Japan, and was attended by over 24 000 persons. In the Final Report of the Conference, which was partly dedicated to the Declaration of Water, Food and Agriculture, the Forum pointed out that population growth and the change in consumption patterns, with a dietary preference for animal products, represented a growing demand for irrigated agricultural products. Thus, in recent decades, massive investments, both public and private, had been made in order to improve productivity and food security.

Therefore, the challenge was to guarantee sufficient water in a sustainable manner, especially in those regions and countries where water is limited. As a result, a substantial increase in water productivity was required, as well as investments in the modernization of irrigation systems and the development of new groundwater resources. This approach needed to be based on considering irrigation as a service to agriculture, and not as an end in itself. Among the recommendations made by the Forum were:

- Greater strategic development of land and available groundwater resources.
- Investment strategies for irrigation that pay particular attention to poor rural sectors, in order to reduce poverty and guarantee food security in the rural communities.
- Modernization of irrigation programs so that they evolve toward more flexible systems for management and control that are service-oriented, with systematic participation of users in the decision-making process.

- Creation of a clear framework for the management of irrigation programs that give a greater sense of ownership to the farmers.
- Adaptive and specific research that identifies and promotes the best options for increasing the productivity of agricultural water, in keeping with environmental conditions, as well as research and development of appropriate technologies that include the protection of agriculture and environmentally friendly equipment.
- Promotion of constructive dialogue between the public and private sectors associated with irrigation.
- Progress toward ensuring that agriculture contributes to the conservation of biodiversity, the restoration of ecosystems and replenishment of aquifers.
- Substantial additional investments for the modernization of water management, rehabilitation of irrigation systems, and upgrading of equipment, with appropriate financing mechanisms (Secretariat of the Third World Water Forum 2003:116-117).

The Fourth World Water Forum was held in Mexico City from 16 to 22 March 2004, and reaffirmed the principles and orientations of the previous forums, as well as the Millennium Declaration. In the Ministerial Declaration, the country representatives concluded by reaffirming the critical importance of water to achieving sustainable development, which included the eradication of poverty and hunger, rural and agricultural development, reduction of water induced disasters, and achieving environmental protection and sustainability. They also underscored the need for including water and health services as priorities in the national processes and, particularly, in the national strategies for sustainable development and poverty reduction. Furthermore, they reiterated the commitment to move forward with the objective of reducing by half in 2015, the number of people who still do not have access to drinking water. Similarly, they recognized the important role of governments, parliaments, and water users in the integrated management of water resources (Secretariat of the Fourth World Water Forum 2006:220-221).

The Fifth World Water Forum was held in Istanbul from 16 to 22 March 2009, with more than 33 000 participants from 192 countries. For the first time, nine Heads of State participated in it. In the Declaration of Heads of State, they called upon all governments, international organizations and users to adopt a common vision and form a network in order to develop and handle water resources in a sustainable manner, and to guarantee access to drinking water and health for all.

In that Declaration, they acknowledged that the world faced global changes such as rapid population growth, migration, uncontrolled urbanization, changes in land use, economic expansion, modification in exchange patterns and climate change, which had a direct negative impact on groundwater resources. These changes were a serious threat for the availability and quality of water and exerted pressure against over-extraction. The economic crisis that had occurred and its consequences on the management of water resources and its services should be evaluated.

They also pointed out that water had the power to destroy lives and dwellings, as occurred through floods, hurricanes and droughts, and that it was expected that climate change exacerbated those catastrophic events. Groundwater resources must be managed with the appropriate and preserved infrastructure, hence the highest priority must be given to investment in this area.

They underscored the fact that were there was need for new policies and adaptation of strategies and institutional reforms that would include the contribution of local governments and water users, as well as international commitments, financial mechanisms, technology and innovation in order to manage the major global issues relating to water and adapt the management of water resources to global changes (WWC 2009a).

In that same forum, the ministers and heads of delegation issued a declaration in which they ratified the commitments of the national governments related to water, its use, sanitation and health. They recognized the need to achieve water security, as well as the challenges that lay ahead caused by global changes. On that basis, they declared that they would intensify their efforts to reach international agreements that would improve access to water, sanitation and the health of ecosystems in the shortest possible time through policies and adequate financial resources. They pointed out that they would provide greater support for the management of groundwater resources with respect to the basins and aquifers within each country, and through international cooperation agreements in order to meet the economic, social and

environmental demands for equity, taking into account the interests of all users. They committed to improving water management, as well as the productivity and efficiency of agricultural water including, wherever necessary, the construction of irrigation canals and improving the capture of rain for agriculture, so as to increase productivity in grain production and preserve the groundwater resources. This would be done through sustainable production that would address the needs of a growing population and changes in consumption patterns by improving standards of living, particularly in the rural areas, and trying to ease poverty and hunger.

They also reiterated their support for development projects within the countries related to water, especially those related to energy, food security and poverty eradication. Efforts would be made to maintain and expand existing infrastructure for water storage, irrigation, energy production, navigation and disaster prevention, as well as to restore degraded ecosystems, prevent contamination, and promote the development of investment in desalination and wastewater treatment.

Furthermore, in order to improve governance of the water sector at the national level, the following was proposed:

- Promote reform in the institutional management of water.
- Strengthen the laws and regulatory frameworks within the water sector.
- Prevent corruption and increase integrity in the implementation of policies related to water.
- Ensure transparency in decision-making.
- Strengthen public participation by all users of water.

Scientific research, education, development, and adoption of new technologies would be supported and sustainable use of water would be promoted. Likewise, an invitation was made to international organizations and institutions to support international efforts toward improving the sharing of experiences and the exchange of best sustainable practices for water resources. Finally, the ministers concluded that the topic of water was a cross-cutting issue, which means that also they would appeal to the highest-level authorities outside of the water sector in order to establish coordination and synergy in public policies and in financing mechanisms, as well as

continue working in a coordinated manner with the parliaments of the countries (WWC 2009b).

For its part, the United Nations General Assembly, at its meeting on 28 July 2010, adopted the Resolution on the Human Right to Water and Sanitation (A/RES/64/292), in which:

1. It recognizes that the right to drinking water and sanitation is a basic human right for full enjoyment of life and of all human rights.
2. It calls on the States and the international organizations to provide financial resources and facilitate the increase in capacity and transfer of technology through international assistance and cooperation, in particular to the developing countries, in order to intensify efforts to provide the entire population with cheap access to drinking water and sanitation.

The Sixth World Water Forum, organized under the slogan Time for solutions, was held in Marseilles from 12 to 17 March 2012, with delegates from 173 countries, 15 Heads of State and 112 Ministers, Vice Ministers and Secretaries of State. In the Ministerial Declaration adopted by that Forum, the commitments under chapter 18 of the Rio Agenda 21, and the United Nations resolutions aimed at achieving the millennium goals for water were reiterated. In the Declaration, the ministers confirmed their commitment to contribute to economic development through a green economy, a strategic role for water in food security, and energy generation. With regard to agricultural water, they pointed out that:

> *12. Water is key for agriculture, rural development, food processing and nutrition, as there can be no food security without water. Therefore, water and food security policies need to be integrated, ensuring at the same time efficient use and protection of water resources. To achieve food security for a growing world population, in a context of global climate change, solutions involve tailor-made and innovative approaches to address the diversity of situations worldwide, taking into consideration the availability and quality of water, soil and land, the level of infrastructure development for rain-fed and irrigated agriculture, the exposure to floods and droughts, the sustainable utilization of water resources and the institutional capacity of the stakeholders involved.*

13. We intend to ensure that water and food security policies meet the needs of the most vulnerable, in particular local communities, smallholder farms, women and indigenous peoples. Soil and water management needs to be promoted to minimize erosion, land degradation and water pollution, with a view to increasing total food supply-chain efficiency "from field to fork." Solutions include water saving storage technologies and practices in rain-fed and irrigated areas, reduction of water and food losses and waste, safe re-use of wastewater in agriculture and industry, intensification of the cultivation of traditional and new water stress-tolerant plant varieties, and the involvement of food security stakeholders, especially producer organizations, in water policies. The commitment of the G20, D8 and other relevant entities to address water and food security is welcome (WWC 2012).

Furthermore, they underscored the interdependence between water and energy, which means that the policies of both should be standardized through multisectoral processes. In this way, water and energy efficiency can be improved, particularly in the use of the agricultural and industrial water, thus contributing to reducing the effects of greenhouse gases.

The ministers also resolved to support the initiative Sustainable energy for all, by recognizing that hydroelectricity is a viable source of renewable energy, and promoting the production of more energy per drop. Furthermore, they ratified their decision to promote investment in the retention of multipurpose water and utilization of wastewater as a renewable energy source, as well as promote the development of solar and wind energy projects for water use and sanitation.

They also pointed out that success with this strategy would depend on good governance, funding and a favorable environment for water policies. Within the Declaration they mentioned:

23. Good water governance requires multi-stakeholder platforms and legal and institutional frameworks enabling the participation of all, including indigenous, marginalized and other vulnerable groups, promoting gender equality, democracy and integrity. Given the particular role of local and regional authorities in the principle of subsidiarity, we recognize the need to strengthen their capacity to fulfil their responsibilities, as appropriate.

They also pointed to the following priorities:

- Acceleration of the implementation of human rights obligations relating to access to drinking water and sanitation for everyone's well-being and health, in particular for the most vulnerable, and improving wastewater management.
- The interlinkages between water, energy and food security, ensuring full policy coherence and well-functioning water- related with a view to exploiting synergies and avoiding adverse consequences across sectors, as a basis for sustainable growth and job creation.
- The incorporation of water in all its economic, social and environmental dimensions in a framework of governance, financing and cooperation, taking into account the progress achieved towards the Millennium Development Goals by 2015 and beyond (WWC 2012:6-7).

The Seventh World Water Forum was held in the cities of Daegu and Gyeongbuk, in South Korea, from 12 to 17 April 2015, with more than 40 000 participants. In the approved Ministerial Declaration, the ministers declared their political intention to translate the commitments agreed upon into policies, plans, and national actions, and to intensify joint efforts to cooperate on issues related to water at the global level.

They also reiterated the fact that water was at the heart of sustainable development, and supported the inclusion of a central objective devoted to water and water-related goals in the Post-2015 Development Agenda. They also emphasized the importance of the topic of water in light of climate change, the need to move forward with cooperation among countries bordering the same body of water, the desirability of developing effective response mechanisms based on the growing risks of water-related disasters, and the importance of international cooperation between developed and developing countries, international organizations, financial institutions and the public and private sectors.

Additionally, they emphasized the central role of science and technology and the need to establish public policies based on science, and regulations supported by appropriate institutional mechanisms (WWC 2015:2-3).

The Organization for Economic Cooperation and Development (OECD) has also played an important role in establishing guidelines and recommendations so that its member countries can improve their public policies and programs related to water.

In 2012, the OECD published the study entitled The quality of water and agriculture, in which it pointed out that high-quality water resources are vital not only to guarantee human health and maintain ecosystems, but also to provide visual and recreational benefits. It also points out that in recent decades, greater investment in the OECD countries have helped to drastically reduce contamination in the urban centers, industries, and wastewater with substantial progress in improving the quality of the waters in rivers, lakes, estuaries and groundwater reserves.

This led to attention being paid to reducing the different sources of agricultural contamination. Over the last three decades, in accordance with the OECD guidelines, governments, agrochemical companies, and water servers have provided significant support to the agriculture sector, introduced regulations, and provided technical assistance to farmers. With this, a certain degree of progress was achieved in reducing the agricultural pressure on water systems, but they fell short of what is required in order to achieve the objectives of the water policy. These objectives include the need to improve the environment, diminish the cost of drinking water treatment, protect public health, and reduce the cost to farmers of inefficient use of pesticides and loss of nutrients and soil into the bodies of water (OECD 2012a:20).

Since 1972, the OECD has adopted the polluter pays principle for assigning costs for pollution prevention and control measures, in order to promote rational use of limited environmental resources and to prevent distortions in international trade. The principle means that the person/entity that pollutes should bear the cost of the measures determined by the authorities to guarantee that the environment is kept in an acceptable state. The costs of these measures must be reflected in the cost of the goods or services that have caused the pollution, whether through production or consumption. These measures should not be accompanied by subsidies that would create significant distortions in trade and international investments. The principle means that whoever generates pollution should defray the costs that the pollution has created for others.

In keeping with OECD guidelines, agriculture has had significant success in increasing production in order to meet the growing demands for food, forage, fiber and fuel. Expansion of crop production has been made it possible through greater use of nutrients and pesticides, and intensification of crop and livestock production systems, including irrigation. Agricultural systems, however, have not been fully efficient in the use of agricultural inputs, and their intensification has given rise to fragile degraded soils, to loss of vegetation, to increased land drainage and to other changes that alter the environment.

Among the main agricultural pollutants are nutrients (nitrates and phosphates), pesticides, heavy metals, land sediments, organic matter, acids, biological pollutants and mineral salts, produced by inadequate agricultural practices, the spread of fertilizers, livestock production, drainage and inappropriate use of land.

The OECD has also pointed out that climate change will have a heavy impact on agricultural water pollution, due to the use of pesticides and biocides in areas subject to higher temperatures, to pollutant mobilization caused by extreme climate events, and to increase in salinization. These changes, however, can be controlled for the most part by proper farm management and adjustments to the public agricultural policy, which includes better regulation, monitoring, and development of long-term research programs (OECD 2012a:55-60).

In the OECD countries, in order to tackle the problems relating to the quality of agricultural water, a combination of public policies that include economic instruments, environmental regulations, information and persuasion has been used at both the national and local levels. Among the economic instruments are:

- Fines for pollution, that is, application of the polluter pays principle;
- Agro-environmental payments, which are monetary payments from the government to the farmer to solve environmental problems;
- Imposition of maximum limits on polluting emissions;
- Environmental regulations, which include fines for farmers in order to reduce the impact of pollution on agricultural water; and
- Information instruments for farmers (OECD 2012a:84-99).

The OECD study concluded that a strategy for sustainable management of water quality in agriculture, which seeks to reduce the abatement cost expenditure of the programs and diminishes the external costs of agricultural pollution, should consider the following: comply with existing regulations and standards for water quality; eliminate perverse support in agriculture and thus diminish the pressure on water systems; take into account the polluter pays principle in order to reduce water pollution in agriculture; set realistic objectives and standards with respect to water quality in agriculture; improve the spatial orientation of the policies to those areas where water pollution is most acute; evaluate the profitability of different political options to address water quality in agriculture; adopt a holistic approach for policies relating to agricultural pollution; and establish information systems to support the farmers, water managers and political authorities (OECD 2012a:147).

As suggested in the overview of the agricultural sector for the next ten years, the projected production growth in North America, Turkey, Australia and New Zealand could increase the pressure on water systems as a result of greater use of chemical inputs, increased fragility of agricultural lands, expansion of production in marginal lands and intensification of livestock production. Furthermore, it has been estimated that climate change will influence water quality due to sediment mobilization by floods and to decreased dilution of the pollutants due to severe droughts.

The OECD document points to the following conclusions:

> A greater challenge for agriculture is to produce more food, forage, fuel, and fibers in order to meet the growing demand. Crop production has positive external effects on the markets, such as conservation of irrigated land, and negative effects such as water pollution. Since there are no markets for these externalities, even though they can provide great benefit to, or impose a high cost on society, there are few incentives for farmers to absorb the costs of these external effects of production, apart from their own motivation to do so.

The main challenges for the political authorities with respect to issues of water in agriculture are to reduce the pollutants generated by the farms in the water systems and to strengthen agriculture in order to create and preserve the benefits associated with water systems (such as recreational use).

The impact of agriculture on the quality of water has remained stable or is increasing. There exist very few examples of significant improvements in the reduction of that impact in OECD countries during the period 2000-2010. Agriculture is the principal source of water pollution.

The financial, social and environmental costs of water pollution caused by agriculture in the OECD countries exceed one billion dollars annually.

The outlook for the next ten years for agriculture and water quality suggests that the growth and intensification of agricultural production could increase the pressure on water systems in some countries.

For years, the policies for coping with agricultural water pollution have cost taxpayers billions of dollars annually.

Policies have usually fallen short of achieving the water quality objectives in agriculture.

Furthermore, in order to move forward with sustainable management of water quality in agriculture, the OECD made the following recommendations:

- Use a combination of policy instruments for tackling water pollution.
- Require compliance with existing regulations and standards for water quality.
- Eliminate perverse support for agriculture to lessen the pressure on water systems.
- Take the polluter pays principle into account in order to reduce water pollution.
- Set realistic objectives for water quality, as well as standards for agriculture.
- Improve the spatial approach of the policies toward the areas where water pollution is most acute.
- Evaluate the cost of effectiveness of the different policy options in order to deal with water quality in agriculture.

- Carry out a holistic assessment of the policies relating to agricultural pollution.
- Establish information systems in order to support the farmers, water administrators and those responsible for policies on this issue.
- Facing the challenge of sustainable management of water quality in agriculture requires a high level of political commitment and a common vision among the different users.
- Changing the behavior of farmers is a key aspect in increasing the acceptance of policies, approaches and practices (OECD 2012b:11-18).

03

ISSUES AND OPPORTUNITIES FOR THE AMERICAS

Water situation in the American continent

The Americas possess 46 % of the world's water resources and has an average annual rainfall of 1084 mm. Per capita water availability is approximately 30 000 m^3 per year.

Compared to other regions of the world, the Americas has a relative abundance of water. However, the distribution of water sources and the availability of water among the population is unequal, due to the seasonality of the rains, the distribution of water resources and the diversity of geography and climates in the different regions. The American continent has regions with abundant water resources such as the watersheds of the Amazon, the Mississippi, the Rio de la Plata and the Great Lakes. However, two-thirds of the continental surface area is made up of arid and semi-arid soils, where the rains are markedly seasonal, so based on the time of year, there is abundance or scarcity. These natural differences are compounded by the effects of poor agricultural practices and deforestation, which have reduced the recharge of aquifers and the effects of climate change.

This means that there may be a notable disparity in rainfall, freshwater and renewable per capita water availability among the countries of the Americas. According to data from the World Bank, as shown in Table 1, Costa Rica is the country with the highest average rainfall, with 2926 mm of rainfall per year, followed by Panama (2682 mm), Columbia (2612 mm), Nicaragua (2391 mm) and Grenada (2350 mm). In contrast, the countries with the lowest rainfall are Canada (537), Argentina (591 mm), United States (715 mm), Mexico (752 mm) and Antigua and Barbuda (1030 mm).

The water resources, and the fresh water supply of the countries of the continent also offer marked contrasts. The United States is the country with the most total freshwater disposal, with 478.4 billion m^3, followed by Mexico, with 79.8 billion; Brazil, with 58 billion; Canada, with 45 970 million; and Argentina, with 32 570 million m^3 of water. The countries with the lowest total freshwater availability are Antigua and Barbuda, Saint Vincent and the Grenadines, Grenada, Saint Lucia and Dominica.

Finally, considering the size of its population, Suriname is the country with the highest amount of per capita renewable water per year, with 166 200 m^3, followed by Canada (82 650 m^3), Peru (54 963 m^3), Chile 51 188 m^3) and Colombia (45 006 m^3). The countries with the least renewable water per person per year are Barbados (292 m^3), Antigua and Barbuda (580 m^3), Haiti (1285 m^3), Dominican Republic (2088 m^3) and El Salvador (2850 m^3).

TABLE 3. Water availability in the Americas.

(1) Average precipitation (per year)
(2) Total fresh water availabilty (m^3 billions)
(3) Annual fresh water availability (% domestic resources)
(4) Volume of renewalable water (m^3 billions)
(5) Population
(6) Renewable water per capita (m^3 /year)

COUNTRY	(1)	(2)	(3)	(4)	(5)	(6)
Antigua and Barbuda	1030	0.005	9.615	0.052	89 612	580.3
Argentina	591	32.57	11.801	276	40 764 561	6770.60
Bahamas	1292				347 176	-
Barbados	1422	0.061	76.125	0.08	273 925	292.1

TABLE 3 (continuation)...

COUNTRY	(1)	(2)	(3)	(4)	(5)	(6)
Belize	1705	0.15	0.938	16	356 600	44 868.20
Bolivia	1146	2.027	0.668	303.5	10 088 108	30 084.90
Brazil	1782	58.07	1.072	5418	196 655 014	27 550.80
Canada	537	45.97	1.613	2850	34 482 779	82 650.00
Chile	1522	11.34	1.283	884	17 269 525	51 188.40
Colombia	2612	12.65	0.599	2112	46 927 125	45 006.00
Costa Rica	2926	2.68	2.384	112.4	4 726 575	23 780.40
Dominica	2083	0.017			67 675	-
Ecuador	2087	15.25	3.53	432	14 666 036	29 455.80
El Salvador	1724	1.376	7.752	17.75	6 227 491	2850.30
United States	715	478.4	16.977	2818	311 591 917	9043.90
Grenada	2350	0.01			104 890	-
Guatemala	1996	2.933	2.686	109.2	14 757 316	7399.70
Guyana					756 040	-
Haiti	1440	1.2	9.224	13.01	10 123 787	1285.10
Honduras	1976	1.194	1.245	95.93	7 754 687	12 370.60
Jamaica	2051	0.585	6.218	9.404	2 709 300	3471.00
Mexico	752	79.8	19.511	409	114 793 341	3562.90
Nicaragua	2391	1.288	0.679	189.7	5 869 859	32 317.60
Panama	2682	0.452	0.306	147.4	3 571 185	41 274.80
Paraguay	1130	0.49	0.521	94	6 568 290	14 311.20
Peru	1738	19.34	1.197	1616	29 399 817	54 966.30
Dominican Republic	1410	3.485	16.595	21	10 056 181	2088.30
St Kitts and Nevis	1427				53 051	-
St Vincent and the Grenadines	1583	0.01			109 365	-
St Lucia	2301	0.017			179 000	-
Suriname	2331	0.67	0.761	88	529 419	166 220.00
Trinidad and Tobago	2200	0.232	6.031	3.84	1 346 350	2852.20
Uruguay	1265	3.66	6.203	59	3 368 595	17 514.70
Venezuela	1875	9.064	1.255	722.4	29 278 000	24 673.80

Source: World Bank 2013, cited in OECD 2012b:8.

Water situation in the regions of the Americas

Central America

The estimated water resources of the Central American region amount to 23,000 km^3 per inhabitant per year, with strong variations between and within countries. Seventy per cent of these resources are to be found in the eastern part of the Caribbean Sea, with 30 % on the Pacific Ocean side. Rainfall in the region ranges from 1250 to 5000 mm per year. The region has a marked seasonality of rains. On the Caribbean coast it rains practically all year round, with slight reductions in April and October, while in the Pacific the rainy season runs from May to November.

The Central American region has sufficient water resources for agriculture. However, the seasonal variation of rainfall, insufficient irrigation works, watershed degradation and deterioration in water quality affect agricultural water use. In addition, the region has been seriously damaged by the effects of climate change, deforestation and poor agricultural practices.

In Central America there are 23 shared transboundary watersheds, covering 191 449 km^2, which represent 37 % of the area of the region. It is estimated that the irrigated area in this region is approximately 500 000 hectares (OECD 2012b:74-75).

Andean Community

The Andean region comprising Bolivia, Colombia, Ecuador and Peru, has a marked rainfall variation. The main water sources in the area come from the Andes. The average annual rainfall is 1853 mm. Ten per cent of the planet's water resources are concentrated in this region. The average per capita water availability is very high: 53 000 m^3. Availability for Peru and Bolivia is close to 68 000 m^3, while that of Colombia is 47 000 m^3 and that of Ecuador is 32 000 m^3. There is a notable regional diversity. The Pacific coast is arid while the equatorial Andes is the wettest region. The pattern of rainfall also presents seasonal variations.

There are also large shared watersheds, in which 83 % of the water is concentrated. The most important is Alta Amazonia, where 70 % of the water resources in the region are found and the availability of water per capita is 210 000 m^3 annually on average. Also in the region are the Titicaca and Plata watersheds, which cover 77 % of the territory of the Andean Community.

In recent years, the water resources of the Andean region have suffered from the effects of climate change, particularly the el Niño and la Niña phenomena, which have accelerated the retreat of the Andean glaciers. This poses a serious risk to population and productive activities, as an estimated 40 million people could be at risk of water shortages by 2020. Seventy- eight per cent of the region's fresh water is destined for agricultural use. In recent years, there has been a deterioration in water quality due to pollution (General Secretariat of the Andean Community 2010:14-31).

Southern region

South America is one of the regions with the world's largest water resources. There are two of the largest regional basins in this region, the Amazon basin, which covers an area of 6.1 million km^2, which includes Brazil, Bolivia, Ecuador, Colombia, Peru and Venezuela, and that of Paraná. The rivers converging in these countries are the Amazon, the Orinoco, the Rio de la Plata, the Paraná and the Magdalena, whose average flows are 120 000, 30 000, 22 000, 15 000 and 7 000 m^3 per second, respectively. The region has 29 transboundary aquifers and its water potential is estimated at 2.4 million km^3. Another important aquifer is Guaraní, with an extension of more than one million km^2 and a tributary of 40 000-55 000 km^3 of water (Dieser and Gargiulo 2010).

This region is one of the main producers of soybeans, maize, cereals, tropical products and meat products in the world. The commercial agriculture sector is highly technical, with intensive use of irrigation. In Argentina, the water supply per inhabitant exceeds 20 000 m^3, although 76 % of its territory is arid and semi-arid. Its average rainfall is 600 mm and its renewable water resources are 276 km^3. The potential of irrigated land in Argentina is 6.3 million hectares, although the irrigated area is 1.5 million. Brazil, on the other hand, possesses 12 % of fresh water on the planet, with an annual precipitation of 1765 mm, although with a great regional variation in its extensive territory. It has 12 watersheds. Both countries have problems caused by pollution and climate change (Jiménez and Galizia:39-63, 98-100).

Northern Region

This region also exhibits a remarkable diversity in its geography, climates and water resources. Canada is the country with the third largest water resources on the planet, after Brazil and Russia, with 6.5 % of renewable water resources. Its territory has many lakes, including the Great Lakes, which constitute the watershed with the largest amount of fresh surface water in the world. However, most of these resources are in the Arctic, so it is not in immediate use. The majority of the population lives in the southern part of the country, that accounts for 2.6 % of the world's freshwater supply, below the United States average.

In addition, in recent decades there has been a marked retreat of glaciers, which has generated severe problems and has become a constant concern for neighboring regions with few water resources. There has also been an overexploitation of groundwater by the growth of cities and industries and their pollution. Climate change has particularly affected the arctic regions of the country (Jiménez and Galizia 2012:39-63, 114-116).

The United States is divided into two regions marked by the difference in precipitation. The eastern part receives annual rainfall with an average of between 650 mm and 1500 mm, while the western part has rainfall ranging between 125 mm annually in the southwest and 2500 mm in the northwest forests. The country has underground water resources in practically all of its territory. However, there is considerable overexploitation of groundwater which is accelerating the recharge processes at the expense of surface water flows. Eighty per cent of the water consumption is obtained from surface water. The remarkable urban growth and industrialization, especially in the arid and semi-arid region of the Southwest, and the increasing volume of water used in agriculture, industry and domestic services have led to a growing scarcity of water, because of a reduction in the flow of rivers, such as the Missouri (Jiménez and Galizia 2012:268-273).

In Mexico, the average precipitation is 775 mm, of which 72 % evaporates, 26 % runs off at surface, and only 2 % is used. The recharge in its aquifers is 2471 m^3 per second, of which 889 m^3 / s is extracted for use. Agriculture uses 77 % of the water, 14 % is used for public supply, 5 % for electric power generation and 4 % for industry. The country has a marked seasonality, as most of the rainfall occurs in the summer. There is also a marked asymmetry among the regions of the country. For example, Tabasco has a precipitation thirteen times greater than that of Baja California Sur. The population concentration also does not correspond to the distribution of water resources, since 77 % of the population lives in the north, center and northwest, where 31 % of available water is located.

Groundwater is used to irrigate 2 million hectares of arable land and covers half of the demand for industry and 70 % of cities. In recent years, overexploitation of aquifers has seen a marked increase. Between 1975 and 2006 the number of overexploited aquifers supplying 80 % of the volume of water extracted from the subsoil, increased from 32 to 104. The critical zones are in some of the main agricultural regions of the country: the Bajío, the Lagoon, the northwest and the Valley of Mexico. The country has 86 irrigation districts, which serve more than half a million farmers and irrigate 2.8 million hectares (Jiménez and Galizia 2012:310-318).

The Caribbean Region

The Caribbean region comprises 17 countries (14 islands and three countries located on the continent). It is a humid tropical region whose temperatures fluctuate between 24 °C and 32 °C. The highest rainfall occurs in Haiti, Guyana and Suriname, with 2387, 2350 and 2331 mm annually, respectively. The lowest occurs in Antigua and Barbuda, with 1030 mm annually. In several of the islands the main source of supply is surface waters. The reserves of these waters are only 8 m^3 per inhabitant in Trinidad, 16 m^3 in St Lucia and 45 m^3 in St Vincent- amounts that contrast with the 1161 m^3 per inhabitant in Honduras.

Several worrying situations are already present: Barbados consumes almost 100 % of its water resources; St Lucia and Nevis have a water deficit of 35 % and 40 %, respectively, and Antigua and Barbuda depend on water desalination to meet its demand. Although countries on the continent have greater water resources, they are more exposed to droughts and floods. The region is very vulnerable to weather phenomena. Since the 1990s, it has suffered severe droughts. In 1994 and 1995 Barbados had its worst drought in a hundred years. As a consequence of climate

change, it is estimated that the average temperature will rise between 2 ° C and 3 ° C by the end of the century and that harmful level will increase from 5 mm to 10 mm per year (Cashman 2013:3-7).

TABLE 4. Average precipitation per year (mm).

COUNTRY	ANUAL AVERAGE
Antigua and Barbuda	1030
Bahamas	1292
Barbados	1422
Belize	1422
Cuba	1705
Dominica	1335
Dominican Republic	2083
Grenada	1410
Guyana	2350
Haiti	2387
Jamaica	1440
Puerto Rico	2051
St Kitts and Nevis	1427
St Lucia	2301
St Vincent and the Grenadines	1583
Suriname	2331
Trinidad and Tobago	2200

Main uses of water in the Americas

The use of water has a considerable regional variation in the American continent. In 2000, it was estimated that Latin America had 13 477 km^3 of renewable water resources annually, from which it extracted 252 km^3 annually, and in that region agriculture used 71 % of the water extracted, the industrial sector 10 % and the urban household sector 19 %. Water extraction, as a percentage of the region's renewable resources, was 1.9 %. In North America, which is the region in the continent where the greatest amount of water is extracted, water resources were estimated that year at 6253 km^3, while the extracted water was estimated at 525 km^3. The water used in agriculture represented 39 % of the water extracted and the extraction rate was 8.4 %. In the Caribbean region, renewable water resources were estimated at 93 km^3, with a total extraction of 13 km^3, a water use in agriculture of 69 % and an extraction rate of 14 %. At the beginning of the 21st century, Latin America was the region with the largest volume of water resources, North America was the one that extracted the most water and the Caribbean had the least amount of water resources and extracted the largest percentage of water from its renewable resources.

As shown in Table 5, based on the latest estimates by the Food and Agriculture Organization of the United Nations (FAO), total renewable water resources in North America were estimated at 5668 km^3, in Central America and the Caribbean at 734 km^3 and in South America at 12 724 km^3. The country with the greatest amount of renewable water resources was Brazil, while the ones with the least amount of resources were the Bahamas and the Lesser Antilles. The region that extracted the most freshwater was North America, especially the United States and Canada, with 529 km^3 per year. The region where the smallest amount of fresh water was extracted was the Lesser Antilles and Bahamas, with 0.6 km^3. Across the hemisphere, the percentage of extracted water used in agriculture was 48 %, with South America being the region with the highest percentage, with 71 %, while the Lesser Antilles and the Bahamas used only 17.6 % of the water extracted. As can be seen in both tables, although between 2000 and 2007 there was a slight increase in renewable water resources in the Americas, there was also an increase in water extraction (790 km^3 in 2000, 859 km^3 in 2016) and a decrease in the percentage of water destined for agriculture (60 % and 48 % respectively). At the same time, industrial use of water at the hemispheric level increased from 22 % to 37 %, while urban domestic use decreased from 18 % to 14 %.

Infrastructure and Storage

As the FAO has pointed out, since the 1980s, investment to expand and modernize irrigation infrastructure, which had grown considerably in the preceding decades,

TABLE 5. Water extraction in the Americas by sector.

Regions / subregions	Water extraction by sector						Total water extraction (km^3/yearly)	Percentage water extraction from renewable water resources (RWR)	RWR (km^3/yearly)
	Municipal (km^3/yearly)	%	Industrial (km^3/yearly)	%	Agriculture (km^3/año)	%			
Americas	**123.15**	**14.3**	**320.59**	**37.3**	**415.34**	**48.3**	**859.09**	**4.4**	**19 535.70**
NORTH AMERICA	**79.41**	13.0	**288.80**	47.4	**241.43**	39.6	**609.64**	10.0	**6077.00**
North America	*67.97*	12.8	*281.52*	53.2	*179.85*	34.0	*529.34*	9.3	5668.00
Mexico	*11.44*	14.2	*7.28*	9.1	*61.58*	76.7	*80.30*	19.6	409.00
CENTRAL AMERICA AND THE CARIBBEAN	**7.60**	**22.9**	**6.04**	**18.2**	**19.59**	**59.0**	**33.22**	**4.5**	**734.60**
Central America	*3.26*	27.0	*1.29*	10.7	*7.52*	62.3	*12.08*	1.9	636.55
Caribbean - Greater Antilles	*3.97*	19.3	*4.60*	22.4	*11.96*	58.2	*20.53*	22.2	92.55
Caribbean - Lesser Antilles and Bahamas	*0.36*	*59.8*	*0.14*	22.6	*0.11*	17.6	*0.61*	11.1	5.50
SOUTH AMERICA	**36.15**	**16.7**	**25.76**	**11.9**	**154.33**	**71.4**	**216.24**	**1.7**	**12 724.10**
Guyana	*0.11*	5.4	*0.16*	7.6	*1.79*	87.1	*2.06*	0.6	340.00
The Andes	*10.94*	18.2	*3.91*	6.5	*45.22*	75.3	*60.06*	1.1	5336.90
Brazil	*17.21*	23.0	*12.72*	17.0	*44.90*	60.0	*74.83*	1.3	5661.00
South America	*7.89*	10.0	*8.98*	11.3	*62.42*	78.7	*79.28*	5.7	1386.20

Source: (Food and Agricultural Organization, Italy) 2016. AQUASTAT (online, database). Rome, Italy. Consulted July 8, 2016, 19:12. Available at http://www.fao.org/nr/water/aquastat/main/indexesp.stm.

ceased to do so both because of economic problems brought about by crises which affected the world economy, and because of the low profitability of these investments and governments' budget deficiency.

The American continent has an extensive network of irrigation infrastructure, with dams, canals and wells. The largest and most modern are in North America, although as IICA has indicated, precise information is needed on the status of this infrastructure in several of the countries of the continent (IICA 2014). It is estimated that there are 48 million irrigated agricultural hectares in America, although only 39 million of these are used. IICA's cited document states that the amount of new irrigated land on the continent has declined from 12 million hectares by 1970 to half, due to the structural problems of the countryside in most of the American countries. The same has happened with investments for the maintenance of the irrigation infrastructure. Of the plots irrigated at the mainland level, it is estimated that 75 % is used for surface irrigation, 22 % for irrigation by spraying and 3 % for localized irrigation.

Transboundary groundwater and aquifers

The continent has a considerable amount of groundwater, which is mainly used in agriculture. The vast majority of cities also depend on them. There is, therefore, an overexploitation of this resource, which has become more acute in recent years. Overexploitation has caused pollution and salinization of groundwater, which has deteriorated the water quality of a great portion of it. In most countries there is also inconsistency and lack of coordination between public policies for the management of groundwater and surface water.

There are 62 transboundary aquifers on the American continent: 27 in South America, 19 in North America, 12 in Central America and 4 in the Caribbean. One third of these is located in arid and semi-arid zones. It is estimated that 20 of them are exploited intensely, while 16 are located in areas of intensive agriculture or industrial areas with high salinity.

To address and solve this problem, governments and users of these resources must coordinate their activities to ensure their conservation and sustainable use.

Impacts of climate change on agricultural water

The effects of climate change have had a strong impact on the hemisphere. In the period 2000-2005, climate-related disasters increased 2.4-fold in Latin America and the Caribbean (LAC). It is estimated that only 19 % of these events produced losses of almost USD 20 billion.

As a consequence of climate change, there has been a decrease in rainfall. Reduction and instability of rains and rising temperature, sea level and the presence and magnitude of droughts and hurricanes will have a direct negative effect on the population (particularly the poorest), health, water related services and economic and recreational activities. These changes will also have repercussions on the ecological chains and the animal and plant species of the continent (IICA 2014:17-18).

Agriculture plays a central role in this process. On the one hand, droughts, floods and hurricanes that have occurred in recent years pose a severe threat. De-icing, rising temperatures and reduced rainfall and seepage affect the reduction of groundwater and increased pollution and salinization. Likewise, climate change increases the generation of greenhouse gases derived from agricultural activities, which alters the carbon and water cycles. At the same time, agriculture is part of the solution to the effects of climate change, as sustainable agriculture contributes to curbing desertification, increasing water leaks and recharging aquifers, preserving biodiversity and carbon (IICA 2014:19).

The scenario for the following decades is worrying if these problems are not addressed, as it is anticipated that food production may be reduced and agricultural products become more expensive, with a consequent impact on food requirements, especially in the most vulnerable social sectors. At the same time, more pressure would be placed on governments and relevant sectors to address these problems, in terms of allocating increased investment resources and assistance for mitigating these effects.

In addition to agriculture, hydroelectric power generation is another sector that is being affected by climate change. In the Andean region, the 20 % decrease in glaciers in the Cordillera represents a risk for electricity generation and water supply in the region.

The areas that will be most affected by climate change are expected to be coastal regions and islands. There is also a change in agriculture with a decrease in the surface area in hot and humid areas and a change in crops in temperate zones. The small rural producers sector is the one that will face the most risks and could be the most affected by the precarious technological conditions of their production, the lack of resources and the high degree of vulnerability in the regions where these producers live (IICA 2014:22-23).

Responding to the risks of climate change is already one of the biggest challenges for public policy in the American governments and will be even moreso in the future.

Use of Agricultural Water in the Americas

One of the biggest challenges is to produce more food to meet the needs of a population that will double in 40 years with fewer resources and in particular, less water. The diversity of types of agriculture on the continent and within each country, where there is the coexistence of on-farm consumption sectors with precarious conditions of production and modern commercial agriculture sectors with high rates of efficiency and productivity, makes it necessary to propose broad and transparent general criteria for the use of water that may be adapted to the specific conditions of each region and country.

In the last 50 years, the irrigated land has doubled and water extraction tripled. This resulted in increased pressure on the continent's water resources, where irrigated agriculture grew from eight million to over 52 million hectares in 2016. However, irrigated agriculture still represents a very small percentage, since it constitutes just 13 % of the total agricultural area.

Rainfed Agriculture

As with the rest of the world, most of the agricultural land in the Americas is rainfed, i.e., 87 % of arable land. There are countries where almost all of their agriculture is rainfed. In Saint Kitts 100 % of its agricultural area is rainfed; in Dominica, 99 %; in Canada, 98 %; and in Paraguay and Belize 87 %. In 24 countries of the Americas this agricultural system is used in more than 80 % of its arable land.

In general, rainfed agriculture has lower levels of productivity than irrigated agriculture. It is estimated that productivity in grain cultivation on rainfed areas is 65 % lower than in irrigated agriculture. Although there are some rainfed regions with high productivity, as in the Midwest of the United States, in many other regions of the continent the conditions are different, due to the variation of rainfall, the poor quality of the land and the substandard practices of farmers.

It is imperative to improve the productivity of rainfed agriculture, which constitutes the vast majority of continental agriculture and on which most producers depend. This is necessary because less technology is used in this system and traditional practices prevail in many regions. This should be strengthened with sustainable practices that preserve ecosystems as well as the availability and quality of water resources. As IICA has pointed out, technological alternatives should be sought to improve productivity without expanding the agricultural frontier and without increasing the extraction of groundwater (IICA 2014:29-30).

TABLE 6. Irrigated and rainfed agricultural areas in the Americas. (Ha by thousand).

COUNTRY	CULTIVATED AREA *	IRRIGATED AREA **	RAINFED AREA	% IRRIGATED
Antigua and Barbuda	5.0	0.4	4.6	8
Argentina	40 699.0	2357.0	38 342.0	6
Bahamas	12.0	1.0	11.0	8
Barbados	12.0	5.4	6.6	45
Belize	110.0	3.5	106.5	3
Bolivia (Multinational State of)	4670.0	297.2	4372.8	6
Brazil	82 808.0	5400.0	77 408.0	7
Canada	50 651.0	1218.0	49 433.0	2
Chile	1766.0	1109.0	657.0	63
Colombia	3448.0	1087.0	2361.0	32
Costa Rica	552.0	101.5	450.5	18
Cuba	3576.0	557.6	3018.4	16
Dominica	23.0	0.2	22.8	1

TABLE 6 (continuation)

COUNTRY	CULTIVATED AREA *	IRRIGATED AREA **	RAINFED AREA	% IRRIGATED
Ecuador	2663.0	1500.0	1163.0	56
El Salvador	945.0	45.2	899.8	5
Unites States of America	154 437.0	26 708.0	127 729.0	17
Greanada	10.0	0.4	9.6	4
Guatemala	2036.0	337.5	1698.5	17
Guyana	448.0	143.0	305.0	32
Haiti	1350.0	97.0	1253.0	7
Honduras	1475.0	89.7	1385.3	6
Jamaica	215.0	30.7	184.3	14
Mexico	25 668.0	6460.0	19 208.0	25
Nicaragua	1790.0	199.1	1590.9	11
Panama	748.0	32.1	715.9	4
Paraguay	4585.0	136.2	4448.8	3
Peru	5534.0	2580.0	2954.0	47
Dominican Republic	1155.0	306.5	848.5	27
St Kitts and Nevis	5.1	0.0	5.1	0
St Vincent and the Grenadines	8.0	0.5	7.5	6
St Lucia	10.0	3.0	7.0	30
Suriname	66.0	57.0	9.0	86
Trinidad and Tobago	47.0	7.0	40.0	15
Uruguay	2363.0	238.0	2125.0	10
Venezuela (Bolivarian Republic of)	3400.0	1055.0	2345.0	31
TOTAL	**397 290.1**	**52 163.8**	**345 126.3**	**13**

* Arable land plus permanent crop area.

** Area equipped for irrigation: total.

Source: FAO (Food and Agriculture Organization of the United Nations, Italy). 2016. AQUASTAT (online, database). Rome Italy. Retrieved 11 Jul. 2016, 21:41. Available at http://www.fao.org/nr/water/aquastat/main/indexesp.stm.

Irrigated Agriculture

Irrigated agriculture has been essential to the development of civilizations since mankind's earliest times. In recent times it has played a central role in feeding ever increasing populations and in seeking to resolve the serious hunger problems prevailing in the world's most disadvantaged regions. As a result, agricultural irrigation systems have experienced considerable growth and have boomed in the second half of the 20th century.

However, as shown in Table 6, in the Americas today, only 13 % of the agricultural area is cultivated under the irrigation system. The countries with the largest irrigated area in the continent are Suriname (86 %), Chile (63 %), Ecuador (56 %), Peru (47 %) and Barbados (45 %). In contrast, in St Kitts and Nevis, there is no irrigated agriculture and in Dominica only 1 % of arable land is irrigated, in Canada 2 % and in Paraguay and Belize 3 %.

In addition to these contrasts between countries, there are also marked disparities among regions within countries, as irrigated agriculture is concentrated in the most modern commercial agriculture areas where farmers have greater resources for investment, technology, credit and access to markets.

It is estimated that this type of agriculture will increase further in the future, due to the greater demand for food that is expected and as one of the responses to the changes caused by climate change. It is possible to continue to develop technologies that increase the efficiency of irrigation and increase irrigated areas without increasing the amount of water supplied, thanks to greater efficiency. This is an important area of opportunity, since the average efficiency of water used by the plants in the irrigation systems is less than 40 %.

Some of the challenges that must be faced to achieve integrated management of water resources and an increase in the efficiency of irrigation systems are as follows:

- Reduce extraction rates and overexploitation of aquifers, eliminating the negative incentives that promote the use of water by volume rather than productivity.
- Increase efficiency in the use of irrigation water by training users, improving technology and infrastructure, and using irrigation methods that are more appropriate for the crops on which they are used.
- Reduce pollution of aquifers caused by agricultural, industrial and domestic activities.
- Establish better regulation and coordination among institutions dealing with water.
- Modernize and rehabilitate irrigation infrastructure.
- Halt and reverse environmental degradation caused by salinization of aquifers, soil saturation and sediments in dams.
- Train the human resources involved in water management.
- Ensure water rights and property ownership, updating the legal and regulatory framework to overcome conflicts that prevent proper extraction and use.
- Define inclusive policies for all user sectors.
- Improve efficiency in the use of rain in rainfed agriculture and the use of irrigation throughout the agricultural cycle.

It is also necessary to reuse water from domestic and industrial use that is not contaminated with chemical or biological waste that cannot be disposed of, and use it for the irrigation of crops such as cereals. Also, drainage systems and irrigation practices should be improved, and the problem of salinization of soils solved. A balance must be struck between water use and agricultural productivity, to ensure sustainability (IICA 2014:32-33).

Virtual water and water footprint in Latin American agriculture

The concepts of virtual water and water footprint were developed at the end of the last century and at the beginning of the current one. The first one has contributed to identifying how the consumption of water in one place impacts the water resources in another. Traditionally, water has been considered a national or international resource in the case of shared catchment areas, but it has not been seen as a global resource and consumption has been considered only in terms of the demand of national users, without considering water demand as an export product. A paradigm shift is therefore required where water is considered to be a global resource and the relationship between the virtual water trade, water scarcity and food security is taken into account.

Until now, international trade regulation does not consider the sustainable use of water in producing countries. The countries that export products, the cultivation of which made use of considerable water resources, have seen a reduction in these products and generate social and environmental costs that are not reflected in the cost of the products that they export. Conversely, countries that import virtual water are those which save water, but do so with greater dependence on the outside world and less food sovereignty.

Between 1996 and 2005, there were significant contrasts in the Latin American countries in these areas. On the one hand, Argentina and Brazil were the largest exporters of virtual water in the region and ranked second and fifth in the world. In contrast, Mexico was the main importer of virtual water, being the second largest importer in the world, behind Japan, with a water dependence abroad of 42.5 %. This situation is complex, because although it allows Mexico to preserve its water resources, that external dependence affects its food sovereignty (Vásquez and Buenfil 2012:41-42).

The concept of the water footprint, in turn, serves to identify the volume of fresh water used to produce a good. It also specifies the place where the water was obtained, its type (green or blue), the pollution it generated and the place where the good produced was consumed. This facilitates observation of patterns and trends in water use and its relationship with commercial flows of virtual water.

As shown in table 7, between 1996 and 2005, Latin America accounted for 10.5 % of the world's water footprint. In addition, the water footprint of national consumption per inhabitant was 29 % higher than the world average. The world average of water dependence from abroad is 21.7 %. The Latin American countries with the highest water footprint are Brazil (335 374 mm^3), Mexico (197 425 mm^3) and Argentina (59 546 mm^3), while Panama (4063 mm^3), Nicaragua (4674 mm^3) and Costa Rica) are the ones with the lowest water footprint.

Countries with the highest water footprint per inhabitant are Bolivia (3548 mm^3), Brazil (2207 mm^3) and Uruguay (2133 mm^3), while those with the lowest water footprint per inhabitant are Nicaragua (912 mm^3), Guatemala (983 mm^3) and El Salvador (1032 mm^3).

Finally, the countries with the highest percentage of external water footprint are Mexico (42.5 %), Venezuela (34.3 %) and Chile (33.4 %), making them highly vulnerable and dependent on the outside world. The lowest percentage, on the other hand, are Paraguay (2.9 %), Argentina (3.8 %) and Brazil (9.2 %).

TABLE 7. Water Footprint in Latin America 1996-2005.

(1) Country
(2) Total Water Footprint (mm^3)
(3) Water Footprint per capita (mm^3/pop/year)
(4)% external water footprint/total

(1)	(2)	(3)	(4)
Argentina	59 546	1607	3.8
Bolivia (Multinational State of)	29 161	3468	9.4
Brazil	355 374	2207	9.2
Chile	17 888	1155	33.4
Colombia	55 123	1375	19.9
Costa Rica	5906	1490	31.2
Cuba	18 712	1687	13.3
Ecuador	24 820	2007	11.8
El Salvador	6138	1032	31.4
Guatemala	11 215	983	18.9
Honduras	7417	1177	14.7
Mexico	197 425	1978	42.5
Nicaragua	4675	912	16.0
Panama	4063	1364	30.6
Paraguay	10 565	1364	2.9
Peru	28 460	1088	32.4
Dominican Republic	12 472	1401	32.1
Uruguay	7053	2133	20.5
Venezuela (Bolivarian Republic of)	42 142	1710	34.3
Latin America	**898 153**	**1783**	**20.3**
WORLD TOTAL	**8 525 064**	**1385**	**21.7**
% LATIN AMERICA/WORLD TOTAL	**10.5 %**	**52 163.8**	

Source: Vásquez and Buenfil 2012:41-42.

Therefore, it is necessary that water management public policies aim to achieve a more efficient use of water, improve practices and applied technologies, bring about change in consumption habits through environmental and water education, and ensure that countries give greater importance to virtual water trade and water footprint in decision-making (Vásquez and Buenfil 2012:5-6).

Innovation and Water

Against this background, it is clear that it is essential to increase the productivity of agricultural water in order to achieve three objectives: reducing pressure on water resources, reducing environmental degradation and improving food security conditions (IICA 2014:39).

This requires the development of innovations in the following four areas:

A. Innovations in plant efficiency for water use

Water productivity depends to a large extent on the efficiency with which plants use the vital liquid as a result of absorption, metabolization, evaporation and transpiration. In recent decades, there have been notable advances to improve their efficiency and genetic varieties have been developed that yield more with less water. Biotechnology has made a significant contribution to these advances. This has enabled the development of genetically modified, drought-tolerant varieties of rice, wheat, sorghum, maize, soybeans and cotton. Similarly, bacterial bioremediation and wastewater treatment techniques have been developed for cleaning the water and removing hydrocarbons and heavy metals, as well as developing saltwater tolerant plants.

B. Innovations in water use in production units

Other innovations are related to how water is used in production units to increase productivity. These innovations include the application of technologies that improve soil management, make fertilizer use more efficient and achieve a more precise and focused water supply, such as precision irrigation, micro irrigation and underground irrigation. This is known as precision agriculture, which uses computerized systems that, with the support of satellite measurement systems, enable the supply of the precise amount of water and other inputs required by the plants in a timely manner.

One limitation of these technologies, besides being not yet well known, is their high cost, which cannot be paid by small farmers. It is therefore necessary to make them more accessible to producers, which makes technology transfer and agricultural extension essential (IICA 2014:41-44).

C. Innovations in the channeling and supply of water

These innovations aim to improve the way in which water reaches the producers. For this, innovations are developed in the operation of irrigation systems, canals and conduits, as well as in the management of water resources. Other innovations of this type seek to reduce the evaporation of water, by redesigning the canals, converting to more efficient crops in water use and, controlling weeds competing for water with crops. They also include innovations designed to reduce the seepage, runoff and displacement of clay, salts, iron and humus entrained by the water course, as well as to minimize water pollution and salinization of soils and to promote recycling and reuse of the water. The success of these practices requires the participation of users and community management of water resources.

D. Innovations in watershed management

In recent years, the use of georeferencing and geomedical technologies, as well as cybernetic resources have been extended to improve water management, in order to know precisely their availability and to build models that facilitate management that guarantees water supply, in light of new challenges such as climate change and population growth. These innovations have served as support for decision making on the allocation of water resources to users, with the intention of giving priority to their use in the most important activities for social development. This type of innovation is also oriented towards the preservation of water resources, both in quality and quantity, as well as the monitoring of climatic conditions, water availability and pollution levels, in order to detect risks in a timely manner.

Achieving success in water policies, integrated water management and increased productivity is a shared responsibility of all water stakeholders, including producers, governments, research institutions and international organizations.

04

STRATEGIES AND GUIDELINES ESTABLISHED BY IICA: MINISTERIAL DECLARATIONS AND PUBLIC POLICIES FOR ACTION

The Inter-American Institute for Cooperation on Agriculture (IICA), responsible for promoting competitive, sustainable and socially inclusive agriculture in the hemisphere, has *established a series of strategies and guidelines to strengthen the integrated and sustainable* management of inland water resources.

At the Summit of the Americas held in Port of Spain in 2009, the leaders of the hemisphere recognized the negative impact of food crises on the peoples of the hemisphere and pledged to take urgent and coordinated action to overcome it, for which they urged ministers to develop activities that improve access and availability of food and strengthen the institutional capacity of Member States. They also determined that a multidimensional and multisectoral approach to agriculture was necessary to achieve sustainable development and food security.

In the IICA Strategic Plan 2010-2020, it was pointed out that the countries of the Hemisphere should achieve a more competitive and sustainable agriculture that would improve the well-being of the rural population, guarantee the conservation of natural resources and contribute to the achievement of food security.

That document determined that the main trends in the agricultural sector in the Americas were:

- A more interactive and volatile global scenario with expanding markets.
- An increase in rural poverty, which meant a brake on development.
- A close relationship between agriculture and climate change.
- An increasingly important role for agriculture in the Americas to meet the growing global demand for food.
- Problems and structural limits to the development of mainland agriculture.
- Predominance of subsistence agriculture in the region (IICA 2011:7-11).

It was also recognized that the scenario of international agricultural markets had a markedly unstable behavior, and that there was an increasing demand for agricultural products, both for population growth and for the increased use of agricultural products for energy and industrial purposes.

Similarly, it was pointed out that by the end of the first decade of the new millennium, there were about 200 million people living in poverty in Latin America and the Caribbean (LAC) and that inequality, despite efforts, policies and government budgets to mitigate it, continued to grow.

The 2010/2020 Strategic Plan stated emphatically that while agriculture was contributing to worsening climate change, it could at the same time be very useful in reducing its negative impacts, and it was therefore imperative to design and implement public policies aimed at overcoming those problems.

It was also recognized that the Americas, as a net food exporting region, with the potential to increase agricultural yields, would play a central role in meeting future world food demand. For this to happen, a solution needed to be found for problems relating to the destruction of forested areas caused by the expansion of the agricultural frontier, the effects of desertification, salinization and poor drainage, as well as the increased demand for water for human and industrial consumption, the deterioration of aquifers and the reduction in water quality.

For this reason, it was concluded that it was necessary to develop a new paradigm that would address the four great challenges of American agriculture:

1. Being competitive and improving productivity.
2. Contributing to the development of rural territories.
3. Contributing to the conservation of natural resources.
4. Contributing to the achievement of food security (IICA 2011:19-21).

It was also concluded that there was a need to strengthen international cooperation by overcoming four problems:

1. Lack of coordination of multiple initiatives related to agriculture.
2. Lack of collaboration among international institutions.
3. Channeling of cooperation towards problems that were not a priority.
4. Dispersion of efforts, the absence of adequate accounting of expenses and the null evaluation of products, results and impacts.

Faced with this situation, a call was made to renew policies and institutional capacities for agriculture and rural development, to modernize legislation, to renew policy instruments, to strengthen the capacity of entities responsible for the agricultural sector and to contribute to the development of the capacities of companies and individuals.

The Strategic Plan 2010-2020 outlined the strategic objectives that should guide IICA's action:

1. To improve the productivity and competitiveness of the agricultural sector.
2. To strengthen the contribution of agriculture to the development of territories and rural well-being.

3. To improve the capacity of agriculture to mitigate and adapt to climate change and make better use of natural resources.
4. To improve the contribution of agriculture to food security (IICA 2010b:34-39).

On that basis, IICA developed its *Medium Term Plan 2010-2014: For Competitive and Sustainable Agriculture for the Americas*. In it, IICA proposed a new paradigm for mainland agriculture that would help improve the incomes of countries and producers, guarantee food security and be a bulwark to counteract climate change. It proposed a commitment to a more productive, more inclusive and more sustainable agriculture.

In that plan, the Institute addressed the most relevant issues of mainland agriculture, such as the relationship between agriculture and the environment, natural resources and climate change, biotechnology, biosafety, agroenergy, agrotourism, rural agribusiness, organic agriculture, agricultural insurance and rural development with a regional approach.

In that document, the Institute pointed to the need for mainland agriculture to take advantage of the opportunities of a crisis environment and market volatility to attract investment into the sector, given the demographic conditions of the hemisphere, the richness of natural resources and biodiversity, and the availability of land to increase the agricultural frontier.

It emphasized the need to develop a competitive, sustainable and inclusive agriculture that respects and preserves the environment and uses scientific and technological advances to increase productivity and to co-opt small producers at higher levels of development (IICA 2010a:9-15).

IICA identified the following as strategic objectives and priority actions:

1. Improve the productivity and competitiveness of the agricultural sector.
2. Strengthen the contribution of agriculture to the development of territories and rural well- being.
3. Improve the capacity of agriculture to mitigate and adapt to climate change and make better use of natural resources.
4. Improve the contribution of agriculture to food security (IICA 2010a:18-19).

IICA specified that it would focus its limited resources and efforts on contributing to the achievement of those strategic objectives in which it had more technical capacity, experience and recognition. Its technical cooperation objectives included administration of risk management related to natural resources and climate change, in order to reduce levels of uncertainty among agricultural producers, to protect natural resources and to address the consequences of climate change.

Having established the four strategic objectives mentioned above, it identified four programs of technical concentration and cross-cutting coordination. One of them was called "Agriculture, natural resource management and climate change".

This mandate and these objectives served to guide IICA's activities and decisions on the main themes of mainland agricultural agenda in general and the issue of water in particular.

Thus, the Institute defined strategies and guidelines for the management of inland water resources in the Declaration of Ministers of Agriculture signed at the ministerial meeting held in Buenos Aires, September 25-26, 2013.

In that Declaration, the Ministers of Agriculture of the Americas established a series of pronouncements and commitments to contribute to the achievement of the Millennium Development Goals and to support United Nations efforts for integrated water resources management.

The starting point of the declaration was the recognition on the part of ministers of the need to strengthen food security through a sustainable increase in agricultural productivity. They also recognized that mainland agriculture would play an important role in contributing to the growing food needs of the world.

In order to fulfill this role, ministers indicated that agriculture in the Americas had to face the challenge of increasing production and productivity and that it should seek solutions to the reduction of fertility caused by soil degradation, problems related to climatic change and the pressures for water use by the different users of this resource.

They also noted that freshwater is a finite, vulnerable, essential and strategic resource for sustainable development and that, although there are abundant water resources in the Americas, their distribution and availability present significant variations and inequalities between countries and regions, and that climate change is changing the spatial and temporal patterns of the water cycle.

They also recognized that countries were making significant efforts to improve integrated water management, to promote the adaptation of agriculture to climate variability and to combat desertification and drought. They noted that in order to achieve integrated water management, a multidimensional and inclusive approach was required for all stakeholders, and that it was necessary to use agricultural water more efficiently in order to obtain more food products with less water and with less social and environmental impact.

The ministers noted that one of the major challenges was to overcome the inequality in access and use of water resources of small producers and women farmers, many of whom inhabit different regions of the continent, and depend totally on rainwater for their agricultural activity.

They also emphasized the importance of innovation to optimize the integrated management of water and its sustainable use in agricultural work, as increased productivity would contribute to freeing water for users in cities, industry and services, as well as reduce environmental pollution while improving conditions for achieving food security and greater well-being of the population (IABA and IICA 2013:1-3).

The ministers recognized that integrated water management was essential because it was a crosscutting issue and such management had to be carried out through inclusive programs and projects that promoted development.

This was based on the fact that there is a multisectoral institutional framework that serves multiple water users, signifying a challenge for national public policies, which should have a multisectoral and participatory approach, with the objective of full equity in satisfying an extremely diverse demand.

For this reason, the ministers called on the countries of the continent, international funding and cooperation agencies, and agricultural research and innovation centers to promote national and regional programs aimed at increasing capacity, innovation and technology transfer for the sustainable use of agricultural water.

They also called on the Inter-American Institute for Cooperation on Agriculture (IICA), the Food and Agriculture Organization of the United Nations (FAO), the Economic Commission for Latin America and the Caribbean (ECLAC), The Regional Office for Latin America of the United Nations Environment Program (UNDP-ROLAC), the United Nations Development Program (UNDP), the Caribbean Agricultural Research and Development Institute (CARDI), as well as other related organizations *to lead, coordinate and support a technical cooperation program that promotes integrated management of water resources in agriculture and which necessarily includes the strengthening of the capacities of the ministries of agriculture and other institutions within the sector* (IABA and IICA 2013:3-4).

Consistent with this call, the ministers of agriculture of the Americas committed to the following public policies:

- To develop and consolidate the participation of the ministries of agriculture in the establishment and implementation of national policies for integrated water management, to ensure access and supply in the quantity and quality necessary to face the challenges of agriculture and rural development.
- To promote long-term agricultural policies based on scientific and technical principles that take into account the sustainable use of water and the challenges of climate change.
- To establish policies that enable the development, commercialization and use of products derived from innovation, including biotechnology, that reduce agricultural water consumption and increase productivity (IABA and IICA 2013:4).

With regard to institutional strengthening and capacity building, the ministers of the continent committed themselves to:

- Promote capacity building of the ministries of agriculture, related public institutions and producer organizations to promote the design and implementation of policies and instruments for integrated water management; promote dialogue and consultation with other economic and social sectors and coordinate efforts with international organizations.
- Promote the participation of agricultural sector representatives in national multisectoral bodies that deal with issues related to integrated water management and its governance.
- Boost, in coordination with the educational institutions of each country, the renewal and strengthening of education systems in agriculture, including water management in teaching and research.
- Carry out capacity development programs for the efficient use of agricultural water, aimed at entrepreneurs, producers, peasants, women, youth and their organizations.
- Promote agricultural research, extension, training and education to advance the identification and characterization of water uses in different production systems and types of producers.
- Promote the development and transfer of technology for the collection and efficient use of water, identifying appropriate and accessible technologies for different types of producers (IABA and IICA 2013:4-5).

The ministers of agriculture of the Americas also committed to promoting integrated water management and addressing the challenges of climate change through the following actions:

- To promote integrated management of agricultural water based on scientific principles and with respect to the legal system, culture and traditions of each nation and its indigenous communities.
- To strengthen and modernize agricultural information systems in relation to water resources.
- Initiate or strengthen water-related agricultural planning and programs, including diversification, conversion, direct seeding, irrigation and relocation of production projects.
- Strengthen public and private intersectoral work related to risk management in agriculture caused by natural disasters.

- Strengthen hydrometeorological, early warning, risk management, climate scenarios and prevention and prediction of extreme event systems, through the incorporation of new satellite technologies, telemetry, geoprocessing and georeferencing (IABA and IICA 2013:5-6).

They were also given the following commitments related to water innovation and productivity:

- To strengthen innovation in production systems along the agri-food chain, to improve water management used in rainfed and irrigated agriculture.
- To focus efforts on innovations that improve water productivity through technologies for sustainable use, precision agriculture, fertigation, hydroponics, biotechnology, water harvesting, and watershed management.
- To improve the articulation of agricultural innovation systems and proactive leadership to conduct research on the efficient use of agricultural water.

Finally, the agriculture ministers committed to promoting investments in water infrastructure by strengthening technical assistance programs to improve irrigation water quality and national and international cooperation, as well as by continuing to support IICA's hemispheric agenda of the use of agricultural water in its Member countries (IABA and IICA 2013: 6-7).

Institutional aspects in the use of agricultural water in the Americas

In order to fulfill the mandates outlined by the heads of state and the ministers of agriculture of the continent, IICA advanced the definition of global and regional objectives and strategies for water in the document "Water, food for the land" (IICA 2014).

In that document, agreed to by the member countries at the ministerial meeting held in Argentina in 2013, one of the central issues was the analysis of the institutional aspects that influence the use of agricultural water. This document stated that integrated management of water resources requires sound regulatory frameworks to ensure the availability of water for the different sectors.

The public sector has the responsibility to lead and coordinate the development and implementation of coherent and comprehensive public policies that ensure food security and poverty reduction, for which it is imperative to improve agricultural productivity and conserve natural resources.

IICA conducted a detailed study of water in the Americas, in which it concluded that water is a priority issue on the agendas of all the countries and is addressed through a wide variety of institutional arrangements and instruments. However, it corroborated the results of previous work such as that of the OECD 2012, in the sense that water management is carried out through the participation of different ministries and levels of government and with different management policies and instruments.

The diversity of institutions, policies, regulations and standards, as well as the multiplicity of users, create coordination problems for the implementation and coordination of actions. For this reason, one of the greatest challenges is to resolve the lack of coherence and articulation between the various legal and administrative mechanisms that exist today.

Particularly with regard to water for agricultural use, the countries of the continent are limited to allocating and operating irrigation water, although the importance of water resources to raising agricultural productivity, addressing climate change and ensuring sustainability has led various ministries to review their structures and functions. This has resulted in a state vision and coordinated management of irrigation water, as has happened in Ecuador and Peru (IICA 2014:50-52).

However, there is a need for greater involvement of the ministries of agriculture to develop policies that improve the uptake and conservation of rainwater for use in rainfed agriculture.

It is therefore necessary to strengthen the capacities of the ministries of agriculture to establish greater coordination with the other ministries responsible for water management and to promote comprehensive public policies that define the goals and priorities of research and innovation in the management and use of agricultural water.

The document indicates that there are two issues that require special attention to achieve a new paradigm that promotes the integrated and sustainable use of agricultural water: water ownership and the rights of the various stakeholders of agriculture to access its use. The consensus is that the ultimate ownership of water belongs to nations and that all human beings have equal rights to its use. However, this consensus is complicated in the case of transboundary waters.

On the other hand, all agricultural producers, including, of course, small producers and indigenous ethnicities, must have equitable and universal access to national waters, through participatory management. However, this participation by the different users is not institutionalized, so it only occurs in an isolated and exclusive way in the territories.

Neither traditional principles and customs, nor specific courts, are required to resolve disputes arising from the use of water. These are resolved through generic laws and non-specialized courts; therefore, their decisions are often unfair and hurt the actors with less bargaining power and fewer resources.

Among the areas offering the greatest opportunities for building a hemispheric water governance agenda are:

A. *The development of comprehensive long-term policies with a state vision for the revitalization of water in agriculture, consistent with the geographical conditions, uses, users and agricultural policies defined by countries to address the challenges of agriculture. This definition should be based on sound scientific principles, taking into account the nature of the water resource and the challenges of climate change.*
B. *The construction of an environment that favors attracting investments for the modernization of water and agrometeorological infrastructure, as well as the incorporation of new technologies, including spatial and communication technologies, as mechanisms for the efficient management of water resources.*
C. *Support from the public sector in creating the necessary conditions for the development of new innovations and for the implementation of the current state-of-the-art innovations, some of which involve georeferenced monitoring systems,*

precision agriculture and the use of new technologies for the development of varieties tolerant to water stress.

D. *Governments' push for the renewal and strengthening of education systems in agriculture, including, as a matter of priority, capacity-building programs for women, associations of producers and users of water, in order to implement policies and innovations requiring new human capabilities.*
E. *Establishment of information systems, including early warning systems, that would enable timely decision-making for designing policies and management tools and to take timely action on land, regions and production areas* (IICA 2014:56-57).

Recommendations

In order to meet the challenges of water management in the continent, IICA made a series of recommendations to the ministries of agriculture, with a view to outlining a hemispheric agenda that establishes priorities and focuses its interventions on those actions that offer opportunities for greater impacts. These are:

1. To promote the institutional strengthening of the ministries of agriculture

A necessary first step is to strengthen the capacities of the ministries of agriculture to design and implement policies and instruments for integrated agricultural water management, as well as to strengthen their capacity for dialogue, consultation and coordination with other economic sectors and with the international community. This seeks to ensure the inclusion of producers and the rural population in national policies and international agreements. It is also intended to develop and implement investment projects in irrigation and for the management and conservation of rainwater for rainfed agriculture, as well as ensuring that agricultural water is sufficient, in quality and quantity, for sustainable and competitive production of food, fiber and energy.

To comply with this recommendation, IICA proposed the following actions:

a. To analyze the current institutional structure, strengths and weaknesses, and identify the water strengthening needs for agriculture in the ministries of agriculture of IICA member countries.
b. To design, establish and execute an inter-American cooperation program for the strengthening of ministries.
c. To promote and strengthen existing regional mechanisms for the analysis and definition of common strategies for the integrated management of water resources for agriculture.

2. To promote integrated water management to achieve agricultural sustainability and address the challenges of climate change

One of the biggest challenges of agriculture is adapting to climate change to ensure sustainability. In order to achieve this, the following was proposed:

a. Strengthen and develop efficient information systems based on new technologies.
b. Regionally integrate information systems to make more accurate forecasts of hydrometeorological events.
c. Promote crop diversification, conversion and relocation projects, in order to adapt to climate change and water availability.
d. Strengthen agricultural information systems with respect to availability and allocation of water for better decision-making.
e. Promote investment in irrigation infrastructure based on performance indicators that incorporate indicators of social inclusion and environmental impact.
f. Promote investment to improve the collection, harvesting and use of rainwater in rainfed agriculture.
g. Encourage the organization of users for better water management.

3. To strengthen innovation to improve productivity of water resources in agriculture

IICA has promoted innovation as a fundamental issue to improve agricultural water productivity. It has focused its activity on four main areas of action:

i. Use of water by plants.
ii. Improvements in the use of water in plots or production units.
iii. Improvement in the piping and supply of water.
iv. Innovations in watershed management.

Efforts in all these areas will address the challenges of the physical and economic scarcity of water.

It is also necessary to increase the productivity of agricultural water to meet the demand for food, especially due to the lower availability of water resources that exists today, and which may worsen in the future. For this reason, IICA has recommended focusing the efforts of the countries in:

a. Developing and strengthening information systems and dissemination of innovations for the use of agricultural water, taking advantage of new information and communication technologies.
b. Promoting public-private partnerships to improve water use efficiency and reduce pollution of water resources.
c. Strengthening programs for the development of capacities that improve water productivity, and which are suitable for different types of agriculture and users.
d. Focusing innovation on:

   - Identifying, evaluating and disseminating indigenous and traditional technologies for the use of agricultural water.
   - Promoting precision agriculture.
   - Improving the knowledge, use and sustainability of groundwater used in agriculture.
   - Promoting biotechnology to improve water productivity.
   - Evaluating and promoting the use of alternative crops.
   - Promoting the use of recycled water.

4. To strengthen the training of human resources in the new paradigms for agriculture

All actors involved in water are required to have an adequate level of knowledge to innovate and solve the problems and challenges facing agriculture in a context characterized by market volatility, competition for water use, pollution and the effects of climate change. For this reason, IICA called on the ministers of agriculture to:

a. Promote the training of human resources in new paradigms that develop a competitive, sustainable and inclusive agricultural sector.
b. Provide producers, especially small and medium-sized producers, with skills and knowledge that improve the innovation capacities required for the development of intensive and sustainable agriculture.
c. Foster the training of a new generation of specialists in agriculture, new scientists and service providers.
d. Recognize the importance of women as a vital agent for the integrated management of water, promoting initiatives that help close gender gaps, improve the inclusion of women in decision-making and achieve full recognition of rural women's rights, including those related to property.

05

PRINCIPAL ACTIONS AND WATER PROJECTS PROMOTED BY IICA

In order to comply with the mandate of the Heads of State of the Americas, and implement the strategies and directives defined by the ministers of agriculture of its member countries, IICA has devoted itself to the task of working jointly with the governments to define and promote a water agenda.

The actions and main projects that IICA has carried out since 2011 within the framework of that agenda are described below:

2011

Mexico, Ecuador and Costa Rica

- IICA promoted the hosting of workshops in these three countries in order to validate instruments for assessing the processes for adapting agriculture to climate change at the national level, and the degree of commitment by the institutions in channeling resources to initiatives that focus on synergies between environment and agriculture.

- In Mexico the Institute supported the Senate Environmental Commission in drafting and reviewing the versions of the Draft General Legislation on Climate Change for Mexico, that was submitted for review by the Congress.

Argentina

- Within the framework of the project "Intelligent Agriculture, Carbon Footprint and Water Footprint", the document "Argentina with intelligent agriculture" was prepared, and institutional coordination began in order to establish guidelines for a national carbon imprint strategy. Furthermore, as a result of IICA cooperation, projects of that were coordinated with the National Institute of Agricultural Technology, a number of climatological data, a description of family agriculture and its production systems in three selected areas, and an evaluation of the climate information collected in Argentina are now available.
- The draft proposal for a program to promote projects for payment of ecosystem services was prepared and delivered to the Secretariat of Agriculture, Livestock, and Fisheries.

Colombia

- The demonstration phase of the Agroproduction Plan for the Riego del Triángulo de Tolima District was conducted, during which 66 hectares were selected among the small producers to implement the plan. Property irrigation systems were constructed and 14 crops were planted in order to evaluate their agronomic and economic behavior.

Ecuador

- The Institute provided technical cooperation to the Vice-Ministry of Agriculture to prepare the proposal for the National Irrigation Plan. Additionally, a course on risk management and early warning systems was given in the province of Pichincha.

Costa Rica

- There was collaboration with the Ministry of Agriculture and Livestock of Costa Rica in the formulation of the base document of the project "Water for Guanacaste, Costa Rica." The statements made in this document take into account the concepts of ecosystem approach, watershed management, and integrated management of water resources.

Honduras

- The Institute participated in the creation of the National Agriculture Adaptation Node to Climate Change.

Barbados

- Technical demonstrations were carried out on the effective use of iron-cement tanks for water collection and storage, which is a more practical and economical alternative for the agricultural community.

Saint Kitts and Nevis

- The Department of Agriculture implemented the Plan of Action for Water Management, which was designed with support from IICA, and which has led to the inclusion of natural resources management into the development strategies for the country.

Saint Lucia

- Water collection was promoted in schools as a means of promoting the rational use of water in agriculture and as a teaching tool in natural science programs in the schools.
- After hurricane Thomas, the Disaster Recovery Plan for Saint Lucia was formulated in collaboration with ECLAC.

2012

Argentina

- IICA contributed to increasing the development potential of the food and agriculture sector in several provinces through: a) conducting feasibility studies for 15 project profiles for public investment in infrastructure as well as production and commercial development, coordinated with the governments of ten provinces; b) evaluation of 25 provincial project profiles; c) updating of

six provincial strategies for livestock development within the framework of the agreement between IICA and the Provincial Agricultural Services Program of the Ministry of Agriculture, Livestock, and Fisheries; and d) the formulation of the advanced profile of the Integrated Water Resources Management and Development Program of the Southern Region and the Province of Buenos Aires, as well as plans and projects for development and territorial activation.

Brazil

- The Institute helped to reduce deficiencies in the articulation and coordination of public institutions within the water sector in two territories with low development indexes, thanks to which there was increased efficiency in the use of water and in the delivery of water supply services, as well as in the quantity, quality and sustainability of the supply.

Honduras

- IICA collaborated in strengthening the technical capabilities of the government authorities responsible for integrated management of irrigation and drainage, and who are in charge of spearheading the preparation of the National Irrigation Plan.

2013

Argentina

- Nearly 160 staff members and technical personnel from public and private institutions in the food and agriculture sector, producers and sectoral stakeholders were trained in climate change impact on agriculture and regulations regarding carbon and water footprint applied to the international trade in food and agriculture. Additionally, studies were made available to them to help in the formulation of a national strategy with regard to climate change and agriculture. Studies were also conducted on climate and water, which contributed to strengthening the management of natural resources by the institutions both at the national and local government levels.

Brazil

- IICA supported the program "Water, food for the land" for the systematization and analysis of the research findings for "Water for a new agriculture in the Americas."
- Technical management was done to implement the program InterÁguas with the ministries of the Environment and National Integration and the National Water Agency.

Costa Rica

- The Institute collaborated with the National Animal Health Service and the Secretariat of Sectoral Agricultural Planning in policy-making, strategies and action plans in the areas of irrigation, drainage and use of water in agriculture, as well as integrated management of water resources.

Haiti

- IICA promoted, within the framework of an integrated farm strategy, the use of technologies that improve feeding and increase earnings in family agriculture. To that end, agricultural modules and covered orchards were established and facilities were constructed for the collection of water, and reservoirs for rainwater storage and fish farming in polyculture systems.

Suriname

- The Institute provided training in irrigation systems that made it possible to strengthen extension services. 38 extension workers from the Ministry of Agriculture were trained in the introduction of irrigation systems for greenhouses in order to mitigate the impact of climate change, improve management systems for agricultural water and increase productivity by eliminating seasonal variations.

Venezuela

- IICA strengthened the capacities of national institutions in topics relating to the management of water, climate change and food security, and partnered with the Venezuelan Agriculture, Forestry, and Grazing Land Network, thanks to which it

promoted agricultural adaptation to the effects of climate change and mitigation of the effects of production activity on the environment.

2014

Argentina

- IICA technical cooperation made it possible to address with the government agencies topics of interest for Argentine agriculture such as production of bioinputs, strengthening of plant and animal health services and area-based management, by focusing on localized food and agriculture systems, knowledge management for food security and management of water resources. Furthermore, IICA participated in activities against desertification and drought in the Calchaquíes Valleys of Argentina.

Bolivia

- Bolivian agriculture benefited from IICA through various actions and projects related to the following topics: knowledge management for food security, good agricultural practices and management of water resources, among others.

Uruguay

- IICA partnered in a series of technical events to strengthen the capacities of staff members of the Ministry of Livestock, Agriculture and Fisheries and of other institutions in the livestock sector of Uruguay. The following topics were addressed, among others: policy design and evaluation, risk profiles in food, ecology of grasses, food safety management, family agriculture, rural extension, water management and value-added.

Paraguay

- Within the framework of the Executive Core Project that IICA co-finances, two rainwater harvesting systems adapted to the Chaco area were put in place, each with a storage capacity of 70 million liters for drinking water and livestock production. In addition, there is a proposal to establish the baseline for interventions in integrated water and soil management.

Mexico

- The Government of Mexico and IICA carried out a program for strengthening capabilities in agriculture, through which 295 technical personnel from 15 Caribbean countries were trained in protected agriculture, rural tourism, family and backyard agriculture, protection of soil and water, plant pathology and sheep production, which are areas of great importance for the development of Caribbean agriculture.

Suriname

- IICA Technical cooperation with Suriname included activities related to the integrated management of water and soil, natural disaster preparedness, risk management and agricultural insurance, among others.

Saint Kitts and Nevis

- IICA assisted in the training of farmers, extension workers and students for the adoption of new shade production technologies, with improvement in land and water efficiency.

Guyana

- In Guyana, IICA collaborated with the country´s School of Agriculture for training in the operation of two bio-digestors with the aim of reducing animal water pollution and obtain benefits from alternative energy sources.

Panama

- The Institute assisted the Panamanian agricultural sector in promoting training in topics such as integrated water management, biotechnology and biosafety, knowledge management for food security, fair trade and tourist development.

Honduras

- Innovations are being in promoted in Honduras for sustainable development of the rice- sector, through a strategy of competitiveness and a medium- and long-term investment program. Both proposals include topics on water and soil management, seed production, infrastructure and equipment, innovation, and capacity building.

Peru

- The Institute increased the capacities of approximately 3500 people who participated in 30 technical events related to forestry innovations, access to and use of water, renewable energies in agricultural activities, rural habitat, environmental water services, good agricultural practices, management of chains and territories.
- IICA technical cooperation carried out other actions on behalf of Peruvian agriculture related to institutional innovations in support of family agriculture, integrated water management, knowledge management for food security, training of plant health inspectors and climate change, among other topics.

Venezuela

- With regard to gender-focused cooperation, support was provided by IICA and the Nestle company to 217 women from ten communities the area of influence of that company to strengthen their capacities in storage, use and quality control techniques for integrated water management.

Nicaragua

- As part of the Institute's multinational projects, activities were carried out to build capacities and strengthen institutions with regard to bio-inputs, knowledge management, monitoring of veterinary drugs and integrated water management.

Barbados

- IICA supported increased capacity building for the Ministry of Agriculture, the Saint George's Farmers' Cooperative, the Organic Producers Association, the Consumers Association and private sector individuals in order to promote and apply measures for adaptation to climate change and increased resiliency through initiatives in organic production, water management, protected agriculture and permaculture.

Saint Lucia

- The Institute, in collaboration with the Australian International Development Agency, donated pure breed goats and sheep to the members of the Small Ruminants Cooperative Society, as well as an irrigation pump to members of the Pineapple Growers Cooperative Society to supply irrigated water to their demonstration plot.
- Furthermore, in collaboration with FAO, assistance was offered to the Ministry of Agriculture, Food Production, Fisheries, Cooperatives and Rural Development for the rehabilitation of five kilometers of agricultural drains and eight kilometers of river, through the planting of trees and engineering works following the destruction caused by a storm in December 2013.

Brazil

- IICA contributed to consolidation of the National Agenda for Integrated Management of Water Resources, through the Water Sector Development Program InterÁguas, which was co-financed by the World Bank, with a view to achieving greater articulation and coordination between stakeholders in the sector by promoting integrated management of inter-sectoral water resources. In this regard, IICA signed a technical cooperation agreement with the Ministry of National Integration (MIN), the Ministry of the Environment (MMA), the Ministry of Cities (MCID) and the National Water Agency (ANA) for matters such as reuse of water and safety of dams.

Saint Vincent and the Grenadines

- IICA and FAO established collaboration in an effort to recover, clean and rehabilitate three watersheds, including improvement of forest systems.

2015

Several countries

- 940 producers, civil servants and academics from 16 countries were trained in integrated management of water resources, water irrigation and harvesting systems, integrated waste management and soil degradation.

Bahamas

- Progress and innovations were explored through research on aquaponics in order to improve methodological and knowledge tools as an option for areas with

problems of access to good soil and water. In collaboration with Earth University, IICA conducted research via two projects implemented by the Aquaponics Research Center.

Costa Rica

- In partnership with the National Groundwater, Irrigation and Drainage Service, through the utilization of a methodological tool for the preparation of productive development plans and better management of water resources in agriculture, a strategic plan for productive development was formulated for the 8800 hectares comprising the zone for expansion of the Southern Canal of the Arenal-Tempisque Irrigation District.

Guyana

- IICA facilitated the reopening of the Tapakuma cassava processing factory, which serves as a model for income generation in rural communities. This facility will serve the cassava producers in Tapakuma and neighboring communities. The Institute also contributed its technical know-how for engineering distribution from the factory, training in food security, management of the organization, water catchment for the farms and record-keeping. Additionally, IICA prepared the business plan to seek funding for renovating the facilities and supervised the work.
- The IICA Delegations in Guyana and Suriname, together with producers and processors from Caridad, Sirikie, Tapakuma, and Mainstay, shared experiences in water collection as well as negotiation and strategic planning.
- A regional workshop was held on integrated water management with Caribbean technical personnel in order to discuss best practices in water collection and management, climate change and family agriculture. The participants shared experiences and visited the Demerara Conservancy and the Hope Canal, which are examples of rain water catchment and drainage techniques utilized in Guyana for the urban areas and agriculture.

Paraguay

- Within the framework of the joint cooperation activities between the European Union and IICA, management of the water resources in two municipalities of el Chaco was improved, through the provision of water supplies for household and agricultural use, following the implementation of a rainwater harvesting project. The technical capacity to install and maintain drip irrigation systems was also increased.

Suriname

- 32 persons in Suriname and 26 in Guyana participated in horizontal cooperation programs organized by the delegations of IICA in both countries. Support was provided for the joint programming of workshops on water and risk management, communication and mitigation. Furthermore, in Tapakuma (Guyana) and in Brokopondo and Ovia-Olo (Suriname), joint workshops were directed toward groups of indigenous women producers, and focused on project development and on the exchange of best agricultural practices.

Honduras

- The Secretariat of Agriculture and Livestock and the Secretariat of the Environment have the profile of a project to develop the National Irrigation and Drainage Plan, in collaboration with national institutions and international cooperation agencies linked to management and use of water for agricultural irrigation.

Peru

- Within the framework of the project “Knowledge management and institutional capacity development to promote the comprehensive management of water in family agriculture”, more than 100 producers, technical personnel and professional leaders of the public and private institutional framework in Costa Rica, Nicaragua, and Peru strengthened their capabilities through training activities carried out in those countries and in Spain. Training materials and an inventory of water management technologies in family agriculture, a profile of competencies and the curriculum for training promoters were also generated.

Uruguay

- IICA collaborated in the systematization of experiences on the new institutional framework for water in Uruguay, related to the process of establishment and

functioning of the regional water councils and the watershed commissions put in place under the constitutional reform of 2004.

Venezuela

- Within the framework of improving the capacities of institutional and community stakeholders for social area-based management with gender inclusion, the Institute contributed to strengthening the capacities of 243 people in eight communities in the area of influence of Nestle Venezuela S. A., in techniques for the conservation, use, quality control and local management of water.
- Along with its strategic partners including the Universidad Centroccidental Lisandro Alvarado, IICA managed to elevate the topic of water and carried out two symposia in this regard.
- In strategic partnership with Nestle Venezuela, the Institute strengthened capacities in the application of a methodology for the intensive rice cultivation system and in the use of more efficient techniques to improve water consumption and yields, which benefited producers in the central plains of Venezuela.
- IICA contributed to the conceptualization and characterization of family agriculture in Venezuela, as a result of capacity building in family farming for food production, job creation, environmental preservation, rural tourism, and the social management of territories and water resources, benefiting 120 people within the public, private and community sectors.

Barbados

- The Ministry of Agriculture, Food and Water Resources Management boosted its ability to conduct demonstrations on the application of technologies and innovations in the protected agriculture systems. Personnel from that ministry benefited from a program implemented by IICA, the Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food of Mexico and the Regional Center for Comprehensive Services in Protected Agriculture, within whose framework experts in protected agriculture conducted a course on greenhouse operation and management of protected agriculture systems.

Canada

- Through the Research and Internship Assistance Program, IICA supported knowledge generation in Argentina, Uruguay and Canada on the use of synthetic radar opening to identify snow-covered areas for water use, in addition to the optimization of a technique for early detection of the Nosema ceranea infection in the colonies of hibernating honey bees.

Saint Vincent

- The Institute conducted demonstrations of water harvesting for extension workers and consultants from the Ministry of Agriculture, who now have more knowledge and tools to train farmers in the principles and practices of climate smart agriculture.

Trinidad and Tobago

- A project relating to an agricultural communication protocol enabled all the stakeholders in risk management to work together, with guidance from IICA, in the provision of timely and relevant information to farmers and other institutions participating in risk management in the agricultural sector, so that they can be better prepared to deal with extreme climatic conditions. Additionally, workshops were held on risk detection, leading to an improvement in the capacities of staff members of the Disaster Preparation and Management Agency, the Ministry of Agriculture, Lands and Fisheries of the meteorological services of the country; the University of the West Indies; the Environmental Agency; the Water Resources Agency and two farmers' organizations.

06

MAIN SUCCESS STORIES IN WATER PROJECTS PROMOTED BY IICA

In collaboration with the governments of the countries of the Americas, academic and research institutions and other international cooperation agencies, IICA has promoted several relevant water projects with high impact in the countries and regions. These developments include:

1. PROJECT ENTITLED "THE DEVELOPMENT OF IRRIGATED AGRICULTURE IN BRAZIL IN SUSTAINABLE SCENARIOS"

The purpose of this project is to strengthen and expand irrigated agriculture with the intervention of the National Ministry of Integration. Specifically, its purpose is to implement and develop actions within the federal government to strengthen and expand irrigated agriculture in a sustainable manner. The agreement for the execution of the project was signed on March 12, 2008, with an initial estimated time period of 48 months, which was later extended until 2014.

Historically, the management of irrigated agriculture in Brazil was characterized by the vulnerability of the institutions in charge of running it. This had affected the concept design and implementation of sustainable policies, programs and projects for the irrigated agriculture sector, conceived and implemented by the irrigation subsector without seeking to include the public and private sectors, tertiary sector organizations and sectors involved in the topic of irrigated agriculture.

Within this context, the Ministry of National Integration decided to create a favorable environment for discussions and knowledge exchange concerning the potential of irrigated agriculture to promote development in Brazil. With the goal of advancing food security, social inclusion, job creation and income generation in the rural environment, new paradigms had to be created for irrigated agriculture.

This technical cooperation project (TCP) has a key role to play in achieving this goal, since it was conceived on the basis of new strategies, methodologies, mechanisms and tools that streamline irrigated agriculture in a sustainable manner.

Promoting irrigated agriculture is one of the strategies of the federal and state government to minimize the vicious cycle of poverty, with great potential to generate income in the rural areas of Brazil.

This TCP covers several dimensions including sustainability (economic, social, political, cultural, environmental, institutional and social management), and political organization and participation. Likewise, it seeks to promote cooperation networks to generate knowledge, recover traditional wisdoms and promote technological innovation.

The main actions carried out by the TCP include:

- Planning and executing the National Seminar on Irrigated Agriculture and Sustainable Development, held in 2009, with more than 368 participants, including local authorities and experts. The conclusion of the meeting stated the need to reposition irrigated agriculture in the current scenario of sustainable, economic, environmental and social development and at the same time, strengthen the Ministry of National Integration as the entity in charge of agricultural irrigation policies.
- Creation and consolidation of the Permanent Forum for Irrigated Agriculture. This forum is a space to exchange, articulate and disseminate technologies and experiences, and a support mechanism for knowledge management and cooperation for irrigated agriculture.
- Creation of the technical report used as a basis to consolidate the National Research and Irrigated Agriculture Program.
- Creation of the technical report used as a basis to consolidate the National Program of Technology Transfer, Technical Assistance and Rural Extension in Irrigated Agriculture.
- Creation of the technical report used as a basis to consolidate the National Program of Education and Training in Irrigated Agriculture.
- Creation of the Irrigated Agriculture Master Plan in the State of Minas Gerais, with a methodology that must be used in the creation of the National Irrigated Agriculture Master Plan and other state regulations.
- Execution of statistical studies for irrigated agriculture in Brazil.

These actions were developed with the creation of the National Irrigation Secretariat and the Irrigation Policies Department in May 2011. These improvements have been essential to consolidate institutions and policies focused on irrigated agriculture in Brazil, and will have a strong impact on social development and to address the lag experienced by the poorest rural sectors in the country.

The original budget allocated for the project was 21 million BRL, which was later adjusted to 12 million. The totality of these resources were granted by the Ministry of National Integration.

The main goals and products expected from the TCP are described below:

Immediate goal 1: To develop planning and structural development tools to improve the contribution of the Federal Government to the development of irrigated agriculture.

- Product 1.1: Federal Proposal for Structuring the Irrigated Agriculture Support System.
- Product 1.2: Permanent Forum for Sustainable Development of Irrigated Agriculture, designed and structured.
- Product 1.3: National Information System for Irrigated Agriculture, designed and structured.
- Product 1.4: National Program of Education and Training on Irrigated Agriculture.
- Product 1.5: National Research and Development Program.
- Product 1.6: National Program for Technology Transfer, Technical Assistance and Rural Extension in Irrigated Agriculture.
- Product 1.7: Studies on the potential of irrigated agriculture, environmental impact assessments and other necessary compensatory measures.

Immediate goal 2: To develop management tools to consolidate the participation of the National Ministry of Integration in professional training, assimilation of knowledge and technology and the necessary surveillance and evaluations to improve the quality and productivity of the national irrigation system.

- Product 2.1: Farmers, technical experts and professionals of the irrigated agriculture supply chain, trained and qualified.
- Product 2.2: Research and development in the irrigated agriculture production chain, and proposals made to this end.
- Product 2.3: Technology transfer, technical assistance and rural extension in irrigated agriculture, used and applied.
- Product 2.4: Technical and operative management, follow-up and evaluation of the cooperation project developed, and technology applied.
- Product 2.5: Other additional instruments for managing irrigation perimeters, developed and applied.

2. PROJECT ENTITLED "INSTITUTIONAL STRENGTHENING AND DEVELOPMENT OF THE WATER SECTOR WITHIN THE MINISTRY OF NATIONAL INTEGRATION: WATER INFRASTRUCTURE, IRRIGATION AND CIVIL DEFENSE (WATER SECTOR DEVELOPMENT PROGRAM - INTERÁGUAS)"

Issues of concern

Brazil has one of the largest freshwater reserves in the world, an invaluable natural resource. However, the problems associated with the distribution of water in space and time, together with the contamination caused by the massive concentration of population in urban centers, are both significant challenges.

The imbalance in water distribution is illustrated by the fact that the Amazonian region, with a very low population density, contains 80 % of the total freshwater available in Brazil, and states located in semiarid regions only have 4 % of the national water resources and are home to 35 % of the total population of the country.

Some of the biggest concerns in Brazil include water scarcity in semiarid regions, contamination of rivers that cross the cities and frequent floods that cause severe damages. Likewise, a large part of the irrigation systems, water supply and sewage networks are expensive and inefficient.

In terms of water resources management, Brazil is divided into 12 hydrographic regions: I) Amazonas II Hydrographic Region; II) Tocantins-Araguaia Hydrographic Region; III) Northwestern Atlantic Basin; IV) Parnaiba Hydrographic Region; V) East-Northeast Atlantic Basin; VI) San Francisco River; VII) Eastern Atlantic River Basin; VIII) Southeastern Atlantic Basin; IX) South Atlantic Basin; X) Uruguay Hydrographic Region; XI) Paraná Hydrographic Region; and XII) Paraguay Hydrographic Region.

Studies carried out reveal that the regions in most critical condition are the ones in the Northeast Atlantic, due to scarce rainfall and high evaporation, and the ones in the South Atlantic, caused by irrigation demand. For the rest of the regions, the mean values show a favorable ratio between water availability and demand.

Brazil has a large amount of available water, but its distribution in time and space is not uniform. This availability accounts for approximately 14-19 % of the fresh water circulating on the planet's surface, of which 80 % is concentrated in the Amazon region. The semiarid region of the Northeast, on the other hand, has a very low relative amount of water available when compared to the Amazon region.

In order to address these issues, the Government of Brazil designed the Pluriannual Federal Government Plan (PPA, 2012-2015), which includes the following programs: a) Water Supply Program, b) Irrigated Agriculture Program, c) Risk Management and Disaster Response Program, and d) Water Sector Development Program (InterÁguas).

The Water Supply Program highlights the importance of adopting comprehensive measures to improve water resources management and increase water availability to cover human needs in regions with a water deficit, thus addressing the growing need for water in the agricultural, industrial and service sectors.

The Irrigated Agriculture Program takes into account that the increase in agricultural productivity is strengthened by the inclusion of other techniques such as irrigation and drainage, which help control available water for crop development.

In Brazil, only 5 % of the cultivated area is irrigated, covering 15 % of the total food production. Worldwide, 18 % of cultivated land is irrigated, where 56 % of the food is produced.

The Northern and Central Western Regions have the greatest potential for agricultural development based on irrigation and drainage techniques. In order to leverage this potential, it becomes necessary to modernize national irrigation policies so that effective investments can be made based on the National Irrigation Plan, with the support of an adequate institutional structure for managing these policies.

The Risk Management and Disaster Response Program addresses the issue of disasters caused by the most common natural phenomena in Brazil, namely floods, landslides, droughts and windstorms. Floods have the greatest impact on the urban population due to the density of these areas, most of which are located near the shores.

The program

Its purpose is to create an integrating environment to enable the continuity of successful sectoral programs such as the Sanitation Sector Modernization Program (PMSS) and the National Water Resources Development Program (PROAGUA). It also seeks to strengthen intersectoral articulation for more efficient use of water and related services. This is a project developed jointly by the Ministry of National Integration (through the Water Infrastructure Secretariat and the National Irrigation Secretariat), the Ministry of Environment and Cities, and the National Water Agency.

The project is based on the following premises:

- Water is essential for socioeconomic development, and many sectors, directly or indirectly, depend on water products. For this reason, it becomes necessary and relevant to move forward in the specific context of each sector and strengthen intersectoral articulation and coordination.
- Although in recent years there has been significant progress in the institutionalization of legal and operational instruments, the areas of water management and other associated services in Brazil have always been affected by disparities and conflict at the federal and state levels, in sectors competing for the same resource and in the regions and units of the Federation. This compromises the efficiency and efficacy of the water sector and the resulting government actions.
- It is therefore necessary to strengthen the institutions dedicated to creating and implementing water management policies, including those in charge of sectoral water policies, in order to achieve sustainability in the region.
- The region must also promote proper regulation, oversight, planning and social control, so that the goals established based on these practices can be the same goals set for service providers and institutions, to ensure the sustainability of investments.
- Large government investments have been made in the water sector; however, many works were projected and executed without proper planning for the multiple uses of water, which resulted in undesired effects such as conflicts or potential conflicts between the different users, and in the underuse of these resources. (ANA s. f.:1-2).

Given the magnitude of the problem, the InterÁguas program will have national coverage, paying special attention to priority areas and issues in which water plays a key role in sustainable social and economic development, particularly in underprivileged regions, to help reduce regional inequalities. In this sense, the Northeast region is expected to receive more attention, as well as the least developed areas of the North and Midwest, where government actions are relatively more necessary. In this sense, the program will focus primarily on having a more concentrated and integrated operation in the basins of the San Francisco and Araguaia-Tocantins rivers.

Objective

The objective of the program is to strengthen the planning and management capacity of the water sector, especially in the least developed areas of Brazil. It also seeks to 1) increase the efficiency of water use and service provision; 2) increase the sustainable supply of water of adequate quality and quantity for multiple uses; 3) improve the allocation of public resources in the water sector, thus reducing losses caused by poor articulation and coordination between sectors.

Specific objectives

- To improve intersectoral articulation, focusing on improving the compatibility between water resources planning and users and regional, state and national plans, thus contributing to a more rational and integrated use of water resources to achieve sustainable development.
- To contribute to the consolidation of the National Water Resources Management System, with the consolidation of management tools established by the National Water Resources Policies, as well as the institutional strengthening of entities and users of water resources at the federal and state levels.
- To evaluate and develop methodologies for adequate management of water resources for the different physical, biotic, demographic, economic, social and cultural regions of Brazil.
- To support the implementation of systematic and systems-based management of water resources, taking into account superficial and underground water resources in an integrated, decentralized and participatory manner.
- To promote better structures and the institutional strengthening of basic sanitation services, as a way to ensure proper financial and institutional sustainability, including higher efficiency of service providers and administrative assessment through studies, research, education, training and information systems.
- To provide technical support to the National Secretariat of Environmental Sanitation of the Ministry of Cities, in its mission to implement the Basic Federal Sanitation Policy, create the necessary conditions to establish the National Basic Sanitation System (SINISA) and promote new organizational and management models for sanitation services, fostering associated management through public consortiums.
- To establish control mechanisms and disciplinary regulations as a reference for managing services and strengthening regulations, oversight and social control of sanitation services.
- To consolidate the technical and operational capacity of municipal and state bodies in charge of managing and implementing basic sanitation actions, as well as creating studies, projects and basic sanitation plans.
- To promote health and environmental education, as well as social mobilization for sanitation and water resources.
- To support the planning and development of mechanisms for the implementation of the National Water Infrastructure Plan.
- To support the viability and consolidation of the National Irrigation Policy.
- To provide technical support to the National Secretariat of Civil Defense in its mission to implement the National Civil Defense Policy.
- To support the creation of a risk management plan for disasters, including their identification and monitoring and the creation of a warning system and an emergency response plan (ANA s. f.:4-6).

Structure

InterÁguas is primarily a technical training program focused on water planning and management, institutional strengthening, development of studies and projects, and promotion of investments in infrastructure.

Components

In order to meet its goals, the program is divided into four sector-based components:

1. *Water resources management:* These actions will be implemented by the National Water Agency and the Secretariat of Water Resources and Urban Environment of the Ministry of the Environment, the general purpose of which is to support the consolidation of the National Water Resources Management System and support the Union, the States and the different water resource entities in order to create, perfect, modernize and qualify management instruments.
2. *Water, irrigation and civil defense:* These actions will be carried out by the Secretariat of Water Infrastructure, the Secretariat of Civil Defense and the National Secretariat of Irrigation of the Ministry of National Integration, with the general objective of achieving institutional strengthening and strategic and operational planning in the areas of water infrastructure, irrigation and civil defense.
3. *Water supply and sanitation:* These actions will be carried out by the National Secretariat of Environmental Sanitation of the Ministry of Cities, to enable continuity for actions included in the Sanitation Sector Modernization Program, and support the Secretariat in its mission to implement the Basic Federal Sanitation Policy, promoting the development of the sector to improve quality and achieve universal access to basic sanitation services.
4. *Intersectoral coordination and integrated planning:* This component supports the integrated planning of the water sector, identifying areas of mutual interest, overlaps and conflicts in specific sectoral plans with an impact on water, or that depend on this resource. This component also supports the carrying out of studies, the institutional development of multiple sectors and the management and conservation of water resources, particularly in the basins of the San Francisco and Araguaia-Tocantins rivers.
5. *Management, monitoring and evaluation:* This component seeks to monitor and evaluate the program's actions, to ensure that objectives are met, schedules are followed and general and specific goals are achieved.

Cost of the Program: The total sum for the project is USD 143.1 million, and the investment will be made over five years. 75 % of these resources (USD 107.3 million) come from the World Bank. The rest (USD 35.8 million) is provided by the local counterpart.

Expected results

With respect to the management of water resources, the expectation is to continue implementing water resources management instruments and strengthen the National Water Resources Management System, eliminating disparities between the Federal Government and the states, unifying procedures and establishing criteria for ongoing institutional evolution that can help expand government efficiency to implement policy guidelines for water resources.

With respect to Component 2, Water, Irrigation and Civil Defense, the program will help consolidate the planning and programming of public investments in water infrastructure, irrigation and civil defense, to make the actions of the federal government more efficient in these areas. Likewise, it will seek to strengthen those institutions in charge of the operation and conservation of water infrastructure, and bodies responsible for civil defense, in the case of extreme climate events, by proposing management models for public irrigation systems and creating an information system for risk management associated with extreme weather events.

With respect to Component 3, the main expected results are the following: a) positive evolution of basic sanitation management services; b) improvement in performance indicators and quality of sanitation services; c) positive progress for health indicators among the population; d) increased efficiency and efficacy of these services, which are essential to achieving universalization with quality and sustainability; e) conservation cost reduction; f) improved accessibility to public goods and services in the area of basic sanitation; g) more qualified public and private agents in the sector; h) more educated and trained professionals in the sector; i) higher qualifications in health and environmental qualifications; j) mobilization and social participation in sanitation and k) better integration and articulation between programs, actions and policies for basic sanitation.

Finally, for component 4, the main expected result is the creation of a proper environment for permanent intersectoral articulation, where water-related issues can be addressed in an integrated manner so as to contribute to the rationalization of public spending in the sector and promote efficiency in water use and associated services (ANA s. f.:5-9).

IICA participation

IICA is strongly invested in this project, and participates by providing technical cooperation. The Institute supports the Ministry of National Integration in executing integrated water management and planning actions and strengthening its technical, institutional and operational capacities as set forth in loan agreement number 8074-BR, signed between the Brazilian government and the World Bank to execute the Water Sector Development Project - InterÁguas.

The purpose of these actions is to ensure a more effective and efficient performance by the Ministry of National Integration in the areas of water infrastructure, irrigation and civil defense. IICA has acted as a partner to materialize the project by providing support in the organization of seminars and technical meetings about InterÁguas and reviewing processes to contract specific services including personnel and legal experts, as well as the technical assistance provided according to the terms of reference.

The goal of IICA's participation is to support the Ministry of National Integration in the coordination and strengthening of its capacities to define, plan and execute initiatives (studies, plans, programs and projects) in the water sector, with an integrated approach to problems and solutions identified.

Specific objectives

- Contribute to knowledge improvement in the Ministry of National Integration with regard to the definition, planning, execution, conservation, operation and maintenance of water infrastructure works.
- Provide subsidies for the development of a regulatory framework and a management framework capable of bringing together irrigated agriculture, planning and management in the water sector.
- Identify and propose preventive solutions for potential risks including natural disasters and public catastrophes.
- Develop methodological proposals, guidelines and approaches focused on the coordination and management of activities, institutional intersectoral coordination, integrated planning, follow-up, and internal evaluations within the Ministry of National Integration through capacity development.

Beneficiaries

The project involves a series of initiatives aimed at promoting cultural changes and stimulating and strengthening the social capital of stakeholders. In this sense, it may include issues such as water infrastructure, irrigation and civil defense. It is also conceived as an initiative that promotes integrated management of water supply and demand in urban and rural areas, in the context of specific situations associated with climate and climate change.

The project is particularly beneficial for: urban and rural populations in wide areas of Brazil; large and small-scale farmers of the agroindustrial chain, especially those working with irrigated agriculture; populations affected by or subject to weather events; federal institutions participating in the management of programs and projects related to the water sector; technical experts from the public and private sectors involved in the issue of water infrastructure, irrigation and civil defense; private and public companies providing technical assistance to the agricultural sector; potential investors in agribusiness; agroindustrial exporting companies; the Ministries of Integration, Agriculture, Livestock and Supply, Environment and Agricultural Development; and national and regional development agencies and associated entities.

This collaboration project directly benefits the states, municipalities, and federal institutions associated with the water sector, supporting them in the consolidation of their technical and institutional capacities, which in turn improves planning and management in the water sector.

3. PROJECT ENTITLED ''SUSTAINABLE AGRICULTURE, FOOD SECURITY AND CLIMATE CHANGE IN LATIN AMERICA: CAPACITY BUILDING FOR KEY PLAYERS TO ADAPT THE AGRICULTURAL SECTOR TO CLIMATE CHANGE AND MITIGATE ITS EFFECTS''

Climate change is already one of the greatest risk factors for agriculture in Latin America and the Caribbean (LAC). With acceleration of soil degradation, increased loss of biodiversity, and reduction of agricultural production, the region has also experienced the aggravating factor of more greenhouse gas emissions in the agricultural sector. The responses to this challenge have been limited; however, traditional wisdom and the innovation potential of the sector can make a positive contribution to climate change adaptation and mitigation of greenhouse gas emissions by reducing agricultural emissions and through carbon sequestering in productive systems.

With the purpose of further mitigating the effects of climate change in LAC, IICA and the European Union, together with the EUROCLIMA program, developed a project entitled Sustainable Agriculture, Food Security and Climate Change in Latin America: Capacity strengthening of key players to adapt the agricultural sector to climate change and mitigate its effects.

The goal of the project is to help reduce poverty among the rural populations of Latin America by decreasing their environmental and social vulnerability in the face of climate change. Likewise, it seeks to reinforce the region's capacity to recover from the effects of climate change and promote opportunities for green growth. In order to achieve these goals, the project devises integrated strategies and mitigation and adaptation measures against climate change, in policies and public development plans at the national and (sub)regional levels in Latin America.

More specifically, the project seeks to contribute to food security by strengthening the capacities of key players to adapt the agricultural sector to climate change and mitigate its effects. The total cost of the project was initially 1,590,000 Euros, a sum that would cover 18 countries in Latin America: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay and Venezuela.

The project will be executed over a period of 36 months. It was signed in December 2013 and began in January 2014. The counterparts of each country are the Ministries of Environment and Agriculture.

Main activities and results

- Main activity 1.1: Identifying, systematizing and documenting model studies concerning the impact of climate change on agricultural systems.
- Main activity 1.2: Identifying, systematizing and documenting good practices to adapt to climate change and mitigate greenhouse gases (GHGs) in the agricultural sector, according to the different biophysical and socioeconomic conditions and including practices based on traditional wisdom.
  - Result 1: Officials and technical experts of the agricultural sector and other relevant sectors have access to systematized, validated adaptation and mitigation measures against climate change, as well as biophysical and socioeconomic conditions.
- Main activity 2.1: Organize, implement and document regional and sub-regional workshops.
- Main activity 2.2: Organize, implement and document virtual courses.
  - Result 2: The technical capacities of focal points and their technical teams in member countries of the EUROCLIMA program, and officials and technical experts from the agricultural sector have been strengthened with respect to the knowledge and implementation of good agricultural practices and appropriate technical innovation.
- Main activity 3.1: Designing the interactive database.
- Main activity 3.2: Publishing and validating the interactive database.
- Main activity 3.3: Publishing results from studies and workshops in the interactive database, and keeping it updated.
  - Result 3: Focal points of the member countries of the EUROCLIMA Program, officials and technical experts in agriculture and other relevant sectors use the interactive database on agriculture, food security and climate change, and exchange information with other institutions.

Beneficiaries

- Direct beneficiaries: Focal points of member countries of the EUROCLIMA Program and their technical staff; officials and experts of the agricultural sector, and other associated sectors; the academic and scientific sector associated with agriculture and climate change; and the private sector.

- Indirect beneficiaries: Farmers and their families through access to technology, information and resources that enable adaptation to climate change and emissions reduction; other stakeholders of civil society concerned with the issue of climate change, through access to information and management capacity building; the general population in the beneficiary countries who are interested in the issue of climate change.

Long-term impact

The main achievement expected from the project is to advance sustainability and achieve lasting effects that will extend beyond the intervention per se; also, to establish the proper conditions for these achievements to be sustainable and resistant to the risks they may be exposed to.

In the case of the EUROCLIMA/IICA-UE project, results are expected to be highly sustainable. IICA will create a "sustainability strategy" for this component, which will include specific actions to achieve sustainability, such as practical commitments or inter-institutional agreements with member countries.

The strategy will focus on the sustainability of all results generated by the component for the agricultural sector under IICA's responsibility. At the end of the project, inter-institutional commitments must be in the process of execution in at least six countries.

Upon completion of the EUROCLIMA/IICA-UE project, IICA must be able to move sufficient resources to support the countries and transfer and implement practical, innovative technologies concerning issues of adaptation, aimed at improving productivity and sustainability in the agrifood sector, thus ensuring the implementation of good practices and tools recommended by the project. In key issues of the Cross-cutting Coordination Program on Agriculture, Natural Resources Management and Climate Change, IICA has been involved in the design of programs and projects regarding climate change and agriculture, in order to position these topics in national agendas and identify more environmentally-friendly production methods.

The project involved cooperation actions aimed at raising awareness of the need to use water more rationally, including the Smart Agriculture Program (Argentina), the Intergovernmental Technical Cooperation Program for Land Management of Processes for Adaptation of Agriculture to the Effects of Climate Change (Mesoamerica), the General Climate Change Act (Mexico), a range of different irrigation plans in Colombia and Costa Rica, and agroforestry plans in Haiti, Ecuador and Peru.

4. PROJECT ENTITLED "STRENGTHENING WATER RESOURCES MANAGEMENT AND IRRIGATION SYSTEMS FOR FAMILY FARMERS IN THE CHACO OF PARAGUAY, ARGENTINA AND BOLIVIA"

Cost: USD 113,200
IICA Resources: USD 110,500
Duration: 18 months
IICA work teams

- IICA Delegation in Paraguay
- IICA Delegation in Argentina
- IICA Delegation in Uruguay
- IICA Delegation in Bolivia (Project Coordinator)

Problem and context

Three main challenges affect the Chaco region. The first one is the need to transform agriculture by creating conditions to promote inclusion for family farming and strengthen local and national markets; the second one is the development of agriculture and rural populations; and the third one involves achieving clean farming and protecting natural resources, preserving the productive potential and using water more efficiently.

The region is characterized by low, irregular rainfall, and this has led to the implementation of actions focused on water management and water harvesting methods, well drilling and construction of reservoirs to ensure supply. However important these measures may have been, they failed to include capacity building for production, needed for crop management, health and creation and implementation of production plans. Most of the systems that were in place did not have positive impacts and as a result, it became necessary to develop actions to connect family farming with water management.

The project

The purpose of the project was to enable water access and use for family farmers in the Chaco region by identifying, systematizing and transmitting knowledge on appropriate developed technologies for water management, and to strengthen the capacities of experts, extensionists and farmers.

The project represented an opportunity to design and validate a concurrent project model that could be used in other territories and integrate state and regional technological innovation institutions, in order to obtain solutions and strengthen the capacities of family farmers and experts in the region concerning water harvest, irrigation farming, fertigation and farm management, with special emphasis on the efficient use of water, improvement of productivity and care for natural resources. This allowed for the leveraging of resources with strategic partners such as the Financial Fund for the Development of the Cuenca del Plata (FONPLATA), the Paraguayan Institute of Agricultural Technology (IPTA) and the Pilcomayo Commission, among others.

Strategic goals of the Medium-term Plan, which the project contributes to fulfilling

Given that the project promotes the strengthening of water resources management and irrigation in an engaging, participatory manner, as well as the transfer of technology with technical assistance to improve competitiveness in the territories involved, it also contributes to achieving strategic objective 1 (to improve the productivity and competitiveness of the agricultural sector), 2 (to strengthen agriculture's contribution to the development of rural areas and the well-being of the rural population), and 3 (to improve agriculture's capacity to mitigate and adapt to climate change and make better use of natural resources) of IICA's Medium-term Plan.

The project focused on three priority issues:

1. Innovation, transfer of irrigation technologies and water harvesting.
2. Integrated water resources management, increasing the productivity and effect of efficient use of water in agriculture in the South American Chaco.
3. Promotion of family farming by strengthening the capacity of family farmers to access and manage water, thus improving their productivity.

The components and scope of the projects involved:

» **Systematization of technologies:** By identifying, compiling and systematizing appropriate water management technologies (water harvesting, storage, irrigation) for family farming in the Chaco region, small-scale family farmers were able to access relevant information on harvesting, storage and irrigation technologies for their own production systems.

» **Technology transfer:** The project conducted integrated, simultaneous actions to generate and transfer an efficient, sustainable model designed to access, manage and use water efficiently, focusing on the specificities of family farming in Chaco. These actions created direct benefits in the intervention territories for the institutions that were carrying out the operational plans to achieve integrated management of water resources.

» **Capacity development:** During the execution of the project, different activities were conducted aimed at strengthening the technical capacities to manage water resources in an integrated manner. 30 technical assistants and 100 small-scale farmers were trained through these activities.

The content of the project is related to the actions included in the 2014-2018 Medium-term Plan of IICA in the following manner: Agriculture, Territories and

Rural Well-being Program (Action 1: Integrated and sustainable management of rural territories; Action 2; Contribution of Family Farming to the Rural Economy); Innovation for Productivity and Competitiveness Program (Action 6, Knowledge Management and ICTs for Innovation); Agriculture, Natural Resources Management and Climate Change Program (Action 3: Efficient and integrated management of natural resources).

The project was executed in Paraguay, Argentina, Bolivia and IICA delegations in the countries, with the support of the Ministry of Rural Development and Lands (MDRyT) of Bolivia, part of the Intendancy of Lt. Irala Fernández in Paraguay, and the Center for Validation of Agricultural Technologies (CEDEVA) of the Government of the Province of Formosa in Argentina. These three institutions provided technical resources (and the possibility of contributing financial resources as the project moved forward), and helped identify the direct benefits for the Chaco region, shared by all three countries. The project was coordinated by the IICA delegation in Bolivia.

Given the distance and characteristics of the region that was subject to the intervention, each country had access to consulting services provided for the following topics: i) technology systematization for water harvesting, storage and irrigation; ii) knowledge transfer with respect to adequate and successful technologies for small-scale family farmers; iii) drafting of operating plans with synchronized intervention and a study on the efficient use of water; and iv) technical assistance to train local experts and advise on the training of small-scale family farmers in Chaco.

Beneficiaries and impact

The direct beneficiaries of the project are small-scale family farmers in the province of Gran Chaco in the department of Tarija, Bolivia, the province of Formosa in Argentina and the department of Villa Hayes in Paraguay. Indirect beneficiaries include input suppliers and consumers in the region who will have access to adequate, high-quality local products.

The project will add value by implementing concurrent actions at the national, regional and local levels; likewise, it will develop capacities in an integrated manner in the three countries covered by the project.

Furthermore, the concurrent operative plans have facilitated joint work by all stakeholders with one common goal, and as a result, the implementation of appropriate technologies for the specific conditions of each location. This allowed small-scale farmers to improve their productive development and access new local and international markets, implementing a sustainable and environmentally friendly approach.

The final goal of the project was to promote competitiveness and improve income and productivity by using resources, especially water, more efficiently. This will lead to more competitive and sustainable farming, which in turn will help achieve food security.

5. PROJECT ENTITLED "KNOWLEDGE MANAGEMENT AND INSTITUTIONAL CAPACITY DEVELOPMENT TO PROMOTE INTEGRATED WATER MANAGEMENT IN FAMILY FARMING (GIAAF)"

Total cost of the project: USD 206,445
Duration: 24 months (2014-2016)

Problem and context

Latin America in general, and Costa Rica, Nicaragua and Peru in particular, share a common problem, which is the lack of institutional capacity to deal with the problem of water in family farming in an integrated manner. One of the reasons for this is the limited access by farmers' organizations and technical teams in the supporting institutions to existing knowledge of good practices and innovations resulting from successful experiences in the territories and reference countries. This may be related to the fact that the content and tools promoted by the public, private and cooperative sectors are too spread out, and also because of the poor articulation between key players and the mechanisms used to generate, disseminate and make good use of this knowledge.

This institutional limitation is also affected by the lack of trained human resources capable of directing and promoting processes aimed at improving water management through adequate institutional, methodological and technological innovations and

practices adapted to family farming. Another root cause can be found in insufficient training, which has failed to be relevant, accessible, sustainable and of acceptable quality, and has focused more on merely providing information instead of developing the capacities of people and institutions.

This situation has resulted in weak policies and investments to support water management in family farming, as well as insufficient innovation to achieve efficient, sustainable use of water, which therefore exposes family farming to economic, social and environmental risks.

The project

In order to address these challenges, the project entitled ''Knowledge Management and Institutional Capacity Development to Promote Integrated Water Management in Family Farming (GIAAF)'' was implemented with the purpose of contributing to the development of a more competitive, sustainable and inclusive agriculture, by strengthening institutional capacities and promoting improvement processes for water management in family farming with an integrated approach, pursuant to the strategic goals of the 2014-2018 Medium-term Plan of IICA, namely: strategic objective 1 (to improve the productivity and competitiveness of the agricultural sector), and 3 (to improve agriculture's capacity to mitigate and adapt to climate change and make better use of natural resources).

The project was executed by IICA in collaboration with other relevant institutions in the topic of water management for agriculture in the partners countries, including: The National Water Authority (ANA) of the Ministry of Agriculture and Irrigation (MINAGRI) of Peru; the National Subterranean Water, Irrigation and Drainage Service (SENARA) of Costa Rica; the National Water Authority (ANA) of Nicaragua; and the National Irrigation Technology Center (CENTER) of the Ministry of Agriculture, Food and Environment (MAGRAMA) of Spain.

IICA Representatives in the countries were responsible for internalizing and adapting the project to their respective country strategies, taking current instruments into consideration (flagship projects, externally funded projects, rapid response actions and pre-investment initiatives of the Technical Cooperation Fund). Similarly, the overall coordinator of the project was in charge of monitoring other initiatives throughout the institute, to create synergies and complement efforts.

Likewise, IICA coordinators in the countries and its Permanent Office for Europe put together a national team with the counterparts designated by the institutions of the consortium in charge of executing the project. These counterparts acted as a bridge to access these institutions internally to facilitate the project's actions at the national and sub-national levels.

One of the project's strategies was to formalize institutional partnerships to achieve the expected results. These partnerships included agreements with Helvetas Swiss Intercooperation for the design and implementation of the Virtual Knowledge Management and Capacity Development Platform in GIAAF; the International Tropical Agriculture Center (CIAT) for the organization of an activity to share experiences; with the ''Ayuda en Acción (Help in Action)'' program, to train advocates of good practices and innovation in GIAAF; and with CENTER-Grupo Tragsa to organize internships and trainings in Spain.

Another important part of the project involved contracting the services of consultancy agencies, specialized in topics such as: a) creating a communication and resource-capturing strategy; b) creation of a reference framework document or baseline for knowledge management and capacity development in GIAAF; c) design and implementation of the knowledge management and capacity development platform in GIAAF, and d) design and preparation of different educational, multimedia resources in the virtual training program for advocates of good practices and innovation in GIAAF.

Within the framework of the components developed during the project, the following results were obtained:

- *Communication and management of the project*. Beneficiaries and key players were able to participate in the project management and in the dissemination of its results. Likewise, new sources were identified to obtain resources for the promotion of integrated water management in family farming.

- *Knowledge management in GIAAF.* Fifteen months into the execution of the project, the direct beneficiaries of the project were able to access available knowledge on good practices and institutional, technological and methodological innovations to promote GIAAF.
  At least 30 farmers in charge of family farming organizations in the reference territories, as well as 60 technical experts from supporting institutions were acquainted with good practices and innovation conducted by the institutions and reference countries, within the framework of an event aimed at sharing experiences and launching the GIAAF virtual platform fifteen months into the project.
- *GIAAF capacity development*. As a result of the activities included in the component, family farmers' organizations from the territories and the relevant supporting institutions were able to train their leaders and technical experts as advocates of good practices and innovation, twenty-one months into the project.
- *The aforementioned achievement was the result of three activities:* Firstly, nine months into the project, 30 farmers in charge of farmers' organizations and 60 technical experts from relevant supporting institutions participated in national workshops and were trained as advocates of good practices and innovation in GIAAF.
- Additionally, fifteen months into the project, at least 20 trained advocates (including farmers and technical experts from all three countries) increased their level of knowledge of good practices and innovation in GIAAF, through an international internship and training in Spain.
- Finally, twenty-one months into the project, at least 90 new advocates (including leader farmers and technical experts of all three countries) were trained through an on-line program for GIAAF advocates.

Beneficiaries and impact

The program targeted family farmers' organizations, ministries of agriculture, dependencies and other entities responsible for water management in family farming, as well as private and cooperative development institutions interested in improving their support services in this regard. 90 of the direct beneficiaries were leader farmers and 120 were technical experts involved in public and private programs and projects aimed at promoting family farming in three reference territories. Likewise, families belonging to selected farmers' organizations were also beneficiaries of the project.

The project managed to generate added value by facilitating the integration of content, tools and key players around a virtual platform that allowed them to have access to knowledge and capacity development, in line with the profile of advocates of good practices and innovation for GIAAF.

These two mechanisms will result in the capacity development of leader farmers and technical experts, to allow family farmers' organizations and supporting public institutions to have advocates capable of orienting improvement processes for water management from an integrated perspective, adapted to the distinctive features of this type of agriculture.

6. PROJECT ENTITLED "FTG-1795/09 - ADAPTATION OF MAIZE AND BEAN TO CLIMATE CHANGE IN CENTRAL AMERICA AND THE DOMINICAN REPUBLIC: A TOOL TO MITIGATE POVERTY"

Problem and context

The Mesoamerican region is the point of origin of maize and the common bean. These crops are the main food source of the area and therefore have an impact on food security and income for rural populations. In terms of consumption, maize is the third most important product worldwide, after rice and wheat. Given their high protein content, beans are a very good complement to the family diet. The production structure of these crops takes place in the context of family farming, and the issue of climate change poses an even bigger threat for them. Maize plantations do not show significant fluctuations, and drought and floods have made their expansion more difficult.

As for beans, farmers in Central America have included new areas for seeding as a result of the price rise; however, the excess or scarcity of rainfall at critical times has resulted in losses for many of them. Furthermore, the growing demand has put pressure on the price rise since 2008. Production has remained quite stable, and climate variability has led to early droughts at the beginning of the seeding period,

more intense rainfall during some periods, and the development of diseases and pests with a negative impact on productivity and food security.

Fortunately, the region is genetically diverse, which makes for a solid base to select, improve and evaluate new varieties.

Protocols used to select maize germplasm and deliver it to farmers include the following steps:

a. Introduction and cross-breeding (hybridization).
b. Generation of populations.
c. Selection and evaluation of elite individuals, populations and genotypes.
d. Validation and distribution of new varieties or potential hybrids.
e. Maintenance of seeds from parent plants or genetic variability.
f. Consideration of new genotypes.

This evaluation considers aspects of adaptation to different abiotic conditions such as drought, limited moisture, soils with low nitrogen content, excess moisture and acid soils. The process is supported by the International Maize and Wheat Improvement Center (CIMMYT).

In the case of beans, the Bean Research Program (PIF), created by El Zamorano together with the International Tropical Agriculture Center (CIAT) and the Universities of Puerto Rico, Nebraska, Michigan and Pennsylvania, through the Dry Grain Pulses Program or CRSP, has, since 1996, generated improved lines of Mesoamerican bean (red and small black bean). On the other hand, the University of Puerto Rico has developed improved lines for the Andean type, mainly cultivated in Panama and the Caribbean. These improved lines have been distributed to the INIAs through greenhouses and regional tests (SISTEVER), under Zamorano's responsibility and with the support of CIAT.

The generation of new varieties prioritizes resistance to the common mosaic virus and golden mosaic virus, as well as the resistance to web blight, common bacteriosis and angular stain. Likewise, over the past ten years, efforts have been made to improve tolerance to abiotic factors, mainly drought and conditions of low-fertility in soils, as well as adaptation to low areas and tolerance to high temperatures.

These developments are the basis for seeking solutions to the expected effects of climate change. Recent studies, including model studies, show that the impact of global warming could cause a significant drop in maize and bean yield over the next thirty years. A temperature increase of 1O C could generate a loss of 5%, whilst a 2OC would result in a loss of 20% for Central America. Therefore, the ability to identify genetic material with a capacity for adaptation and resistance to pests and diseases becomes an urgent priority.

One of the project's main limitations for research and innovation is the lack of financial and human resources. A recent informal survey, designed by SECCI, RND and FONTAGRO, which targeted national research institutes in Central America and the Dominican Republic, showed that there are no consolidated strategies for climate change, that existing actions tend to be too specific and dispersed, that needs and vulnerabilities are similar in the different countries and that a joint approach is needed for the region.

7. PROJECT ENTITLED "SUSTAINABLE ENERGY AND CLIMATE CHANGE INITIATIVE"

The project

The project has contributed to reducing poverty in the region, by conducting research aimed at improving maize and bean adaptations to climate change, thus strengthening food security and the well-being of vulnerable farmers in Central America and the Dominican Republic.

The different regional maize and bean thematic networks established by the SICTA, identified and registered maize germplasm (yellow and white grains) and beans (red and black), with high productivity, resistance and adaptability to climate change available in national gene banks, international centers of the Consultative Group for International Agricultural Research (CGIAR) and other organizations, including universities. A participatory germplasm evaluation was conducted in pilot communities of each participating country, focusing on maize and bean thematic networks of the INIAs in pilot communities.

The project provided support in:

a. identifying, evaluating, developing and distributing improved and adapted maize and bean germplasm, to counteract the direct consequences of climate change and its impact on food security and nutrition; and
b. strengthening the research capacity (human and technological resources) and implementation strategies and policies to adapt to climate change, in the short and long term.

The project focused on obtaining information on rainfall, temperature and evapotranspiration in areas of interest in order to correlate the performance of promising genetic material and the development of risk management strategies. The primary sources of information for analysis and correlations were the national meteorological institutes, the INIA meteorological stations and a new climate information database developed by the IDB. The researchers were able to identify the factors or variables considered relevant and appropriate to establish the basis for future research on maize and bean crops with a potential for adaptation to climate change, working closely with specialists, farmers and the communities of the region.

The information obtained on promising genetic material, both local and improved, was distributed to the famers, pilot communities and participating institutions. The maize and bean networks used a group focus for technology transfer and adapted printed materials to the academic levels of the populations in the production areas.

The project had a three-year timeline and was financed with non-reimbursable technical cooperation funds provided by the Korean Poverty Reduction Fund (KPR) through FONTAGRO. Other local in-kind contributions included a sum of USD 378,722 provided by SICTA, INIA and the thematic networks (INTA in Costa Rica; CENTA in El Salvador; Zamorano in Honduras; ICTA in Guatemala; INTA in Nicaragua; IDIAF in the Dominican Republic and IDIAP in Panama). The total cooperation cost was estimated at USD 698,722.

Scope and results

The project was able to identify maize (yellow and white grain) and bean (red and black) germplasm with high productivity, resistance and adaptability to climate change, available in national gene banks and in the international centers of the Consultative Group for International Agricultural Research (CGIAR). At least ten materials were obtained with limited tolerance to moisture; twenty bean genotypes were collected with drought tolerance traits; at least 5kg of seeds were available for each of the genotypes identified for maize and bean tests; each INIA had access to at least five sets of maize tests to be established in their countries; and at least 14 regional bean tests were distributed and evaluated in each of the participating countries, just to name a few results.

The INIAs conducted a participatory evaluation in communities of the region's countries, and identified five pilot areas to evaluate maize and two for bean crops; at least two genotypes with tolerance or resistance traits to biotic or abiotic factors were selected; at least eight bean validation plots per participating country were established; at least two advanced materials per country were identified and at least 15 kilos of maize seeds from promising material and 160 kilos of bean seeds from advanced genotypes were produced to be used in validation plots.

In terms of follow-up and analysis of the climate information used to correlate the performance of promising genetic material and develop risk management strategies, the databases containing climate information are now available in vulnerable areas; at least one rain gauge was acquired and installed in each selected area; rainfall and temperatures were recorded in the selected territories; and a document was drafted containing the analysis and interpretation of the information compiled.

With respect to the production and distribution of information on local and improved genetic material with high potential for farmers and other stakeholders, at least100 k of basic maize seeds per INIA and 10 kg of beans were made available for each participating country; at least one local seed production project was implemented per community; and educational material was developed and distributed.

Finally, different issues, variables and factors were identified as a guide for future research on maize and bean crops in order to deal with the consequences of climate change.

07

CHALLENGES

The United Nations Conference on Water and Environment and the Rio Conference on Environment and Development, held in 1992 in Dublin and Rio de Janeiro respectively, as well as the creation of the World Water Council and its seven world forums organized to date, together with the Millennium Declaration and the Ministerial Declarations of the American States have positioned water management at the highest level of decision-making and international involvement. As a result, governments have adopted these recommendations to a greater or lesser degree, which has led to changes in legislations and new policies and programs addressing the issue of water in agriculture.

A recent document published by FAO, entitled Voluntary Guidelines for Agro-Environmental Policies in Latin America and the Caribbean, describes the difficult situation of agriculture in the region, which must be considered as the starting point for the implementation of sectoral public policies related to agriculture. In this document, FAO points out the following:

Latin America and the Caribbean (LAC), "which represents 15 percent of the Earth's surface, receives 30 percent of rainfall and generates 33 percent of the world's water.

Of the available land area, 37 percent is used for agriculture and 47 percent is covered with forest, making the region a major global reserve of agricultural land and forest space.

There are at least 200 million hectares of degraded land, mainly as a result of unsustainable agricultural practices and other anthropogenic processes, such as mining. Latin America and the Caribbean is still the region with the largest forest loss after the establishment of the MDGs. In the period between 2000 and 2010, South America had the largest forest loss in the world, estimated at four million hectares a year, whereas $C0_2$ emissions have continued to increase. While the rate of loss decreased substantially between 2010 and 2015, the net change in forest area in the last five years has been in the order of 2.4 million hectares.

The impact of environmental degradation mainly affects the most vulnerable social sectors, such as family and smallholder farming, artisanal fisheries and small-scale forestry, because they depend directly on natural resources for their livelihood and income generation.

In Latin America and the Caribbean, the family farming sector totals around 17 million productive units and encompasses a population of 60 million people. Family farming represents 75 % of total productive units in the region, and in some countries, it exceeds 90 %.

Latin America and the Caribbean are still home to unsustainable consumption and production patterns, and the region has not transformed its production model. As to the environment, countries in the region have significantly invested in the formation of institutions and legislative enactment since 1992. Nevertheless, insufficient coordination in public action, low awareness of environmental degradation effects and scarce valuation of ecosystem services hinder the efforts undertaken.

An improvement in coordination and greater consistency when it comes to public action in matters of sustainable development policies, together with the effective incorporation of incentives, must be carried out through practical measures. This should be the result of a process that involves different sectors and levels of government and that designs public policies with a strategic and guiding vision. Therefore, sustainable development in Latin America and the Caribbean requires that States play a guiding role among the public and private actors involved" (FAO 2016:v-vii).

IICA's role

The results of the actions undertaken by national governments in the Americas, with the technical and occasional financial support of IICA, reflect significant improvements that improve water management in agriculture. Nevertheless, there is much left to be done, and a deeper and more intensive approach for public, private and social activities is needed. In essence, the countries must follow the guidelines established by the Summit of the Americas, which took place in Port of Spain in 2009, and IICA's 2010-2020 Strategic Plan.

Agriculture and climate change

The impact of climate change on farming activities will be inevitable in the medium-term, and it is essential to increase the number of actions aimed at counteracting these effects. Several factors will affect agricultural performance, including temperature rise, change in CO_2 concentration, sea level rise, the water cycle disruption, changes in its quality and availability and the frequency of meteorological events. More uncertain factors, such as changes in the patterns of extreme climate and rainfall events, will require further analysis and evaluation (Vergara *et al.* 2014).

The impact of the aforementioned factors on agriculture will condition plant growth and yield.

Temperature rise: As atmospheric and soil temperatures rise, crops are less capable of maintaining photosynthesis. As a result, plants grow more quickly, but seeds have less time to mature, resulting in lower yields.

Soil moisture loss: Drought is expected to extend in most of the region, together with a significant loss of soil moisture in superficial layers. These reductions will occur

in food production areas such as the Southeastern Amazonian basin in Brazil, the Rio de la Plata delta and the coastal flatlands in northern South America.

Sea level rise. In coastal areas and deltas, agriculture is susceptible to sea level rise, which prevents farmers from using existing aquifers for agriculture and favors the gradual salinization of the coastal strips. Being near the shore, these productive areas are economically affected by this phenomenon.

CO_2 fertilization. As the concentration of CO_2 and temperature increases, the more plant growth is observed; however, the interaction between these variables may lead to the opposite effect in terms of yields once temperature thresholds are reached.

Other impacts. The change in the distribution of plants and animals caused by the displacement of tropical species and the altitude of their location must be considered as a result of temperature rise. Furthermore, the diversity of genetic species is also under threat given that endemic species find it more difficult to displace or adapt when their habitat is affected (Vergara *et al*. 2014:5-9).

Response measures

The issue of climate change and its effects in the region requires the implementation of activities focused on the adaptation of relevant species in order to mitigate the pressure on current crop patterns and yield loss. The use of improved varieties and adequate production practices for irrigation, soil preservation, direct seeding, zero or low tillage and water management are some of the most important practices aimed at counteracting the impact of climate change on agriculture.

The estimated additional annual investment needed in the region to adapt to climate change is USD 1.1 billion and USD 1.3 billion, a third of which would be allocated to agricultural research (IFPRI 2009). Likewise, the World Bank (2010) considers an annual investment of USD 1.2 and 1.3 billion to cover the adaptation needs of agriculture to climate change.

As part of this strategy, these technical aspects are accompanied by other actions that engage different sectors of society. One of them is to familiarize stakeholders and those responsible for agriculture in the region with the enormous challenge posed by climate change. Awareness needs to be raised by sharing knowledge on the implications of not implementing adaptation processes.

On the other hand, it is paramount to review relevant public policies, making sure they are aligned with low-carbon, climate-resilient agriculture and promote investments in public goods of the sector. It will also be relevant to increase collaborative efforts between research and extension institutions and between the public and the private sector, to create processes aimed at fostering the use of climate-resilient crop varieties. Likewise, a systematization and dissemination of traditional and local knowledge is required, as well as an assessment of the links between international trade and supply chains.

Other response measures include enhanced data collection, monitoring and prognosis, as well as training those responsible for providing and using climate information. It is also necessary to develop programs for public, private and international leveraging, thus promoting agriculture by implementing climate-resilient practices (Vergara *et al*. 2014:9-10).

Institutional development for water management

Several countries in the region have made changes to their institutional structures in order to manage water in an integrated manner. However, it is still necessary in many cases to solve and adjust incongruences in the design of instruments defined by the institutions, with the specific management and/or regulatory needs for water resources; for example, it is essential to address "the high institutional disarticulation and fragmentation of water management and other related natural resources, and the absence of institutional structures and instruments that could help coordinate and respond to the interactions that arise concerning basins, with an integrated and long-term vision" (Peña 2016:49).

Another key issue is ensuring that sufficient resources are provided for institutional procedures. In many cases, there are sufficient institutional arrangements in place to manage different water-related topics, but not the necessary resources to carry them

out. For example, ''States are often weak in developing measuring networks, which are indispensable for adequate management of water, or in the implementation of efficient oversight for dealing with contamination problems, even when the roles and responsibilities are clearly defined in the regulations. Likewise, there are many cases in which legal provisions are, and continue to be, a dead letter, due to the institutional weakness or lack of political will of the organizations in charge'' (Peña 2016:49).

The new water management model has provided users, civil society and the market with roles that must be complied with in order to achieve efficiency in the water system. However, the model should also address the consequences or failures that occur when users do not fulfill their commitments, when control or surveillance activities are not carried out or when the market agents overuse the resource, reaching levels that are detrimental to sustainability. (Peña 2016:49).

In order to improve water management as a whole, institutions must be continuously strengthened. To this end, FAO developed the Voluntary Guidelines for Agro-Environmental Policies in LAC so that governments in Latin America and the Caribbean could have access to more tools and help them define policies and actions for environmental management, including water. These guidelines are based on the following strategic guidance:

- *Rural development with a territorial approach.* Promote rural development with a territorial approach and in accordance with the principles of conservation and the sustainable management of natural resources.
- *Inclusive institutionalism.* Encourage inclusive institutionalism between the private and public sector, and civil society, by promoting synergies.
- *Sustainable production and services model.* Transform the agricultural practices commonly adopted by a production model based on the intensive use of consumables and natural resources into a model of sustainable production and services.
- *Internalizing ecosystem values.* Internalize the value of natural resources and ecosystem services in the policies and models for sustainable production in the agriculture, forestry, fisheries and aquaculture sectors, and promote the elimination of distorting subsidies, by encouraging the development of regulations, sanctions, compensations and schemes to address discrepancies.
- *Equity in the generation and distribution of wealth.* Boost conditions for productivity in the territories through the implementation of equitable wealth generation and distribution strategies (FAO 2016).

The voluntary guidelines issued by FAO to address the topic of integrated water management include the following:

- Provide economic support to promote forest conservation, protection of water sources, an efficient water use and management and soil conservation practices.
- Promote research on the adaptation to climate change, and quantify possible consequences at the local, regional and national levels.
- Promote research focused on reducing water demand.
- Restructure pricing tools related to water use through the application of differential rates in accordance with each production system or process.
- Distribute information on climate change adaptation processes.
- Encourage respectful behavior and enhance the value of natural resources in the sphere of formal and informal education.
- Strengthen the institutional framework aimed at promoting a shift towards environmental sustainability in production and consumption patterns.

This strategic guidance is aligned with a series of sectoral actions that, despite not being mandatory, can provide orientation in the management of agro-environmental issues.

Water and food security

The region of Latin America and the Caribbean has stood out for its level of compliance with the goals of hunger reduction among its population. The percentage and number of people suffering from undernourishment diminished by more than half, and as a result, the region achieved one of the millennium goals set forth in the World Food Summit. However, there are still 34 million undernourished people, which calls for continued efforts to eradicate this scourge (FAO 2015).

These achievements are related to the application of sectoral policies that have favored production growth and other social policies, resulting in a higher number of people with access to food. One of the main reasons for this is that the ''region has shown continuous increase in yields as a result of new practices and improved seeds, and more intensive use of pesticides and fertilizers'' (Vergara *et al.* 2014:3). These positive effects are also related to larger seeding areas.

In order to strengthen food security in the region, special attention must be paid to the specific aspects and conditions of agriculture. When analyzing soil and water availability, one can see the potential for expansion of the production barrier; however, this might affect soil and water conservation programs, and for this reason it is considered more appropriate to increase production based on the recovery of already degraded land.

Furthermore, one of the most relevant aspects of the region is its potential to increase productivity from small and medium-sized farmers, who can include innovations, best practices, technical assistance and genetic breeding into their crops, and thus improve the productive performance of their farms.

> *''Estimates show that nearly 15 million family farms cover almost 400 million hectares in LAC (Berdegué and Fuentealba, 2011). These establishments engage in traditional or subsistence farming and produce 51 % of the maize, 77 % of the beans and 61 % of potatoes consumed in the region (Altieri and Toledo, 2011; Altieri 1999). In Mexico, for example, family farming accounts for 70 % and 60 % of the total surface area dedicated to maize and bean respectively (Altieri and Toledo, 2011; Altieri 1999); in Colombia, on the other hand, coffee accounts for 22 % of the agricultural GDP, and coffee plantations covering five hectares or less account for 96 % of farmers and 62.2 % of the total cultivated surface area for this product (Fonseca, 2003)''* (Vergara *et al.*, 2014:4).

In order to achieve food security, water must be managed sustainably. This is essential to improving the productivity and diversification of irrigated crops in what refers to irrigation, for example. This is particularly true for the region, where one tenth of the cultivated area relies upon irrigation services. In this sense, the future requires sustained investment in irrigation infrastructure and to recover and maintain the existing facilities, which currently fail to efficiently channel, distribute and apply water.

The measures and actions that must continue to be implemented to ensure water sustainability and food security are aligned with the recommendations made by IICA, which are already part of the continental strategy:

- Reduce losses along the production and consumption chain, including the reduction of global food waste and the adoption of healthy diets with less water consumption and waste.
- Ensure safe and efficient use of agrochemicals and other external inputs, and eliminate the use of toxic chemical products, pursuant to the stipulations of international conventions.
- Promote agricultural biodiversity by acknowledging its role in ensuring the stability, resilience and nutritional quality of agricultural production, as well as its importance in providing environmental services.
- Support applied research and development of techniques for sustainable agriculture, promote cooperation and disseminate technological innovations and sustainable management that are adapted and accessible to all levels of farmers, especially family, indigenous and peasant farmers (Pochat 2015:37).

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