Role of Policies in Supporting Adaptation to Climate Change of the Agricultural Sector[1]

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1 Analysis of policy objectives

1.1 Revision of Main Objectives of the Agricultural Sector

Conductive questions:
What are the main objectives within the agricultural sector?

In Costa Rica, two policy instruments contain the main objectives within the agricultural sector, giving the perspective of the short-term policy as well as the long-term policy in the sector. The first instrument is the *National Development Plan 2015-2018 "Alberto Cañas Escalante" (NDP 2015-2018),* which is the definition of short-term policy of the current government administration. Every four years, at the beginning of each administration, the new authorities review the policy objectives in the agricultural sector, and seek to shape its policy objectives in the National Development Plan (NDP). The NDP is a planning tool that sets out the strategic pillars, priorities, objectives, programs and projects, with each government drives its development policy proposal. (MIDEPLAN. 2014)

The other instrument is the *State Policy for the Agro-food Sector and Rural Development 2010-2021*. The Ministry of Agriculture and Cattle (MAG) prepared this state policy based on a process of consultation and consensus with different actors linked to the food sector and rural territories, to build a road map to follow on the shared vision in the sector. In this sense, the agro-food and rural development policy is a long-term policy for the sector. (MAG. 2011)

An important difference between the two instruments is the *NDP 2015-2018* is the basis for planning, implementation and monitoring of government policies, so that their approaches are binding decision of the authorities of the government in power. For its part, the *State Policy for the Agro-food Sector and Rural Development 2010-2021*, aims to establish reference long-term policies on the key issues on which there is consensus on policies requiring promotion and sustainability through the years.

1.1.1 National Development Plan 2015-2018 "Alberto Cañas Escalante"

The *National Development Plan 2015-2018* comprises the policy for the agricultural sector in the short term, which aims to "promote an agricultural and rural sector to be efficient, competitive, highly trained at all levels to ensure food sovereignty and with recognized international positioning". Additionally, the *NDP 2015-2018* aims to promote a sector "respectful of the rights of workers and working quality, doer of the law and committed to the environment and social responsibility" (MIDEPLAN. 2014).

The NDP 2015-2018 in the field of agriculture establishes five strategic areas:

1. Food and Nutrition Security and Sovereignty: This strategic area seeks to strengthen domestic production under a state policy of food security, which will ensure a production base of agricultural foods essential for the nutrition of Costa Ricans.
2. Opportunities for youth in agriculture and rural zones. This strategic area aims to ensure the political roots of future producers and stop the migration of rural youth to activities unrelated to agriculture. The policy encourages agricultural and rural activity with high value added, knowledge-based and innovative enterprises.

3. Mitigation and adaptation of agriculture to climate change: This area seeks to help the agricultural sector in combating climate change to help develop a more resilient agriculture, adapted to the effects of climate change and extreme events associated (Section 3.1.2 details the content of this strategic area).
4. Human development, equity and social inclusion. In social terms, the objective of the agricultural policy is to promote projects and actions to increase employment and reverse the downward trend of the employment rate in agriculture. In addition, the objective is to reduce inequality, prioritizing actions aimed at social groups in vulnerable conditions, as well as the socioeconomic and territorial gaps.
5. Strengthening the agro-export sector. The policy proposes the strengthening of the agro-export activity as generating a greater number of jobs and exports based on the principles of environmental and social sustainability, and clear rules with trading partners.

The NDP 2015-2018 proposes some across-the-board actions to support the implementation of the above strategic areas. For example, this national plan proposes the strengthening of agricultural research and technological innovation through strategic alliances and a national plan for agricultural research and technology transference, which joins the efforts in this field of the National Institute on Innovation and Transfer of Agricultural Technology (INTA), the academia, the private sector and producer associations. This alliance, articulated in the MAG, counts on the work of INTA, the State Phytosanitary Service (SFE) and National Animal Health Service (SENASA), among others.

The research in agricultural technology will focus on the real needs of producers, on aspects such as food security, adaptation and mitigation of climate change, efficient use of clean energy and water, soil protection and biodiversity, and development of technologies to improve production processes in terms of quality, safety, and profitability.

In 2011, MAG publishes the *Sector Plan for Agricultural and Rural Development 2015-2018*, that proposes the specific actions under *the NDP 2015-2018*. The sector plan takes up the pillar of the *NDP 2015-2018*, which aims to promote adaptation measures, mitigation and climate risk management, which contribute to the fulfillment of the National Strategy on Climate Change. (MAG. 2011 b)

1.1.2 State Policy for the Agro-food Sector and Rural Development 2010-2021

The other instrument used for the analysis of the main objectives of the agriculture policy is the *State Policy for the Agro-food Sector and Rural Development 2010-2021* (MAG, 2010). As indicated previously, this policy instrument is referential, intended to serve as a guiding framework for making decisions that allow the transformation of the current food production in a modern, competitive, environmentally responsible and inclusive production system. Therefore, this instrument allows direction, coordination and cooperation for long-term agricultural policy.

A first remarkable aspect of the political vision announced here is the visualization of the agricultural sector as the agro-food sector, which stands out that agriculture and livestock are key activities for the objective of food security and nutrition. The policy emphasizes thus the concept of food security; this do not meant a purpose of self-sufficiency of domestic consumption with domestic agricultural production. Food security implies the timely access to food, based on three components: *access, food and satisfaction of needs*. *Access* refers to

physical and economic possibility of food at all times. The *food* component has a focus on quality and safety features. The *satisfaction of needs* is the focus on the nutritional requirements of individuals to a proper diet and opportunities to satisfy needs according to dietary preferences of various groups of the society.

This policy instrument combines a shared vision between government, producers, academia and social actors that make up the food industry, which favors the development of organizations related to the sector: production organizations of small producers, producer associations, academia and others.

The common vision of this policy is a balance of food security, the benefits to the rural population, competitiveness and nature. The expression of the vision is "a food industry as a development engine for Costa Rica, inclusive, modern, competitive and environmentally responsible". This environmental responsibility is mitigation and adaptation to change climate as well as the agro-environmental management in general.

The policy for the agro-food sector has four pillars:

1. Competitiveness.
2. Innovation and technological development.
3. Management of rural areas and family farming.
4. Climate change and agro-environmental management.

The competitiveness pillar aims to raise the contribution of the Costa Rican agro-food sector to gross domestic product (GDP), exports, employment, investment, profitability and income for farmers, through different programs and quality services that meet the demands of the productive sector.

The competitiveness pillar includes the following strategic actions:

- Strengthening of national capacity of agro-food sector into domestic and international markets and benefit generation for all producers.
- Adaptation of the availability and conditions of financing and insurance to the cycles of the agribusiness sector.
- Generalization of the use of information and communication technologies to the needs of decision-making in the agro-food process.
- Decentralization and simplification of procedures to reduce transaction costs and promote investment and agriculture enterprise.

The objective of the pillar of innovation and technological development is to strengthen and integrate innovative activities and generate and transference technology. This pillar includes the following strategic actions:

- Intensification of efforts for generation and transfer of technology for the food innovation and dynamic change in the sector.
- Protection of national biodiversity and enhance their productive use, in a rational and sustainable manner.

- Maintenance of a competitive production from all agro-entrepreneurs to adverse natural phenomena, due to climate variability and change.
- Ensuring that producers develop their management and decision-making capabilities for innovation.

The pillar of management of rural areas and family farming are looking to incorporate small producers in rural areas and the farm family into commercial channels in economically competitive, environmentally sustainable and socially equitable terms. This pillar includes the following strategic actions:

- Involving target groups into commercial channels through production chains.
- Integration of public and private efforts in rural territories with organizations promoting synergies in the consolidation of value chains.
- Making optimum use of natural resources in the territories to ensure their sustainability.

The goal of pillar of climate change and agro-environmental management is to promote inter-sector efforts to mitigate and adapt to climate change, since this is a global phenomenon affecting the Costa Rican agriculture and other economic activities taking place in the rural territory. In addition, the pillar seeks to achieve management capability for farmers, which would enhance the sustainability of production processes and differentiation of the national exportable supply in international markets.

The pillar agro-environmental management and climate change includes the strategic areas showed below. Section 3.1.3 presents the details of this pillar.

Achievement of sustainability of production processes.

- Prevention of the risks associated with climate variability and provision of adequate care and management of disasters.
- Adaptation of production to new conditions arising from climate variability and change, which means to recover the productive potential by relocating activities, development of new production options, improved genetic materials and new farming practices, among others.
- Mitigation climate change by adjusting production practices and promote action to counter the emission of greenhouse gases and pollution through clean production processes.

Additionally, the policy has as crosscutting area the management and institutional alignment leading to a comprehensive adjustment of public sector institutions.

The following table 1 shows the strategic areas or pillars of both short-term and long-term policies. Both policies show common work areas as agricultural production, income distribution and climate change.

Table 1. Components of the Short-term and Long-term Policies

Short-term policy	Long-term policy
NDP 2015-2018 1. Food and nutrition security and sovereignty. 2. Opportunities for youth in agriculture and rural areas. 3. Mitigation and adaptation of agriculture to climate change. 4. Human development, equity and social inclusion. 5. Strengthening the agro-export sector	**Policy for the Agro-food Sector and Rural Development 2010-2021** 1. Competitiveness. 2. Innovation and technological development. 3. Management of rural areas and family farming. 4. Climate change and agro-environmental management.

1.2 Adaptation Policy for Agricultural Sector

Conductive questions:
Is adaptation to climate change a policy priority for the agricultural sector? Are there explicit adaptation policies – directed to the agricultural sector? Is there a clear prioritization of objectives between food productions, energy production, securing incomes, generating employment?

The introduction of climate change in both policy instruments, the *NDP 2015-2018* and the *Policy for the Agro-food Sector and Rural Development 2010-2021*, has allowed the presence of adaptation for the agricultural sector in the policy of short-term and long-term. This suggests that the topic of adaptation has become a priority in the agricultural sector; however, its approach has been part of the overall climate change policy, treated in conjunction with the mitigation of greenhouse gases.

An analysis of the general government policy as well as the sector policy managed by the MAG, can illustrate the mainstreaming process of adaptation to the national and sector policies. The introduction of adaptation in the sector is since 2010 and only the issue of vulnerability and risk management is clearly part of agricultural policy some years early.

Adaptation in agriculture came into the national policy of the government until the NDP 2015-2018. Earlier, the addressing of adaptation policies directed to agriculture was virtually nil, as shown in the analysis of national development plans since the NDP that incorporates the National Strategy for Climate Change.

The National Development Plan 2006-2010 was the first national policy incorporating the country's strategy on climate change, completed and published later in 2009 as the *National Strategy for Climate Change* (ENCC). This national strategy states: "the country needs to move towards the assessment of impacts and vulnerability to establish adaptation policies and measures, and incorporate such measures in an action plan against global warming." During this period, the government introduces the concept of domestic carbon market as an instrument to

support the finance of measures against climate change and the country's goal to be carbon neutral by 2021. However, this NDP only scarcely mentions the adaptation directed to the agricultural sector, putting it as the most serious consequences of climate change, with negative impacts on productive activities such as agriculture, alongside to the exposition to the severity of extreme hydro-meteorological events. (MIDEPLAN. 2007)

Years later, the National Development Plan 2011-2014 states that on adaptation while "Costa Rica contributes little in the generation of climate change, is extremely vulnerable to the effects because of geographical, economic and social reasons." Again, the approach to adaptation in the agricultural sector is weak, although this plan recognized that "coastal land is highly exposed while is devoted mostly to extensive livestock and agriculture is virtually the second activity in economic importance, being the main products banana, coconut, rice, cocoa and sugar." Therefore, it calls for an "integration of risk reduction variables of environmental disasters in public investment processes and promote adaptation to climate change." This development plan also indicates the topic of land use is "one of the priority elements to be incorporated is the national strategy for mitigation and adaptation to climate change", offering sector proposals aimed at better management in environment, agriculture and tackling of climate change, which in together contribute to "position the country as an environmental power." (MIDEPLAN. 2010)

The National Development Plan 2015-2018 introduced the explicit general government policy on climate change for agriculture. The strategic area related to *mitigation and adaptation of agriculture to climate change*, shows the topic became a priority in the government policy, involving both adaptation and mitigation. This strategic area seeks to "help the agricultural sector in combating climate change to help reach a more resilient and adapted sector to the effects of climate change and extreme events." The NDP 2015-2018 calls for "further research and studies on vulnerability in food-producing rural areas classified as high risky by extreme natural events, in order to take preventive measures of climate risk management, prevent loss of production in these areas, and implement measures to generate strategic information for decision-making." As for the rational use of water resources, The NDP 2015-2018 promotes investment for the rational use of water resources, the revitalization of the irrigation infrastructure and the harvesting and use of rainwater in dry areas. (MIDEPLAN. 2014)

In turn, the analysis of sector policy shows the topic of adaptation has only been included in recent years. Since the early eighties, the focus of the agricultural sector prioritized competitiveness, giving importance to innovation and technology development aimed at improving productivity. An assessment of the objectives of agricultural policy since the nineties shows the prioritization approach remained on the productive topic, complemented by the aspect related to income distribution. The sector policy addressed the environmental topics in very general terms, emphasizing the importance given to risk management.

The objectives of the agricultural policy in the administration 1990-1994 started from an emphasis on income distribution to "promote the continuous improvement of living standards of local farmers and strengthen the participation of traditionally sectors". This administration also gave emphasis on productive aspects by strengthening "the modernization of national agricultural production activities for domestic consumption and export; as well as the inclusion of the sector in the commerce process." This policy expresses the environmental objective in terms of "ensuring the sustainable exploitation of national natural resources."

The main objectives of agricultural policy for the period 1994 - 1998 was the institutional development of the MAG as coordinator of the sector policy, seeking an "efficient governance" based on "training of human resources" and "international technical cooperation" to "improve the level of coordination of the sector."

In the period 1998-2002 the sector policy proposes as priority a "strategic area of competitiveness" seeking the "reconversion" and "institutional modernization of the agricultural sector." The other strategic area the "rural development" based on strengthening the "social organizations and co-management".

For the period 2002-2006 the policy was again focused on "supporting the competitiveness of the agricultural sector" and the "development of human capacities and rural areas". A pillar of "agriculture in harmony with the environment" was oriented to "ecosystem management and use of biodiversity, land use and reducing the vulnerability of the agricultural sector".

The policy for the period 2006- 2010 is focused on the "continued increase in competitiveness" and "sustainable increase in export supply to enable producers to integrate successfully markets" for the "development of new commercial opportunities". On the topic of income distribution, the target was the "promotion of projects with high local added value in socio-economically deprived and environmentally vulnerable regions." Environmental issues in the proposal was the "promotion of integrated management of sustainable production, to achieve a balance between production processes and the conservation and wise use of natural resources."

In 2011, MAG publishes the *Agro-Environmental, Climate Change and Carbon Neutrality Agenda in the Agro-food Sector of Costa Rica*. This document gave to adaptation the importance this issue requires in the agricultural sector, as one of the most vulnerable sectors to climate variability and extreme events. This document resulted in the *State Policy for the Agro-food Sector and Rural Development 2010-2021*, policy instrument discussed earlier and in which all the measures identified for the agricultural sector came from several consultative processes with stakeholders in the sector, thus became the first instrument of MAG proposing specific policies on adaptation to climate change. (MAG. 2011)

Thus, the agriculture policy addresses the issue of adaptation over the course of the last years. Before 2010, the national communications to the Framework Convention on Climate Change United Nations (UNCCC) conducted the approach to the topic of adaptation in the agricultural. From these communications, the National Meteorological Institute (IMN) conducted some vulnerability studies for the sector on adaptation to climate change and extreme events. Section 2 presents some details of these studies of vulnerability.

One remarkable conclusion with the revision of the approaches of the national and sector policies is the subject of adaptation is immersed within the overall climate change policy without departing from the issue of mitigation of greenhouse gases, and the national goal of carbon neutrality by 2021 (see CINPE, 2012 and SIDE, 2015).

1.3 Prioritization among the main objectives in agriculture

A more detailed analysis of government policy, based on the statement of the main challenges of the PND 2015-2018 in the agricultural sector, shows an implicit order of priorities set by the government. The PND 2015-2018 places first the food security and sovereignty, indicating that

"the main challenge facing agriculture is the national food production by increasing productivity, generating added value and production processes with social and environmental responsibility in rural areas". (Government of Costa Rica. 2014)

It is important to see that the government links food security and vulnerability, because states "research should deepen in food security and vulnerability in rural areas classified as high risk by extreme natural events, in order to take preventive measures of climate risk management." This statement seems to propose issue of risk management has a higher priority within climate change.

Later, the NDP 2015-2018 presents the priority of social inclusion and distribution, focused on opportunities for youth in agriculture and rural areas, stating that "in order to improve the living standards of young people and produce more roots in rural territories, agricultural production projects will have more value added and incorporation of technology." This distributional subject also includes the area of human development, equity and social inclusion, proposing: "for better internal market performance, the policy will encourage the organization of producers and the improvement of information technology and communication on market intelligence."

The productive and competitive issue, which seems have been a priority in the past in agriculture is exposed after the other challenges as strengthening the agro-export sector, and the NDP 2015-2018 states that "in foreign trade aims to strengthen its market access and redirection to more profitable activities."

As last challenge, the NDP 2015-2018 declares the subject of adaptation and mitigation of climate change in agriculture, and indicates: "the country and the sector must take the agenda associated with climate change as state policy and the challenge of reaching the C-neutrality by 2021, as the impacts of climatic changes generate numerous effects on rural and agricultural activities."

At this stage, this statement of the main challenges in the NDP 2015-2018 for the agricultural sector seems to reflect the fact the institutional design and programs of MAG target mostly to areas of productive and sustainable agricultural development as well as issues of distribution for the benefit of producers and the rural areas. The issue of climate change and more specifically the adaptation has only reached a marginal treatment, with allocation of a reduce staff dedicated to the topic[3], limited resources and only some concrete actions when it compares with the resources and programs dedicated to other policy areas into the sector. Even though, sections 1.5 and 3.5 show the progressive incorporation of adaptation in actions and measures directed to sustainable development of the sector, and the advance the topic is having in shaping the attention of some government agencies to this issue.

1.4 Concept of adaptation in the government policy

Conductive questions:
How does the government understand climate change adaptation? (Is it about adapting to future climate conditions; or rather is it a risk management strategy; or a safety net strategy?

[3] The staff in MAG working specifically on adaptation is only of four officials.

Adaptation in agricultural policy is a topic that has followed a gradual incorporation into the national policy, but also has followed a change in the focus over the years, from an orientation on vulnerability to extreme events, to go to a broader concept of adaptation to climate change. The National climate Change Strategy defines adaptation following the IPCC as "the adjustment in natural or human systems as response to current and expected climatic change or its effects, which moderates harm or draw advantage and opportunities." (MINAE, 2009)

By 2010 only the sector policy of 2002-2006 alludes to the issue, in the strategic area of "agriculture in harmony with the environment" aimed at "reducing the vulnerability of the agricultural sector." However, it is unclear whether the focus is on adapting to climate change or vulnerability to extreme weather events.

The pillar of Adaptation and Mitigation of Climate Change on Agriculture in the NDP 2015-2018 declares a clear concept of adaptation for the sustainability of production processes. This document defines adaptation as "the need to adapt to the new conditions resulting from climate variability and change, which involves recovering the productive potential by relocating activities, development of new production options, improved genetic materials, new farming practices, among other". In addition, the NDP 2015-2018 separates the concept of risk management from adaptation, since postulates complementary actions to "prevent the risks associated with variability and provide adequate care and management of disasters."

In this regard, Costa Rican policy of climate change adaptation in the agricultural sector seems to have a proper understanding of adaptation and risk management. Adaptation is a long-term process that demands action to make changes in production processes to the new conditions of future climate, while vulnerability to extreme weather events in a present reality, with threats increasing in the future, requiring a management strategy for extreme climatic events.

However, this clear approach of adaptation seems to stay at level of policy declaration. Section 3 and 4 address the actions implemented by the country, showing a low-level execution in terms of the activities of these policy instruments (detailed in 3.1.) and showing an emphasis in the country in activities of risk management as front line of the adaptation actions.

1.5 Policies Promoting Adaptation for Agricultural Sector

Conductive questions:
Are there policies that could implicitly promote adaptation?

Even though there is an adaptation policy for the agricultural sector, this is presented embedded within the overall climate change policy in the country, or within other policies implicitly promote adaptation activities or risk management to variability in climate. Part of this set of policies are below. Section 3.5 complement the list of action promoting adaptation with measures to improve the uptake of adaptation practices.

- National Climate Change Strategy
- The National Water Policy
- The environmental tax for water use
- Policy for the agricultural irrigation use

- Land-use planning and agricultural zoning
- Sustainable agriculture and climate-smart
- Risk management and early warning systems

1.5.1 The National Climate Change Strategy

MINAE publishes the *National Climate Change Strategy* (ENCC) in 2009, with an overall goal to "reduce the social, environmental and economic impacts of climate change and take advantage of opportunities, promoting sustainable development through economic growth, social progress and environmental protection, through initiatives of mitigation and adaptation actions." (MINAE, 2009)

Adaptation is one of six strategic components of the ENCC, meaning “the adjustment in natural or human systems in response to current and expected climatic stimuli”. The ENCC sets seven priority sectors: water, agriculture, biodiversity, fisheries and coastal areas, energy, health and infrastructure. These priority sectors should establish adaptation strategies and assess their vulnerability to climate extremes by defining which events have caused negative impacts and identifying the demanded actions for risk management.

The ENCC provides some actions in the agricultural sector to adapt to climate change (section 3.10.2 shows the financing of these actions):

- Promoting a more technical management of farming systems that take into account climate forecasts, to support decision-making related to planting and crop management.
- Using drainage and irrigation structures to reduce impacts of climate hazards.
- Promoting research and development of technologies in crops tolerant to lower humidity and higher temperature to reduce vulnerability and increase resilience.
- Improving the system of crop insurance and financing possibilities to implement new technologies and use of improved weather conditions to new varieties.
- Improving grazing systems and use more forage species suited to new weather conditions.
- Increase the continuity and competitiveness of the productive sectors by readiness for adverse situations related to climate variations.
- Finally, reduce the economic costs of the impacts of climate change in strategic sectors.

The ENCC highlights the need to determine the possible effects climate change may have on the agricultural sector, by research to determine the response of crops and livestock to these changes and anticipate the effects of climate change, and implement appropriate practices and technologies to promote adaptation of crops.

In terms of water resources, the ENCC calls to encourage technologies and research to increase efficiency in water use in agricultural production, as well as monitoring to reduce vulnerability and promote adaptation to climate change.

1.5.2 The National Water Policy

One of the main policies promoted by the MAG, joint with the SENARA, is the strategy for protection, maintenance and restoration of water bodies and sources of water for agricultural use.

The National Water Policy (NHP), in force since 2009, is the framework for action in the water sector, to address and solve long-term problems in water management, with the implementation of the National Plan of Integrated Management of Water Resources as a technical instrument. According to the Directorate of Water of MINAE (MINAE, 2013), the water balance of the country shows that only 22% of the supply of water is used, but 50% of this water use is made illegally. The urban and industrial growth and the intensification of agricultural, livestock and tourism are pushing the demand of water resources to pollution intensive processes and lack of infrastructure for storage, handling and distribution of water. Section 3.6.2 show the statistics of use of water in agriculture.

Based on information from the Directorate of Water, from the total volume of water exploited in the country, 48% is for irrigation in agriculture and adds 7% for other agricultural use. However, these data are of those legal concessions that remain in the official register of the Directorate, and this office only has an estimate of the number of illegal use and the exploited volume of various bodies, without supervision or control from the state.

The National Water Policy is working in the following areas:

Knowledge Development: This area seeks to ensure the development of skills and knowledge of water resources, in such a manner that allows water security to meet current and future demand. This area is consistent with the goal of having a coordination with MINAE for the establishment and improvement of the National System for Integrated Water Resources Management.

Creating a culture of water: This area seeks to induce through new behaviors regarding water use and interdependence of economic, social and environmental factors.

Vulnerability and adaptation to climate change: This area looks to ensure adaptation actions aimed at dependent sectors of the multiple uses of water, enabling them to reduce the vulnerability of the resource, prevent, and prepare them to the impacts of climate change. In addition, this area seeks to increase national and regional alliances between research institutions, dedicated to analyze the events of hydro-meteorological character and their impacts, to assess risk and establish prevention and adaptation measures to extreme events. Agriculture is a strategic sector in the national policy of water.

1.5.3 The environmental canon for water use

This canon is a charge for the use, management and protection of water resources, as an economic instrument that seeks to internalize the negative externalities generated by users. From the total raised by this concept, 25% should go to the conservation of water resources in protected areas administered by the National System of Conservation Areas (SINAC). Another 25% goes to the National Forestry Financing Fund (FONAFIFO) for payment for environmental services (PES) on private land. The remaining 50% goes to resource management by the Directorate of Water of MINAE.

The canon relates to agriculture in two areas:

- Agribusiness: Water used for agricultural enterprises in the processes of cleaning products, cooling or activities of washing and packing fruit or prepared vegetables, among others.

- Agriculture: Water use in breeding, irrigation and fumigation activities.

Table 2. Canon for use of water by activity (¢ per m^3)

Use	Superficial	Groundwater
Human consumption	1,46	1,63
Industrial	2,64	3,25
Commercial	2,64	3,25
Agribusiness	1,9	2,47
Tourism	2,64	3,25
Agricultural	1,29	1,4
Aquaculture	0,12	0,16
Water power	0,12	

Source: Decree Nº 32868 Canon for Water Use

The amount of the canon for agribusiness and agriculture reveal a subsidy respect other economic activities, but this subsidy is more evident for the case of the use of water for irrigation of rice fields, sugar cane, pasture, coffee and palm oil, as this traditional field crops, exposed to special market conditions. For the canon these activities must pay an amount of 0.12 colons per cubic meter of water to surface water concession and 0.16 colons per cubic meter of groundwater in concession". (See table 2)

1.5.4 Irrigation policy for agricultural use

Costa Rica has the National Service of Groundwater, Irrigation and Drainage (SENARA) under the MAG, as the responsible for public irrigation and drainage service. The purpose of SENARA is to promote agricultural development in the country through the establishment and operation of irrigation systems, drainage and flood protection, on those agricultural projects that seek a fair distribution of land.

According to data from the State of Nation, the total cultivable area requiring irrigation is 8.6% of the country, representing about 430,000 hectares in basins with marked decrease of flow in dry periods, and located mainly in the North Pacific, Central Pacific and Central Valley. The total area equipped for irrigation is 101,500 ha, which represents about 24% of the area that requires irrigation in the country, and 85% of the infrastructure is surface irrigation, which is a unsustainable system using large volumes of water with high evaporation losses. From this irrigation infrastructure, 30% is from public projects and 70% are private irrigation systems (Astorga, Yamileth. 2013).

SENARA irrigation is through Arenal Tempisque Irrigation District (Guanacaste), which has a surface of 27.918 ha and benefits about 1,000 users, mainly from the cultivation of sugarcane and aquaculture of tilapia for export. SENARA also manages the Small Area Irrigation and Drainage Program whose investments go to irrigation districts throughout the country, with an area of 3,433 hectares, benefiting some 3,430 farmers (SENARA, 2013).

Agriculture in the rest of the country fits the rainfall regime, being in the Caribbean and the South Pacific, areas where they have built drainage canals to lower the floods and contribute to the drainage of waters in areas mostly dedicated to cultivation of bananas, pineapples and palm oil.

1.5.5 Land use and agricultural zoning

The *Sector Plan for Agricultural and Rural Development 2015-2018* has as another strategic areas *Strengthening land management programs, agricultural zoning, usability of digital maps and soil erosion and contamination*. In terms of land use, the country has progressed very slowly, and an important advance is the Executive Decree 37623 (PLAN-MINAET-MIVAH) establishes the *National Land Use Policy* (PNOT) which is a set of binding guidelines for national institutions and municipalities in land policy.

In accordance with Article 28 of the Organic Law of the Environment, this decree states the obligation “of state, municipalities and other public bodies, to define and implement national policies aimed at regulating land use … as well as physical-spatial development. This role “in order to achieve greater harmony with the welfare of the population, the use of natural resources and the environmental conservation."

As one of its crosscutting areas the PNOT has Risk Management and Climate Change, which has foundation on the National Emergencies and Risk Management Law (No 8488), and seeks to reduce the vulnerability induced by natural hazards. The PNOT indicates that the "use of land without proper planning are the main vulnerabilities in the country” because of the use of land in activities not according to proper classification (See section 3.4.9).

The PNOT is the strengthen of the zoning policy mostly based so far on the Law of Use, Conservation and Management of Soil of 2001 which is treated in sections 3.4.8 y 3.4.9. This Law shows some level of implementation in classification of soils, however, the fully implementation of zoning is only a project, according to the information provided by INTA.

1.5.6 Sustainable and climate-smart agriculture

MAG has been promoting a sustainable agriculture through extension methods, practices, and training processes aimed at the adoption of good agricultural and business practices and climate-smart technologies. This program promotes projects for the sustainability of agricultural biodiversity, protection of soil and water resources and the adaptation and mitigation of climate change.

Specific actions of climate-smart technologies, as the organic agriculture program, relates not only to mitigation practices for reducing nitrogen fertilizers, but with sustainability practices that will affect the preparation of crop species that will have to respond to future climate conditions.

In turn, the recognition of environmental benefits of programs as Program Promoting Sustainable Agricultural Production (PFPAS) seeks to strengthen recognition of environmental benefits to private individuals and organizations that promote or good agro-ecological projects and silvo-pastoral production practices, and allows better financing for sustainable practices that will impact the activities adaptation to climate change. Section 3.5.2 show the specific application of this initiative.

1.5.7 Risk management and early warning systems

The National Commission of Risk Prevention and Emergency Response (CNE) has a program to monitor high-risk areas such as basins, estuaries, sedimentation areas, landslides and floods, among others, for preventing disasters. The CNE has mapped a preliminary inventory of sources of threats for different territories[4]. Because of the scale and the lack of basic information, the CNE states that the map is limited in some areas of the country, but so far represent a reference on the subject requiring specialized technical maps made on a smaller scale and under methodologies for identifying and mapping threats. The elaboration of the National Plan of Adaptation (See section 3.5.2), expects to increase the precision on the map of threats (DCC. 2014 b).

In order to maintain monitored some threats, the CNE developed the Threat Monitoring Systems (SIVAS), with data and strategic information on the dynamics of the active main threats. In the recent years, the CNE revisit the issue of surveillance of threats by the CNE and invest in the installation of instruments appropriate to monitor the risk zones. As part of its preventive actions, the CNE has strengthened surveillance systems and monitoring and consolidated scientific and technical monitoring of specialized agencies in the field. The commission has permanent contact with the National Meteorological Institute (IMN) in the monitoring of weather phenomena and how affect directly or indirectly in the country. The CNE has been consolidating technical advisory committees, with representation of the main scientific, technical and academic concerning the country to advice on decisions regarding threats and risks[5].

The CNE has developed a virtual portal for public access on its website with the data and information generated by other monitoring systems by universities and research centers, with the aim of making decisions available in a unique window with different monitored threats.

Within the monitoring of threats, the Early Warning System is a concept that includes other components such as active participation of communities, complementing the automatic weather stations that operate in real time in various parts of the country. Section 3.8.2 shows the limited involvement of farmer in the Early Warning System.

The CNE is coordinating risk management and adaptation to climate change, identifying common points between the National Risk Management Plan (PNGR), the National Climate Change Strategy (ENCC) and Plan Action of the National Climate Change Strategy in order to boost coordination of the institutions involved.

2 Climate change vulnerabilities, risks and trends for the agricultural sector

[4] http://www.cne.go.cr/index.php/prevencie-desastres-menuprincipal-93/mapas-de-amenazas
[5] http://www.cne.go.cr/index.php/component/content/article/281-uncategorised/858-2014-03-20-estructura-operativa-bien-consolidada-enfrentara-temporada-lluviosa-2014

Conductive questions:

- What are some key climate change vulnerabilities, risks and trends specifically for the agricultural sector, including the impacts of extreme climate events?
- What are the most important climate changes/events to consider?
- What are the differences in vulnerability and resilience of farmers across various regions in CR?
- What has been the impact of climate events on agro-systems, on agricultural returns and on other relevant sectors including water and infrastructure? How have the above trends and risks been assessed?

2.1 Climate Change Scenarios for Costa Rica

In 2011, IMN presented the study *Regionalized Climate Change Scenarios for Costa Rica*, with scenarios for average precipitation and temperature by 2100 (Alvarez, Luis et al. 2012). In this study, IMN remarks several international studies rank Costa Rica as one of the "more prominent hot spots of climate change in the tropical area." This ranking focuses on the observation that in the dry season between June and August, the country will experience a decrease in precipitation, observed in the historical records and simulations of 20 global models have projected the weather in the country. Similarly, the IMN found in the *Fourth Assessment Report of the IPCC* (2007), the conclusion that during the XXI century the annual rainfall will decrease in most of Central America

However, the IMN states the future climate scenarios do not respond uniformly across the country, and while droughts and high temperatures occur particularly in the Pacific coast, other regions rather experience a significant increase in rainfall, as in the case of the Caribbean coast. This make necessary to talk about scenarios for the climate variability in various regions of the country.

The IMN used five dynamic models for the development of future scenarios (one regional and four global), to the spatial scale down to 1 km resolution. The scenarios are set for the period 2011-2100, but the low-resolution settings are only for the 2071-2100 period, for the periods 2011-2040 and 2041-2070, the model is PRECIS, with outputs to a resolution range of 50 km.

According to the register of climate and climate variability and the historical records, IMN is proposing the climate of the future would be very similar to that currently occurs when there is the phenomenon known as El Niño Southern Oscillation (ENSO), which is a periodic irregularly caused by climate variations in sea surface temperatures over the tropical eastern Pacific Ocean. Under these circumstances of extreme variability, the coasts of the Pacific experience significant deficit of rain, often with drought, and conversely in the Caribbean coastline the greatest impact are the heavy rains that produced heavy flooding, particularly in the rainy season.

2.1.1 Scenarios of precipitation

According to the future climate scenarios (Alvarez, Luis et al. 2012), precipitation for the period 2011-2100 will be in smaller than the current climate, with reductions that can reach up to 50% in some areas of the north Pacific, placing the rainfall levels in 500 mm per year, which is an

extremely dry condition, almost a semiarid climate. In the Caribbean coast, increases in rainfall will be up to 50% in some areas, and it is possible that the rate of increase is greater in the southern Caribbean and lowest in the northern Caribbean. In the north of the country, the models estimate less rainfall of about 10% decrease, similar to the expected decline in the Central Valley where San Jose and the main provinces are located. In Valley of the General, the rainfall expected decrease is between 20% and 65% in the North Pacific (See table 3).

Table 3. Scenarios of precipitation for the period 2011-2100

Region	Effect in precipitations
North Pacific	Decrease up to 50%
Caribbean	Increase up to 50%
North	Decrease about 10%
Central Valley	Decrease about 10%
Valley of General	Decrease between 20% to 65%

Source: Alvarez, Luis et al. 2012

The projections in the short and medium term (2020 and 2050) show a similar pattern of the long-term (2080) but with lower percentages. Thus, in areas where rainfall increases, such as the coastline of the Caribbean and the southern coast, the model estimates an annual rate of rainfall increase not exceeding 30% and 15% respectively. In regions where the model estimates less rain, the percentages of reduction would be less than 15% by 2020 and 35% smaller by 2050.

As for seasonal variations, the data scenarios show that precipitation will be largely diminished during the dry season than at any other time of year, with an earlier onset and greater intensification of short dry periods in winter, known as "veranillos" (Indian summers), and these occur between July and August.

The increase in annual precipitation level in the Caribbean coastline would be a result of rainfall presented in the dry season, corresponding to the months of June to August. This precipitation increase from 50% to over 100% over the average of the current climate simulated by the model. This increase is entirely consistent with the greater intensity of winds in the Caribbean Sea and rising sea temperatures in tropical Atlantic Ocean. In addition, the south central Pacific observes an increase of rainfall in the dry season, although the percentages would not exceed 10%.

Contrary to the dry season, rains in the rainy season for the Caribbean decrease between 5% and 30%, and between 30% and 50% in the north. This would mean a substantial change in the intensity and frequency of weather events that occur during the winter rains, particularly cold fronts from the north, which would result in the decrease in rainfall in the north and the Caribbean coastline during the rainy season.

In the north Pacific, the Central Valley and Valley of the General the decreased of seasonal rainfall is very homogeneous from one season to another. The variations in the magnitude of the changes is a reduction of 10% in the Central Valley, 30% in the Valley of the General and up to 70% in the north Pacific, while in the rain season would be 5% lower in the Valley of General, 15% in the Central Valley and up to 40% in the north Pacific. Only in the south Pacific, particularly south of the coastal line and throughout the year, there is an increase in rainfall,

which would range from 5% to 40%, being higher in the season from May to July. The reason for this feature is mountainous region prevent the influence of the “trade winds”.

As overall results, the greatest impact of climate change in the annual cycle of rainfall would occur in the months now are the major contributors to the annual rainfall (September and October). The decrease in rainfall in the rainy season of the Pacific would be similar to the ENSO phenomenon, which strongly variations not only in the seasonal rainfall regime but also in the circulation of winds. All of the above are optimal conditions for precipitation decrease in the Pacific coast, even to the extent of becoming severe droughts. On the coast of the Caribbean and South Pacific, the overall effect is a net increase in precipitation.

2.1.2 Scenarios average temperature

Regarding the average temperature, the IMN states, the change in the average temperature[6] of Costa Rica range from 0.53 ° C in year 2020 to 3.9 ° C in 2100 (Ordaz, J. et al. 2010). By 2020 the temperature will not increase, but rather may be a slight cooling. However, since 2020 there is an increasing trend with average temperature exceeding 28 ° C since 2050, the 29 ° C from 2070, and 30 ° C since 2090. This reveals a linear trend for the entire period with a rate of increase of 0.34 ° C per decade, despite the increase would be higher in recent decades (up to 0.6 ° C). Some estimates of used models show even higher temperatures, e.g. 31 ° C to 32 ° C towards the end of this century.

The IMN (Alvarez, Luis et al. 2012) makes a comparison of the annual changes in average temperature between the Pacific coast and the Caribbean, and the projections of the annual changes are higher temperatures in the Pacific than those of the Caribbean coast. In both regions, the temperatures will be stable in the first 20 or 25 years, but then increase at rates between 0.32 ° C (in the Pacific) and 0.37° C (in the Caribbean) per decade. At the end of century, temperatures reach 30 ° C in the Pacific and 28 ° C in the Caribbean.

With the climate models the increase in average annual temperature in future scenarios provides greater variations, ranging from 0.90 ° C in 2020 to 3.36 ° C in 2080, and higher on the Pacific coast and lower in the Caribbean. By 2080, in the Pacific coast the temperature will increase between 3 ° C and 6 ° C. In the Caribbean coast, the 2080 temperature decrease of 0.6 ° C and 1.4 ° C.

2.2 Impact of climate variability on agricultural production

According to IMN, the increasing number of extreme weather events that have occurred in the past 20 years suggests that such events are becoming more constant and severe, with the increasing economic losses, and this affects climate variability in such important activities as the agriculture. The emphasis of policy in Costa Rica to promote food security and safety in agricultural production makes essential the adaptation to the climate change, which has a high effect in the production process in the sector (Villalobos, Roberto y Retana, Jose. 1999).

As seen in the IMN climate scenarios, climate change in Costa Rica involve increases in temperature and reduced rainfall in the north Pacific, central Pacific, the north, the Central

[6] The average for the period 1961-1990 represents the current climate modelling and it is used as a reference (baseline or control)

Valley and the Valley of the General. Meanwhile, the coasts of the Caribbean and the South Pacific have slight decreases in average temperature and increased precipitation. These modifications change and other meteorological parameters, expose crops to different environmental conditions, which modify the biological environment and crop productivity.

2.2.1 Limited existence of studies

The studies about the implications of climate change on agricultural crops in Costa Rica have been limited to only three types of basic grains such as rice, beans and corn. The bean crop is a traditional agricultural activity of great economic importance, since this grain legume is the most consumed in the country and is the main source of protein for lower-income population. The bean crop is a major activity in the north of the country, which has become the main producing region of seed, given the climatic, soil and social conditions. Rice is the most consumed grain in the country an essential in the Costa Rican diet. The cultivation of rice is mostly in the north and Pacific coast (Retana, Alberto et al. 2014).

In addition, some studies focused on coffee, one of the largest export in the country's products. Coffee agricultural activity has a greater socio-economic importance of the country, contributing 20% of GDP, generating 37% of foreign exchange and employment contributing 13.8% of the economically active population. The area has the largest coffee production is the central region sector (Villalobos, Roberto y Retana, Jose. 1999).

The other product is the potato, which is the third most consumed by Costa Rican after rice and beans. Potato production is concentrated mostly in the north of the province of Cartago, which is part of the central valley of the country sector (Villalobos, Roberto y Retana, Jose. 1999).

Moreover, some studies analyze the implications of the requirements of water resources in the agricultural sector under the climate change (PRODUS-UCR. 2010).

This set of studies on the implications of climate change on agriculture is limited, given the need to generate more awareness about the phenomenon and productive implications of the adaptation. However, at least these studies are able to confirm that the country will experience new environmental conditions for which producers generally must be prepared and implement measures to adapt to climate change.

2.2.1.1 Assessment of the Impact of Climate Variability on Agricultural Production: coffee, potato and beans

The results of the analyzed cases (beans, coffee and potato) show the climate variability affects the yields of agricultural crops. However, the analyzed meteorological parameters have a distinct effect, depending on the conditions of time during the crop cycle. The analysis conducts to the humidity deficit has a double effect, causes a decrease in water use efficiency and production of biomass. (Villalobos, Roberto y Retana, Jose. 1999)

Additionally, the results show that temperature affects the crop development in all its phases, this is even the weather parameter that caused greater reduction in yields, the maximum temperature being the most influential in reducing the formation of biomass. The maximum temperature implies a greater evaporative demand, which reduces efficiency in the use of water, thus affecting leaf expansion, light interception and perspiration.

The scenarios show CO_2 fertilization effect on crops, with yields rise sharply in all cases. This is because the CO_2 directly increases the cup of photosynthesis and biomass production plant, for which reason, efficiency in water use increases. However, the biological environment is also affected, for which reason it may be expected that an increase is also given in the competitive production of biomass plants (bad boil), which can reduce the growth and yields crop analyzed.

The results for beans indicate that increases in temperature, combined with variations in rainfall, produced a significant decrease in yields. The element that most weight in this effect is the temperature. Even if the isolated effect of increases in daily precipitation tends to increase yields, when combined with increments of +1 ° C and + 2 ° C in temperature, it is observed that the yields begin to decrease. The most significant decreases obtained is using + 2 ° C. The study found the largest declines in yields are by the high temperatures that occur during the day.

As for the effect of a doubling of CO_2 concentration environment, the yields for beans tend to increase. Despite this fact, when combined with increases in temperature, which in turn reduces the growth of crops, the product is getting lower net returns.

In coffee cultivation, the effect of increasing the temperature tends to increase yields, particularly when the increase is + 2 ° C above the maximum temperature, but this is possible when increase the humidity available, with an adequate water supply, as expected in several areas of the Central Valley. Regarding precipitation, the increase of yields is higher.

In the case of potatoes, temperature increase represent a negative factor for biomass production and yields. Low increase of precipitation represent a positive factor for yields. Comparison of the results shows the effect of temperature has a greater weight than the positive effect of the rain.

In potato, the doubling of concentration of CO_2 plays an important role in the results obtained, and the fertilizing effect of CO_2 is increased. However, when analyzing the combined effects of CO_2 with other meteorological elements shows that although the effect of the precipitation is positive, by applying the temperature effect, its negative impact on performance outweighs the other factors.

2.2.1.2 Recent studies in rice, beans and corn

The effect of climate change has also been regarded by the IMN is the study "*Food Security and Climate Change in Costa Rica*," focused of the policy of MAG about food security of three major crops in the Costa Rican diet: rice, beans and corn (Retana, Alberto et al. 2014). The study present the thesis that the greater intensity and severity of extreme weather events will generate barriers and challenges that affect food security and sovereignty. Changes in climate variability, such as those induced by ENSO, have direct implications on the stability of food production system. Increased frequency and intensity of extreme events such as droughts and floods would pose a great threat to food stability.

This study presents a methodological approach to establish the risk in the production of basic grains, as a relationship between *vulnerability* and *threat*. The existence of a *risk* implies a coincidence on time and space of both the *vulnerable system* and the *threat*. In this case, the *vulnerable system* is the sector of basic grains and the threat is the *variability in precipitation* as

a product of the ENSO phases (El Niño and La Niña). Therefore, the risk is the probability of economic loss from the decrease in product returns from climate change.

The *vulnerability*, in turn, is the presence of two factors: the degree of *exposure* and *sensitivity* of the system is threatened. The *exposure* refers to the *geographical location* of crop production and *sensitivity* the level of *response to the impact* of the El Niño and La Niña on yields.

The geographical area of exposure for rice is the Pacific coast region. The northern area have become more important over the years with the expansion of the production, while the Caribbean this activity has virtually disappeared. In the case of beans, the planting area has focused on three regions: the south Pacific, the north Pacific and the north region. The Central Valley and central Pacific region contribute less and the Caribbean region has the lowest participation. In the case of corn, the most exposed area occurs in the south Pacific, north zone and the Caribbean. The basic grains in Costa Rica present a higher exposure in low and flat lands, dense water network and alluvial soils. These areas have historically presented droughts and floods.

The exposure of rice, corn and bean falls in areas that have a marked seasonality, with a well-defined dry season that lasts from December to April, February and March being the driest and warmest months. The rainy season runs from May to November, being September and October the months of highest precipitation. Climate threats in these areas relate to droughts normally associated with the presence of El Niño. Rainy extreme events relate to multiple phenomena of regional variability such as different cyclonic systems affecting the country between May and November (this period in the rain season when cyclone in the Caribbean affects the weather in the country).

Regarding the threat analyzed for these crops, in the study *Climate Variability and Climate Change in Costa Rica* (IMN. 2008), IMN found that the ENSO (alternation of El Niño and La Niña) is the most likely scenario of climate change in the short term (2014-2040) and El Niño in the long terms (2071-2100). The IMN states that there is a moderate probability (70%) of extreme dry conditions that occur in the Caribbean coastline during La Niña and, on the contrary, rainy conditions in the Pacific coast. In the long term, with El Nino dry scenarios predominate throughout the Pacific. In the South Pacific, as well as the north, they show a more variable condition that the rest of regions, scenarios vary from mild to severe dry rainy. The Caribbean coast and the north region present very homogeneous scenarios of rainy conditions.

The findings of the study show the current exposition of ENSO, the bean has a different risk scenario from rice and corn. Both El Niño and La Niña promote situations of significant risk in most of the producers, so the crop has exposition to conditions of extreme drought as much rain. For rice and corn, the greatest risk from extreme weather situations that may adversely affect the performance occurs during El Niño, with dry extreme events, which mainly affect producers in the Pacific and the north, but during La Niña, the risk drops significantly.

Using information from a study that correlates information of damage, territorial units and affected sectors by climatic events (Flores et al. 2014), the analysis found variations in the performance of basic grains. Using data on producer price per ton of grain and production costs of a hectare of land, the analysis estimates of possible economic gains and losses caused by El

Niño and La Niña in different climatic regions. Table 4 shows the results for the three products as a percentage of loss or gain.

Table 4 Possible economic result caused by Climate Variability by 2100

		Percentage of loss or gain		
ENSO Cycle	**Climate Region**	**Corn**	**Beans**	**Rice**
El Niño	Central	9% of loss	4% of gain	
	North Pacific	4% of loss	5% of gain	8% of loss
	Central Pacific	7% of loss	2% of gain	6% of loss
	South Pacific	5% of loss	4% of gain	11% of loss
	North Zone	5% of loss	1% of loss	6% of loss
	Caribbean	3% of gain	11% of gain	3% of gain
La Niña	Central	6% of gain	5% of loss	
	North Pacific	3% of gain	5% of loss	12% of gain
	Central Pacific	18% of gain	3% of loss	10% of gain
	South Pacific	11% of gain	2% of loss	19% of gain
	North Zone	8% of gain	7% of gain	13% of gain
	Caribbean	9% of loss	5% of loss	7% of loss

Fuente: Retana, Alberto et al. 2014

2.2.1.3 Other economic valuation

Another analysis came from ECLAC in the study *Costa Rica: effects of climate change on agriculture* (Ordaz, J. et al. 2010). This study identifies the relationship of production variables such as labor, capital, climate, irrigation and human capital. In the study, the net income of farmers takes into account the prices of production and input costs. This methodology focus on products studied by the IMN: beans, corn and coffee.

In this case, the meteorological data of precipitation and temperature come from the Group of Solar Radiation and Climate Change Center for Atmospheric Sciences of the National Autonomous University of Mexico (UNAM), with projections to 2100.

The results in agricultural products show production diminishing in returns regarding climatic variables. The study found that low level of temperature or precipitation stimulate production until certain level where yields decrease.

The results show that in corn both temperature and precipitation seem to boost production when the temperature and precipitation are high. Regarding the bean, the results show that the temperature stimulates the production at low levels of increase, to a point from which high temperatures discourage production. With respect to precipitation, the results suggest that high levels of rain decrease the production of beans. In coffee, the results show that high temperatures reduce the yield. The higher rainfall increases yields, while low levels of rainfall rather reduce it.

A general conclusion for these three products the country already reached the temperature, which allows the highest yields for these crops, so that climate change may already be having an adverse effect on these crops (Ordaz, J. et al. 2010).

As another indicator of economic impact of climatic variability, the study uses data from the Household Survey of the National Institute of Statistics and Census (INEC), to set the impact on property income. The findings indicate that the rental income of the property decreases to about two dollars an increase of 1 ° C in average annual temperature. This effect represents about 2% of the monthly income from rental property. The study also concludes that the increase of 100 mm in the annual accumulated rainfall implies a reduction of more than one dollar in income from property rental, which is equivalent to a decrease of 1.8% of average income.

The scenarios show that an increase in temperature of 4% cumulatively by 2050 could produce losses in agriculture reaching up to 2% of GDP. While by 2100, the accumulated economic losses would represent 4% of GDP.

As for impacts caused by either changes in temperature and precipitation, the major negative impacts appear to be due to increases in temperature.

2.2.1.4 Livestock vulnerability to the risk of water system

Another study driven by the IMN is the *Evaluation of the Vulnerability and Adaptation to Climate Change of the Water System in Costa Rica*, which aims to make the adaptation of the water system a mechanism to reduce the risk of climate change (PRODUS-UCR. 2010). The study analyzes the relationship between the livestock sector and water resources in order to establish the vulnerability of the agricultural sector to possible effects of climate change affecting water resources in the country.

The information uses data from SENARA on the number of hectares of agricultural production under irrigation, in addition of data from the Rural Development Institute (INDER) and the Livestock Census of 2000 (CORFOGA. 2000).

In Costa Rica, SENARA has two programs of irrigation: Arenal Tempisque Irrigation District with 27.918 ha and about 1,000 farmers, and the Small Area Irrigation and Drainage for the rest of the country, with an area of 3,433 ha and some 3,430 farmers (SENARA, 2013). For livestock, irrigation plays an important role in maintaining a system of pasture production, especially during the summer. In traditional livestock, there are a very low number of animals hectare of grassland, these systems are low profitable due to low productivity and the sub use given to soils.

Through irrigation and fertilization, many producers establish improved pasture on their farms, forming semi-stabling systems, in which the animals use forages and concentrates. These systems are more efficient and that allow a greater number of animals per hectare, freeing land for other activities. In order to improve these conditions of production, the study recommends implementing the semi-stabling on the farm, which allows a greater number of animals per hectare and can free up space for other activities such as agriculture, forest regeneration, farm forestry or another. The stabling is a system that seeks greater production and better quality of meat in the shortest time possible. The important implication for adaptation is a more efficient

system to feed animal improve the alternative of the traditional livestock, threatened by droughts, decrease of biomass of pastures due to the droughts and insufficient sources of water.

In places where irrigation is generated for pastures the study determines necessary to establish efficient distribution systems water, where they avoid the least possible loss, performing calculations on irrigation needs under criteria such as type of grass, soil characteristics, features environmental, topography, etc.

Regarding the type of exploitation in irrigated land, the study sets that 70% of farms are engaged in the production of beef, 23% to dual purpose and only 7% of milk production. In the dry regions with no irrigation, the extensive production systems are dominant, and these systems use of large areas of grazing, low turnover or permanent occupation of the grasslands. This type of management limits the efficient use of pastures and reduced productivity of farms. Proof of this are the low productive and reproductive rates in the region of 150 Kg of meat per hectare per year, calving of 50% and an average-stocking rate is 0.68 animal units per hectare.

The six-month dry season climate characteristic of the dry regions of pacific are the main obstacle for beef cattle under extensive production systems. Despite this, the vast majority of producers have not bothered to secure livestock feed during this critical time, which continues to cause enormous economic losses, decreased weight development and fattening animals, high adult mortality and low pregnancy rates.

Micro-irrigation programs that are used for growing grasses are few compared to the other activities the irrigation system Arenal-Tempisque, so to climatic conditions in the future scenarios in which much of the areas dedicated to the cattle activity are exposed to higher dry seasons, irrigation for pasture should be increased.

Regarding the dairy industry, the study establishes that water plays an important role, either in the process of milking, cleaning or for the agro-industrial process. However, the existing information on water consumption in the dairy systems is low. Based on the research of the Technologic Institute of Costa Rica (ITCR), on farms of milk in San Carlos and Sarapiqui, the study concludes there is an inappropriate use of water resources, with averages of up to 10.387 liters of water per day for washing the corrals and milking areas. The investigation sets a potential for reducing water consumption almost 90%, to 1.090 liters of water per day.

3 Assessment of current national strategies and policies regarding adaptation and risk management

3.1 Adaptation Policy for Agricultural Sector

Conductive questions:
Are there national development plans or other political statements outlining the government's commitment and role in advancing climate change adaptation, specifically for the agricultural sector?

The policy on adaptation in agriculture is rooted in the National Climate Change Strategy, the general policy of short-term in the *NDP 2015-2018*, as well as sector policy in the *State Policy for*

the Agro-food Sector and Rural Development 2010-2021 and the *Costa Rican Sector Plan for Agricultural and Rural Development 2015-2018*, which derives especially from the *NDP 2015-2018*.

3.1.1 National Climate Change Strategy

The policy related to adaptation in the agricultural sector is subject to multi-sectoral and long-term policy published in 2009 with the *National Climate Change Strategy* (MINAE, 2009). MINAE set this policy as the guiding policy on climate change, which should generate the conditions for all actors and sectors for the implementation of actions for both mitigation and adaptation.

The ENCC establishes different actions that could develop the agricultural sector to adapt to climate change, by a more technical management of agricultural production systems, based on the climate forecasts for decision making related with the planting and subsequent harvest. The ENCC promotes research and development of technologies on crops tolerant to lower humidity and higher temperature to reduce the sector vulnerability, increase resilience.

In water, the ENCC sets the climate change will affect significantly the hydrological cycles, and will cause serious impacts on environment and economic activities. Therefore, this national strategy promotes an integrated water resource management, with the incentive for technologies that increase the efficiency of domestic, industrial, agricultural and hydropower water use and research to reduce vulnerability and identification of adaptation actions in the water sector to climate change.

The ENCC sets as general purpose to ensure continuity and competitiveness of agricultural and other economic activities, by preparing them for adverse situations related to climate variations and reducing the economic costs of the impacts of climate change in strategic sectors of the economy.

In 2012, the *Plan of Action for Climate Change Strategy* states that vulnerability to climate change is a complex function depending on many factors, but with influence of two major components: a) the impact related to the intensity or depth of the damage on the farm, locality, sector and region b) the resilience or recovery. Both components affect in a positive way, minimizing the impact or increasing resilience, with appropriate technologies and crop management (DCC, 2012).

The Plan of Action of the ENCC states that greater adaptation production systems will result in a reduction in the vulnerability of systems to climate variability and better resilience to shocks. This results in lower production variability, particularly regarding climate variations losses due to climate change. "In the case of adaptation, the logic of intervention is aimed at supporting the generation, dissemination and adoption of technologies that reduce the level of vulnerability of the production units, especially those most exposed to the effects of climate change units, and direct actions to increase the pool of resources available to the most vulnerable producers. The increase in the resources can be achieved by encouraging greater social participation, access to more information about consequences and ways to address climate change, and improving access to credit" (DCC, 2012). For this reason, the focus of the policy is to small farmers, particularly those related to the production of basic grains (rice, beans and corn).

“Regarding to reduce vulnerability, Costa Rica has made remarkable progress in recent years in the promotion and dissemination of technological innovations aimed at reducing vulnerability

through sustainable production technologies. Perhaps one of the most notable was the process that occurred through the Program Promoting Sustainable Agricultural Production (see Section 3.5.3), using payments under schemes of recognition of the environmental benefits promoted the adoption of a set of technologies that have tested at field level. Many of these technologies can be dual purpose, contributing to GHG reduction targets and adaptation objectives" (DCC, 2012).

Table 5 and 6 show some details of the actions in the Plan of Action for Climate Change Strategy, the stakeholders and budget.

Only the first action related to *Increased use of technologies with tolerance to changes associated with climate change* is directly associated in the plan as adaptation measure, the other are identified as across-aboard actions, but the influence in the implementation of the adaptation actions implies an indirect effect in adaptation.

Since the design of this plan, its execution have been slow, and the advance reported by DCC is of 22% of the plan (DCC, 2015). Section 3.3 shows the allocation of operative budget of the DCC is low and highly dependent on external cooperation, showing weaknesses of the DCC and MINAE to implement a sector agenda and the ENCC to work in adaptation. Sections 3.5.1 and 3.5.1 show the creation of the Adaptation Fund and the design the National Adaptation Plan as the more precise actions in the same line of action of this Plan of Action, because both are the implementation of the objectives stated in the ENCC.

Table 5. Budget of the Plan of Action in Agriculture of the ENCC until 2021

Action	Executing entity	Stakeholders	Budget (Millions of $)
Increased use of technologies with tolerance to changes associated with climate change (continued, heat, rain, pests and others)	MAG INTA UCR UNA	BID FAO FONTAGRO CATIE EARTH	25
Development Plan for Science, Technology and Innovation in climate-smart agriculture	MAG	UCR UNA ITCR IICA CATIE	0,5
Development plan to bring legal, institutional and fiscal framework for the use of technologies	MAG	UCR UNA ITCR IICA CATIE	0,5
Strengthening of an information system for managing risk and improving information on adaptation	MAG	UCR UNA ITCR IICA CATIE	2,5
Increased program financing through schemes of recognition of environmental services, public budget and private investment	MAG/MEIC	UCR UNA ITCR BID FAO IICA	2,25
		Total	**30,75**

Source: DCC, 2012.

Table 6. Budget of the Plan of Action in Water of the ENCC until 2021

Action	Executing entity	Stakeholders	Budget (Millions of $)
Increased resilience in the water sector populations and ecosystems to the CC.	MINAE AyA SENARA	Municipalities ASADAS	1,16

		International Cooperation	
Strengthening decision-making with information needed to improve the capacity of local and national resilience to the effects of climate change on the water resources sector.	MINAE AyA SENARA	Municipalities ASADAS MAG INTECO Industry ICE CNFL International Cooperation Universities	1,27
Effective and comprehensive management of water resources at national and local levels conducive to adaptation to climate change.	MINAE AyA SENARA	Municipalities ASADAS MAG INTECO Industry ICE CNFL International Cooperation	1,50
Creating a new culture for the efficient use and proper water management to climate change.	MINAE FONAFIFO AyA SENARA	Municipalities ASADAS MIDEPLAN INTECO Industry CNE	1,20
Public and private funding for investment and infrastructure management to reduce vulnerability to climate change in the water sector.	MINAE FONAFIFO AyA SENARA	SINAC Municipalities Ministry of Finance ASADAS International Cooperation	0,40
		Total	**5,52**

Source: DCC, 2012.

3.1.2 The short-term policy

The policy for the agricultural sector of the current administration, as mentioned before, is contained in the *National Development Plan 2015-2018.* The pillars *Adaptation and Mitigation of Climate Change on Agriculture*, aims to promote adaptation and mitigation measures and climate risk management, through investment, recognition of environmental services and other incentives. In addition, this pillar fosters the development of green business, eco-friendly businesses and use of technologies to reduce GHG emissions and to maintain and increase productivity in the priority activities.

The pillar of Adaptation and Mitigation of Climate Change Agriculture poses action in five strategic areas:

- Adapting production processes to climate change.
- Mitigation of the agricultural and rural sector to climate change.
- Promotion of green business.

- Comprehensive risk management.

Actions to adapt production processes to climate change

Adaptation actions in production processes aim to maintain production capacity through the development of a strategy of transfer and extension of applied research, agricultural zoning, development of new technologies and varieties resistant to extreme conditions, integrated pest management, decontamination of soil and water, and reducing of erosion.

Among the strategic actions are the following:

a) Programs for land use, agricultural zoning and digital maps of usability of soil.

b) Research for transfer and extension about varieties of crops that respond to extreme weather events.

c) Research programs for obtaining good quality seed of improved varieties tolerant to adverse weather conditions, to their promotion and use.

d) Promotion of efficient use of water resources, development of water storage systems, technologies and investment in infrastructure.

e) Strengthening of irrigation and drainage programs to reduce excess water and expand areas for production.

f) Promoting appropriate use of technology in accordance with the conditions of the crop, region, economic conditions and climate variability and change.

Actions in mitigation of the agricultural and rural sector to climate change

The implementation of mitigation measures to climate change should promote healthy food production, productive environment with a friendly environment and an effective contribution to the country's goal of carbon neutrality. Some of the activities in this field contribute to the promotion of adaptation actions, by the synergy in some mitigation actions in crop improvement. This synergy is especially with the development and implementation of NAMAs in priority productive activities such as cattle, coffee and sugarcane[7], which seek to strengthen programs for sustainable and organic agriculture, through practices and methods of extension and training processes aimed at the adoption of good agricultural and business technologies. According to the Action Plan of the ENCC "many of these technologies can be dual purpose, contributing to GHG reduction targets and adaptation objectives" (DCC, 2012).

Actions to promote green business

To promote green business, the pillar proposes differentiated credit, research transfer and technical assistance for those using biomass sources. The importance of this type of business in the agricultural farm is it strengthens the management, marketing strategies and the development of partnerships between producer organizations, researchers and academia. Strengthening green business focus on agricultural with sustainable practices, together with the

[7] Currently, MAG is working in NAMAs for coffee and cattle.

incorporation of payment for environmental services (PES) for environmentally friendly products, which allows financial flows and favorable management capabilities for incorporating adaptation actions and risk management on the farm.

Actions in the integrated risk management

Risk management will focus in agricultural planning to prevent the risks associated with extreme events disasters affecting agricultural production.

The strategic actions include:

a) Coordination with the National Commission of Risk Prevention and Emergency Response (CNE) in the monitoring program for high-risk areas for disaster prevention (see Section 1.5.7).

b) Establishment and improvement of the National System for Integrated Water Resources Management and the consolidation of national disaster information system with emphasis on hydro-meteorological events (see Sections 1.5.4 and 1.5.6).

c) Joint actions with insurance companies to develop insurance programs based on different climate indexes.

d) Strengthening financial funds for emergencies in work areas of the National Animal Health Service (SENASA) and the State Phytosanitary Service (SFE).

e) Establishment of actions to greater resilience to disasters by extreme natural events of the owners or managers of animals.

f) Development of institutional protocols for prevention and disaster management in the agricultural and rural sector, and establishment of a permanent training plan for farmers and officials.

The budget of the NDP for the agriculture sector is in the Sector Plan for Agricultural and Rural Development 2015-2018 (MAG 2011b). (See Section 1.1.1)

Table 7. Budget of the Sector Plan for Agricultural and Rural Development 2015-2018

Strategic areas	Budget (Millions of $)
Actions to adapt production processes to climate change	8.7
Efficient use of water by users	4.4
Land use	4.2
Sustainable agriculture aimed at the adoption of best practices	0.1
Actions in mitigation of the agricultural and rural sector to climate change	0.3
Actions to promote green business	2.8
Actions in the integrated risk management	16.8
Total	28.6

Source: MAG, 2011 b

3.1.3 The long-term policy

The long-term policy on climate change is contained in the *State Policy for the Agro-food Sector and Rural Development 2010-2021*. As indicated in section 1.1.2, this policy instrument is referential, and that aims to serve as a guiding framework for decision-making. The Policy sets out five strategic areas:

- Climate variability and change.
- Agro-biodiversity.
- Cleaner Production.
- Sustainable management of land and other natural resources.
- Program of recognition of environmental services from agriculture.

Climate variability and change

Climate variability and change is an area whose actions seek to encourage mitigation and adaptation to climate variability and change and the prevention of associated risks. One component of this area of action is the Integrated Risk Management looking for sector coordination on those natural hazards including climate and the processes of soil erosion and sedimentation, risks associated with microorganisms, and other natural events affecting infrastructure. The tools for integrated risk management are:

- National system of risk prevention, care and disaster management of extreme natural events.
- Application of research studies on risk management. These studies looks for technical objectivity to prevention efforts, reducing the effects of extreme natural events and actions of adaptation and mitigation of climate change.
- Regional and local plans for integrated risk management to define those strategies on climate change to be implemented in the short and medium term, according to the priorities established and the allocation of resources.

Adaptation to the effects of climate change involves the sustainability of production processes with actions such as the relocation of activities from those areas where it is losing the biophysical conditions for crops such as temperature or adequate levels of precipitation or water availability, to other areas that are prone to maintain these crops. Another action mentioned is the development of new production options, which means new crops or new varieties of existing crops, presenting greater resistance or better adapted to the new climatic conditions. Improved genetic material is an action to ensure adaptation to climate change with the development of species that show better adaptability. Another area of work is the set of measures to include new farming practices, water management and soil protection, with lines of action to sustain production processes. To adapt to the effects of climate change this area of work proposes the following instruments:

- Program on land use planning for agribusiness: The sector will design and implement gradually a program for the development of agro-productive activities that are adapted to future climate scenarios and future variability, according to the capacity of land use in different areas of the territory.

- Strategies to adapt to climate change impacts: Sector and inter-sector programs consistent with the National Climate Change Strategy and international standards.

- Integral system of plant and animal disease prevention: A system of research and preventive measures to minimize the impact of disease due to habitat modification of the transmitters and the spread of viruses and bacteria that affect globally by the climate change.

This area of climate variability and change also proposes knowledge management and capacity building on climate change, with a program of generation and use of information for the processes of prevention, mitigation and adaptation to variability, climate change and integrated management risk. The instruments in this area are:

- Training programs, information and communication on climate change and environmental policy, to raise awareness and develop a culture of climate change linked to the food agriculture.

- Comprehensive information system on variability, climate change and risk management, with coordination with the IMN, for timely decision-making in the prevention, mitigation and adaptation. Thus, the information system improves the availability and timeliness of weather and climate information in the areas where the agro-food activities take place.

Agricultural biodiversity

Agricultural biodiversity as a strategic area involves the development of strategies and collaborative activities related to the conservation and use of plant and animal genetic resources linked to food production systems.

Clean Production

Clean production is sustainable practices and techniques in the priority agro-production chains, aimed at preventing environmental pollution, more sustainable, productive modernization and competitiveness of businesses, with emphasis on the small and medium enterprises (SMEs). This strategic area and lines of action propose agreements to incorporate practices to comply with mandatory environmental standards and promoting the use of waste food production, as well as participatory organic certification.

Sustainable land management and other natural resources

This strategic area integrates the elements of the policy of management of rural areas and sustainable production and proposes as an instrument the classification of land use and capability with agribusiness, environment and health criteria (see Section 3.4.8). The sustainable management is looking for a balance between production and environment, as part of the modern view of competitiveness. The ordering of territories allow the identification and

prioritization of intervention scenarios, inter-sector strategies, and plans to promote production techniques in priority watersheds and biological corridors.

Recognition sustainable production

This is a program for eco-systemic protection of water, soil, biodiversity and other resources; based on the use of existing economic compensation mechanisms and new ones arise in the future, promoting sustainable use of natural resources. The program will build instruments such as the recognition program of environmental services for the food industry and payment for environmental-grazing and forest services. These compensatory mechanisms allow the financing of measures sustainability of production processes to climate change (See section 3.5.3).

3.2 Institutions for Adaptation Policies for Agricultural Sector

Conductive questions:
What are the main institutions responsible for the design, coordination and implementation of adaptation policies, programs and projects?

The Ministry of Environment and Energy is the institution responsible for the design, development, evaluation and control of sector policies on adaptation to climate change. The implementation of this policy is in charge of the Directorate of Climate Change (DCC), which is a multi-sector coordinator in the formulation of policies, plans, programs and projects focused on compliance with the National Strategy on Climate Change.

The President of the Republic leads the coordination at the highest political level among the main organizations involved in climate change by the National Environmental Council established by the Organic Law of the Environment. The National Environmental Council is responsible for the promotion and recommendation of environmental policies in the country, and is collegiate body that advises the President on strategic issues.

The Environmental Council is composed of the President, or on behalf of him the Minister of the Presidency; Planning Minister; Environment Minister, who serves as Executive Secretary; Minister of Health; Minister of Agriculture, Minister of Education; Minister of Science and Technology and the Minister of Housing and Human Settlements.

The main functions of the Environmental Council are:

- Analyzing and recommend general policies for sustainable use of natural resources.
- Recommending environmental policies in planning processes.
- Promoting development policies in accordance with the principles of the ENCC and other environmental policies.
- Proposing and promoting policies of development of scientific and technological research.
- Promoting pertinent legal reforms in environmental matters.

The Inter-Ministerial Technical Committee on Climate Change is an advisory body of MINAE and support for monitoring of the National Strategy on Climate Change. This committee is composed of the following institutions:

a) MINAE represented by the DCC, as coordinator and technical secretariat.

b) Ministry of Public Works and Transport.

c) Ministry of Agriculture.

d) Ministry of Science and Technology.

e) Ministry of Finance.

f) Ministry of National Planning and Economic Policy.

Other institutions are called to the committee upon to technical matters, such as the National Meteorological Institute and FONAFIFO as the focal point for REDD + in the country.

The Inter-ministerial Technical Committee is responsible for supporting the generation of technical inputs to enable the application of the proposed public policy on climate change and monitor the implementation of the National Climate Change Strategy, the Action Plan of the National Strategy Climate Change and other initiatives at national or international level.

Another function of the committee is support coordination processes of sector actions among different public and private institutions, in order to ensure integrated follow-up action on climate change.

In addition to these institutions, the IMN has identified the following organizations involved with the issue of adaptation and risk management in agriculture:

- Ministry of Agriculture and Livestock (MAG), as head of the policies of the sector.
- National Production Council (CNP), as statistical price provider.
- National Rice Corporation (CONARROZ), related to rice sector.
- National Banana Corporation (CORBANA), related to banana sector.
- Livestock Development Corporation (CORFOGA), related to beef sector.
- Integral Agricultural Marketing Program (PIMA), related to capacity building in marketing for farmers.
- National Horticultural Corporation, related to low farmer organizations.
- Coffee Institute of Costa Rica (ICAFE), related to coffee sector.
- Rural Development Institute (INDER), related to policy of rural development.
- Land Management (INDER), related to policy of rural development in INDER.
- Integrated Food Program PIA (INDER), related od food agriculture policy of rural development in INDER.
- National Insurance Institute (INS), related to insurance system.
- Industrial Agricultural League of Sugarcane (LAICA), related to sugar cane sector.
- Development Board of the Southern Zone (JUDESUR), related to low farmer organizations.
- National Institute for Cooperative Development (INFOCOOP), related to local

government policies.

- National Seed Office (ONS) – MAG. Related to seeds R&D.
- National Institute of Agricultural Innovation Technology (INTA) - MAG. Related to agriculture R&D.
- Executive Secretariat of Agricultural Sector Planning (SEPSA) - MAG. Related to economic R&D.
- The State Phytosanitary Service (SFE) – MAG. Related to policies and actions on crops phytosanitary surveillance.
- National Animal Health Service (SENASA) – MAG. Related to policies and actions on animal Health.

3.3 Budget Allocated for Agriculture Climate Change Adaptation

Conductive questions:
Is there a specific budget allocated to agricultural climate change adaptation?
Are there one or various funding institutions for the implementation of adaptation policies?
Does the budget for adaptation initiatives compete or complement the budget allocated to other actions and initiatives within the sector?

Possibly, the main gap between the policies climate change adaptation in agriculture and the capacity of implementation of their actions in the country is the lack or low specific budget to support the strategic areas and pillars well define in the short-term and long-term policies presented in section 1.1 and detailed in section 1.3.

The allocation of operative budget of the DCC is low and highly dependent on external cooperation, showing weaknesses of the DCC and MINAE to implement a climate change agenda and especially the work on adaptation. Table 8 presents the Operating Budget of DCC and shows this entity only count on $ 11 thousand in 2015 from the budget of MINAE and 99.8% of the budget comes from external cooperation. Only $ 581 thousand are clearly directed to adaptation, but section 3.10.2 show how the budgeted by other funding institutions providing this external cooperation have indirect effect in the actions in adaptation.

Table 8. DCC: Operating Institutional Plan 2015

Concept		Amount ($)
Total Operating Institutional Plan		**6.067.759**
Total DCC Budget		**11.037**
Total International Cooperation		**6.056.722**
Plan of Action of the National Climate Change Strategy	DCC Budget	2.222
	International Cooperation	5.156.444
	Canje de deuda	96.685
	Acción Clima GIZ	429.889
	LECB	232.426
	Programa nacional CC	262.019
	Proyecto movilidad urbana	3.786.037
	BID Fomin	349.389
GHG emission reduction program	DCC Budget	4.444
	International Cooperation	317.963
Adaptation program for productive sectors	DCC Budget	2.222
	International Cooperation	579.537
Improvement of the quality of public management	DCC Budget	2.148
	International Cooperation	2.778

Source: DCC

The declaration of policies in adaptation has improve since 2010, first defining climate chance as a priority into the topics in agriculture policies, and making a specific treatment of the issued represented by the adaptation to the climate change and risk management in agriculture.

However, the policies in agriculture adaptation seem strong in political awareness buy weak in allocation of proper resources to support the specific actions even stated in the policies.

The financial support of adaptation measures is immerse in the general allocation of budget for the sustainable development action the agriculture police involve. The relevant units in the MAG supporting the adaptation measures as INTA, the SFS, SENASA, ONS, SEPSA and the Office of Agricultural Extension, are working in programs influencing the uptake adaptation or risk management measures by farmers, as seen in sections 1.5 and 3.6. However, these units do not have a specific budget defined to fund this measures and the financing is by the general budget dedicated to the sustainable development activities under the responsibility of these units. Table 9 presents the total budget of the agencies related to the implementation of agriculture policies. This budget do not separate the specific budget related to adaptation.

Table 9. General Budget of Agriculture Agencies under MAG

Agriculture Agency	Budget
Ministry of Agriculture and Livestock (MAG)[8]	60.331.481
Directorate of Agricultural Extension[9]	26.974.630
Project in the Sixaola River Basin[10]	576.481

[8] This refers to the central activities of MAG.
[9] Program implemented directly by MAG.
[10] Program implemented directly by MAG.

Executive Secretariat of Agricultural Sector Planning (SEPSA)	1.809.074
National Institute of Agricultural Innovation Technology (INTA)	3.586.111
National Institute of Rural Development (INDER)	70.012.778
National Animal Health Service (SENASA)	25.315.185
The State Phytosanitary Service (SFE)	27.390.185
National Seed Office (ONS)	1.080.000
Integral Agricultural Marketing Program (PIMA)	4.665.926
National Production Council (CNP)	111.116.481
Total	**332.858.333**

Source: SEPSA, MAG

The other institutions outside the MAG and supporting action influencing the uptake of adaptation measures in agriculture have also an unclear allocation of budget directed to adaptation in agriculture. Only SENARA can be the exception of this situation, due to the role of this institution providing irrigation and drainage services to farmers. Section 3.6.2 shows the details of the budget of the programs of SENARA. Section 3.9.2 presents some of the finance by other funding institutions.

However, the allocation of budget for adaptation in agriculture do not seem to compete with other initiatives into the sector, because the support of adaptation measures is part of the sustainable development activities these institutions promote and do not mean any deviation of their competences and functions.

In terms of risk management and attention of disaster affecting farmers, this competence for resources with other initiatives in clearer. Most of the actions in the attention of disasters demands rehabilitations of lost infrastructure of cultivation land, distracting resources suitable for new infrastructure or new crops. Section 3.6.1 shows the estimate of budget dedicated to the attention of disaster in the sector.

3.4 Legislation and regulation related to adaptation to climate change

Conductive questions:
Are there any regulations related to adaptation to climate change specifically for the agricultural sector?

Costa Rica has no specific legislation or regulation aimed at climate change, let alone facing adaptation to climate change in agriculture. The actions related to the subject of adaptation and particularly in the agricultural sector arise rather from policies that issued over the years and used as a legal basis that existing environmental legislation.

3.4.1 Organic Environmental Law No 7554 of 1995

The objective of the *Organic Law on the Environment* is to provide the tools necessary to preserve the rights established in the Constitution, Article 50, which states: "everyone is entitled to enjoy a healthy and ecologically sustainable environment for development, and the duty to

preserve it." This law defines the environment as "the system consists of different natural elements in it and their interactions and relationships with humans."

One of the main contributions of the Organic Law on the Environment is to establish the principles governing environmental policies and the following are legal grounds for adaptation policies:

- The environment is the common heritage of all people ... the State and individuals must participate in their conservation and sustainable use.
- Everyone is entitled to enjoy a healthy and ecologically sustainable environment.
- The State shall ensure the rational use of environmental elements, in order to protect and improve the quality of life of the inhabitants of the country. It is also required to promote economic and environmentally sustainable development... without compromising the options of future generations.

The law also mandates the State to provide, through their institutions, the implementation of an information system for environmental indicators to measure the evolution and correlation with economic and social indicators for the country. This is what has given legal basis to implement policies such as early warning indicators.

These mandates require the government set a harmonious and interrelated set of objectives aimed at improving the environment and manage properly natural resources. The actions arising from the implementation of this mandate should try the following purposes:

- Meeting human needs without limiting the options of future generations.
- Prevent and minimize the damage caused to the environment.
- Regular human behavior and public or private activity regarding the environment, its use and conservation.
- Establish the principles that guide the activities of public administration in environmental matters, including coordination mechanisms.

Another mandate of the law is that the State and its institutions permanently promote studies and research on the environment. These entities deal with disseminate and support the development and implementation of modern, appropriate environmentally sound technologies.

One of the most important regulation of this law is land use, demanding the state, local governments and other public entities, the definition and implementation of national land management policies. This regulation seeks to regulate and promote the economic activities and physical-spatial development, in order to achieve greater harmony between the welfare of the population, the use of natural resources and environmental conservation. The law demands in this area land use planning based on sustainable development, and allocation in territories with districts of irrigation and drainage activities, to guide the use of environmental elements in balance with the sustainable development (see sections 3.4.8 y 3.4.9).

Regarding water, confirms the status of this resource in the public domain and social interests of their conservation and sustainable use. Therefore, the State must have policies to protect,

preserve and restore aquatic ecosystems and the elements involved in the hydrological cycle as components of watersheds.

On soil, the State should have policies to protect and exploit the soil, under the criteria of the proper relationship between the potential use and the economic capacity of the soil and subsoil, which must procure determine potential use and destinations. The State must ensure the granting, amendment, suspension or revocation of permits, concessions or any other authorization on land use, based on management plans for proper use of the soil (see sections 3.4.8).

The Organic Law on the Environment introduces the concept of organic farming, which will be employing methods and systems compatible with the protection and ecological improvement or inputs without using synthetic chemical products. The State shall promote organic farming as a complementary activity to traditional agriculture and agribusiness, for which it creates a system of organic certification and promotes scientific research and technology transfer to organic farming.

In an evaluation of the environment around the organic agriculture, MAG identified in 2013 only 102 farmer, showing a low penetration of this practice in the agriculture of the country (MAG. 2013).

3.4.2 Organic Law of the Ministry of Agriculture No 7064 of 1983

The *Organic Law of the Ministry of Agriculture* sets out the competences of the Ministry of Agriculture within the agricultural sector, and the task to promote agricultural development from research and extension, with socio-economic objectives of according to the needs of the farmers. In addition, the MAG must support rural development policies and renewable natural resources preservation, in coordination with other sector institutions.

Another competence of MAG is addressing the problems that affect agricultural activities, especially those related to diseases, pests and environmental pollution by SENASA. In addition, MAG can participate with other institutions in the sector, identifying the needs of construction and maintenance infrastructure for agricultural development and renewable natural resources, for example irrigation systems with SENARA.

To fulfill these functions the MAG should conduct regulation, rationalization and support of the agricultural and livestock sectors through the establishment of controls, records and regionalization and zoning programs (see section 3.4.8).

3.4.3 General Law on the National Health Service Animal No 8495 of 2006

The *General Law of the National Animal Health Service* provides protection of animal health, veterinary public health and operational competences of the National Animal Health Service (SENASA). This law can give support to a policy of adaptation in this field based on the mandate of the State to preserve, promote, protect and restore the health of animals, in order to procure greater well-being and productivity, in line with the environment. SENASA is responsible for monitoring and regulating the use and exchange of animals, their products and by-products, as well as regulate and monitor the use and exchange of genetic material of animal origin.

The work of SENASA regarding the regulation consist on planning and implementation of control measures the health of the animal population, waste and veterinary public health, SENASA is a

strategic entity supporting the zoning of livestock activities, allowing this entity to regulate in the future these livestock activities to adapt to climate change. This regulation can be based on measures to avoid diseases and pests of animal related to climate chance.

The competences assigned to SENASA include issuing the relevant technical standards; develop manuals of procedures as well as implementing and monitoring animal welfare measures, veterinary inspection, internal displacement, import, export, transit, sanitary cordons and prohibition of travel to infected areas. It also corresponds to the SENASA promote, conduct and communicate research in the field of veterinary public health and animal health. Furthermore, SENASA is the entity that has the power to ask the State of the declaration of national emergency or regional animal health.

3.4.4 Water Law No 276 of 1942

The regulation of the topic water is one of the areas in which the country is more outdated, since its current law dates from 1942, with major conflicts in recent years between the various interest groups to pass a new law.

Since 2000, a participatory process began for the presentation of a Bill of Water Resources. In 2010, the Congress welcomed a proposal as popular initiative, but the current legislative period have four bills, two developed by political parties and one prepared by the MINAE, alongside with the popular initiative. This shows that there is interest from various groups to have a new legal framework on water, but at the same time are different interests among users, the private sector and the public sector (Astorga, Yamileth. 2013).

The current Water Law regulates water bodies that are national domain and tap the water sources under concessions granted by the State, through the MINAE, which corresponds the decisions on the domain, development, utilization, or monitoring on public waters.

The uses for troughs, dairies must obtain the corresponding permits, through procedures determined in this law in the Directorate of Water. Landowners can take rainwater for irrigation for their land and build, without authorization, and have water retention systems, trying to make the harvesting of water a straight-ahead and low cost process.

The owners of coffee processing plants, mills, factories and other industrial enterprises or for the development of hydropower cannot use public water without special permits for that purpose, looking for an ordered and rational use of the resource.

3.4.5 Law establishing the National Service for Groundwater, Irrigation and Drainage No 6877 of 1983

The National Groundwater, Irrigation and Drainage (SENARA) has to promote agricultural development through the establishment and operation of irrigation systems, drainage and flood protection.

SENARA must develop and implement a policy for the use and distribution of water for agricultural purposes, in harmony with the best possibilities of use of land and other natural resources in irrigation districts.

Another function that the law gives to SENARA is research, protect and promote the use of the country's water resources, both on surface and underground, and in the same order, conduct,

coordinate, promote and maintain updated hydrological research to identify those areas and regions where it is feasible to establish irrigation and drainage districts.

SENARA has the power to acquire property and rights to establish, integrate or modify the distribution areas of irrigation and flood protection settlement.

SENARA should guide, promote, coordinate and implement national programs of research and training for the development of all activities related to irrigation, drainage and flood control in coordination with related research centers. In particular, SENARA must coordinate with the National Emergency Commission and other relevant agencies, the development and implementation of prevention programs and flood control, keeping up also the necessary information systems.

3.4.6 Biodiversity Law of 1998

The *Biodiversity Law* aims to regulate biodiversity conservation and sustainable use of resources and distribute fairly the benefits and related costs. The Biodiversity Law gives to the State the obligation to avoid any risk or danger threatening the permanence of ecosystems and the environmental quality.

This law regulates all activities aimed at recovering the structural and functional characteristics of the original diversity of a given area, for conservation purposes, integrating the conservation and sustainable use of biodiversity elements in the development of cultural, economic and environmental policies. In addition, the law regulates the recognition and compensation of knowledge, practices and innovations of indigenous peoples and local communities for the conservation and ecologically sustainable use of biodiversity elements and recognize the rights coming from the contribution of scientific knowledge to the conservation and ecologically sustainable use of components of biodiversity.

The MINAE coordinates the administrative organization responsible for the management and conservation of biodiversity through the National Commission for Management of Biodiversity, which corresponds to coordinate and facilitate dialogue with the political, economic and social sectors around conservation policies, ecologically sustainable use and restoration of biodiversity.

A major contribution of the Biodiversity Law is through the Payment for Environmental Services (PES), established to compensate these services on land in protected areas. The law allows the Regulatory Authority for Public Services authorized to charge users, through the relevant fee, a percentage equivalent to the cost of the service provided and the size of the program or project in an area dedicated to conservation. The entity that collects such payment shall make transfers of funds raised to owners or managers of the land involved.

3.4.7 Forestry Law of 1996

The *Forestry Law* strengthens the Payment for Environmental Services by the creation of the Certificate for Forest Conservation, in order to compensate the owner or holder for environmental services generated by conserving the forest on private farms.

The concept of PSA follows the principle that owners of forests and forest plantations receive payments as a measure of compensation for the services these ecosystems provide to Costa Rican society and the international community.

The environmental services recognized by the PES are:

a) Mitigation of emissions of greenhouse gases (reduction, absorption, carbon sequestration and storage)

b) Protection of water for urban, rural or hydroelectric use.

c) Protection of diversity for conservation and sustainable, scientific and pharmaceutical use, research and breeding, protection of ecosystems and life forms.

d) Natural scenic beauty for tourism and scientific purposes.

The PSA has finance of 3.5% the tax on consumption of fuel and other hydrocarbons, collected by the Ministry of Finance and makes the transfer to the National System of Conservation Areas (SINAC) for conservation areas of the state and National Forestry Financing Fund (FONAFIFO) for forest conservation on private areas.

3.4.8 Law of Use, Conservation and Management of Soil of 2001

The *Law of Use, Conservation and Management of Soil* establishes the obligation of the best available technology and best practices in land use, in order to preserve water, prevent soil erosion and exploit rationally and intelligently the soil. This obligation the law gives legal framework for policies to protect, conserve and improve soils as an integrated and sustainable management of natural resources and the environment.

Among other objectives of the law, MAG is entitle to planning through environmental inventories looking for the balanced between utilization and usability and productive potential of the soil. In addition, this entity must promote the implementation and control practices that prevent erosion and other forms of land degradation, and promote agro-ecology to achieve convergence between the objectives of agricultural production and the conservation of soil and water resources.

The MAG is responsible for implementing the provisions of this law in coordination with MINAE, for which must monitor, evaluate and perform basic studies of land use to define agricultural use, in line with the guidelines of territorial order. MAG must assess the land, making a classification by their agronomic, socio-economic and ecological value to define agricultural zoning. This evaluation is binding for other institutions in the agricultural sector, farmers and specific corporations.

For the preparation of a National Plan of Management and Soil Conservation, MAG must investigate agro-ecological and agronomic for the best use of land, water and other natural resources techniques; also disseminate the results of their research, promoting training in all professional and technical levels, technology transfer in the use, management and soil remediation. It should also provide technical assistance to producers on agro-ecological practices and soil conservation technology.

This law gives to MAG control over land management measures, and tracking of people and companies dedicated to carrying out management plans for use, handling and soil conservation, in order to comply with this law. MAG must maintain an updated data on environmental,

technical and socio-economic issues related to both soil management and conservation and a land use database.

The National Plan of Management and Soil Conservation must define the use of the national territory, identifying suitable areas for different activities according to agro-ecological and socio-economic factors in the regions, with the recommendation of the systems and methods to continue to promote the conservation, improvement, recovery and rational use of soil resources. In addition, the plan must have a definition of critical areas, based on the criterion of the severity of land degradation and its environment, and fundamental limitations to exercise any activity. The law states the revision and adjustment of this national plan every two years.

On the other hand, the law assigns to the MAG, MINAE and Ministry of Health production and dissemination of research about soil management practices.

Law introduces some incentives, for example, any exemptions or incentives, fiscal or tax, as well as access to preferential loans subject to farmers, should be assign by a previous revision and approval by MAG, of the actual or proposed use of the land according to potential use, supported by professional licensed by the Professional Association of Agricultural Engineers. In addition, owners with management practices, conservation of soil are exempt from paying property tax on a forty percent (40%).

Other incentives that flow from this law are public recognition with the distinctive Ecological Flag Soil (Bandera Ecológica en suelos), issued jointly by the MAG and MINAE, payment for environmental services and the granting of a lower tax value to agricultural properties. All farms can qualify for these incentives if follow the management plan approved by MAG and this is instrument with the potential to include adaptation measures as part of a management plan.

3.4.9 Environmental Planning Executive Decree 29393-MINAE of 2001

The article 37 of the Organic Environmental Law states that MINAE must establish an Environmental Management Plan that will regulate the activities that occur in private domain lands included within the forest reserves, protected areas and wildlife refuges. These include agricultural activities carried out on land within territories in the public protection system.

This decree generates an agriculture system depending on the classification of land use in specific geographical area, based as physical, biological and geological factors territories.

This decree introduces the concept of conflict of land use which is defined as "the problem that occurs when the current divergent land use with its ability to land use." Additionally, the decree states a proper use of the soil according to its capability reduce the vulnerability of soils to unavoidable natural phenomena. The improper land use acts as a catalyst and magnifying, causing hazards can become disasters.

Therefore, the correct use is when the land use matches the usability. For annual agricultural crops, the proper use is on soils classified as I, II and III. For permanent crops, the proper use occurs in soils classified as IV, V and VI.

The MAG defines the classification of types of usability as follow:

- Class I lands have little or no constraint on agricultural and forestry activities, including livestock ecologically adapted to the area.

- Class II lands have slight limitations that alone or in combination, reduce the choice of activities or increase production costs due to the need for management practices and soil conservation.

- Class III lands have moderate limitations that restrict the choice of crops. The use for annual crops requires intensive management practices, soil conservation and water.

- Class IV lands have severe limitations, alone or in combination, to restrict their use to semi-permanent and permanent vegetation. Annual crops are possible only occasional, requiring intensive management practices and soil and water conservation.

- Class V lands have severe limitations to the development of annual, semi-permanent or permanent crops or forest, so its use is restricted to grazing or natural forest management.

- Class VI lands are used for forest production and permanent crops such as fruit and coffee, although the latter require intensive management practices and soil and water conservation.

- Class VII lands have severe limitations, so only if forest management of forest cover is allowed. In cases where the current use is different from the forest, forest restoration be sought through forest regeneration through natural regeneration.

- Class VIII lands do not meet the minimum conditions for agricultural or forestry activities some production. The lands of this class are useful only as part of preservation of flora and fauna, protection of aquifer recharge areas, gene pool and scenic beauty.

3.4.10 Urban regulatory plans

The operation of an agriculture activities must follow the Urban regulatory of the municipality of the canton the farm is located.

The license to operate any business granted by a Municipality. In the best of the cases, is a process lasting two or three month. However, due to it is a cross permits requirement (other relevant permits from Ministry of Health, National Insurance Systems and so on), missing some requirement means the process can take between six to twelve months. Same situation if the farm need to register a chance the category of business, from agriculture to livestock or to other economic activity.

For agriculture activities, the only requirement is to locate the farm in zones defined for “rural activities” into the canton (municipal territory). The only exception is for starting a cattle production, because this requires the inspection by SENASA of MAG, to certify the fulfilment of animal exploitation requirements.

In the case of a chance into other agriculture permit, the farmer does not an extra permit. In this way, a permit process do not prevent the innovation in activities in farms.

The requirement of the management plans for use, handling and soil conservation can prevent an activity if the MAG finds farms with areas close to rivers of with slopes making them suitable for practices of protection of rivers and soil. However, if the area of the farm comply with the conditions for soil use in agriculture, the farmer can make chances in agriculture activities with no limitation by MAG.

3.5 Measures to improve the uptake of adaptation practices and influence the resilience of farmers

Conductive questions:
Are there any specific measures to improve the uptake of adaptation practices and influence the resilience of farmers?

The revision of the policies in agriculture and in climate change shows Costa Rica has specific policies focused in the field of adaptation and in risk management, however, the existence of explicit policies, do not necessary mean Costa Rica has a high level of implementation of specific measures in line with these policies. However, many measures focused on suitable development in agriculture have important impact in the uptake of adaptation practices. The measures include:

- The Creation of the Adaptation Fund
- The Elaboration of the National Plan of Adaptation
- The Program Promoting Sustainable Agricultural Production
- The Voluntary Certification in Good Agricultural Practices
- The Assistance for Farmers after Extreme Events
- The Regulation on agrochemicals

These measures to encourage adaptation practices and improve the resilience capability of farmers come from sustainability agriculture policies of MAG and other entities related to the sector. Only the creation of the Adaptation Fund and some action by SENARA in irrigation and drainage, are explicit measures that have adaptation as central objective.

For the identification of existing measures in adaptation and vulnerability to climate change, this analysis also includes the review of the research *Integration of activities and vulnerability and adaptation to climate change*, made by the Tropical Agricultural Centre for Research and Education (CATIE), in order to determine the progress of Costa Rica on adaptation to climate change. The methodology used by CATIE is the identification and analysis of key documents for water, agriculture, biodiversity, energy, health, fishing, coastal areas and infrastructure, which are of priority sectors for adaptation in Costa Rica.

3.5.1 The Creation of the Adaptation Fund

The objective of the Adaptation Fund is “to reduce vulnerability and enhance the resilience of local populations focusing on critical sectors (agriculture, water resources and coastal areas) in order to reduce the negative impacts of climate change” (DCC, 2014).

The Climate Change Directorate of MINAE began in 2012 the design of the Adaptation Fund and with the support of the United Nations Program for the Environment (UNEP), selected Fundecooperacion for Sustainable Development as a National Implementing Entity (NIE). Fundecooperacion has the accreditation from the Adaptation Fund Board (AFB) of the UNFCCC and is responsible for drawing up proposals for adaptation to climate change to the Adaptation Fund, and managing and monitoring the financial resources.

After the country had approved the "project concept", had the opportunity to submit a full proposal with the projects selected through a public call. This whole proposal constitutes a single program, submitted for the next phase of implementation for the Adaptation Fund, for a total of $ 10 million.

Between February and April 2014, the DCC made the call for projects, with information activities to invite organizations to submit proposals; also with publications in the mainstream press, television, radio, as well as in social networks and web pages of MINAE, MAG and DCC.

From the proposal presented through this public call, 26% are small (budget less than $ 70,000) and 74% are large (between $ 70,000 and $ 250,000). The sum of the budgets requested by the proposals presented exceeded $ 16 million. Considering the subject, eight proposals respond only to the agricultural component, seven proposals respond only to the component of water, five proposals respond only to capacity building component, 14 proposals comprising the three components, and 66 proposals given up at least two components. (Fundecooperacion, 2014)

Part of the results of the selection process of projects for the Adaptation Fund, is the creation of a partnership with public and private entities that will enable a counterpart for the implementation of projects of about $ 2 million, amount to be executed between 2015 and 2020, making a total of $12 million for the projects in the Adaptation Fund. One of these alliances is with the Foundation Costa Rica-United States of America for Cooperation (CRUSA), which will provide $ 800,000 for the financing of six selected proposals within the Adaptation Fund, With these 6 projects, various entities involved contribute the equivalent of $ 1,000,000 as counterparties. The other partner is the GEF project "Strengthening the capacities of Associations of Rural Water Supply (ASADAS) to address climate change risks in communities with water stress in northern Costa Rica", which is implemented by UNDP, A y A, IMN and MINAE.

The Adaptation Fund has three components: Agricultural Sector, Sector Water resources, coastal zones and fisheries, and Capacity Building. The details of these components are below:

Component 1: Agricultural Sector

Objective: Enhancing capacity of adaptation to climate change in agriculture

Expected results:

1. A variety of tools and technology options to climate change, to be developed, validated and implemented in the agricultural sector according to each area.

Activities

- Implementation of zoning in selected communities according to vulnerability.
- Identification of technological options that can be adapted or applied in order to improve the capacity to adapt to climate change (drought, heat, rain, pests, and others) and validation of the technical choices by area.
- Implementation of technological options validated to improve climate resilience in agriculture.

2. Financial and technical support for promoting the adoption of options generated in local communities.

Activities

- Creating a program of insurance policies for agriculture including criteria on climate resilience.
- Facilitating access to reimbursable funds to farmers to implement sustainable land management, and implement strategies for adapting to climate change and invest in new rural economic activities[11] as contingency for the impact caused by climate change.

Component 2: Sector water resources, coastal zones and fishery

Objective: Improved management of water resources and improve the resilience of coastal communities vulnerable to climate change.

Expected results:

1. Safety plans for water to develop, implement and improve initiatives resulting from a protocol of vulnerability, and for the identification of infrastructure vulnerability to climate change.

Activities:

- Creation of pilot water safety plans at local and regional levels to mitigate risks of water scarcity or excess, and to implement the plan of irrigation management through the application of an engineering protocol assessment for infrastructure.
- Development and implementation of management plans for selected watersheds.

2. Comprehensive, efficient and effective management of water resources.

Activities:

- Implementation of measures to protect aquifer recharge areas.
- Planning and design of infrastructure for use and distribution in order to improve weather resistance.
- Promoting sustainable and appropriate partnerships with local water manager by conditions of repayable funds to implement sustainable water management, and to implement strategies of adaptation to climate change by investing in new infrastructure as contingency for the impact of climate change.

[11] This entails all those activities created or redesigned to provide more resilience.

3. Integrated Coastal Zone Management

Activities:

- Design and implementation of measures for protection and coastal restoration.
- Developing an integrated management plan for the marine and coastal resources and sustainable production activities in the coastal.
- Development and implementation of strategies for the conservation and restoration of mangroves.
- Promoting repayable funds to coastal communities to adapt to climate change and invest in new infrastructure as contingency for the impact of climate change.

Component 3: Capacity Building

Objective: Improving the capacity of communities, producers, institutions and stakeholders respect to adaptation to climate change.

Expected results:

1. Improved community preparedness through the development and strengthening of early warning systems and protocols for risk reduction in agriculture, water resources and coastal areas concerning climate change.

Activities:

- Development and implementation of early warning systems, risk reduction plans and protocols on priority zones according to their vulnerability.
- Preparation of communities in developing early warning systems.

2. Formation of communities, producers, institutions and interest groups related to climate change, about control measures for adaptation.

Activities:

- Mapping and consultation of stakeholders to determine the level of knowledge and awareness on climate change.
- Promotion and training related to the creation of new rural economic activities due to the impact of climate change, including technical and economic considerations.
- Implementation of programs of information and awareness about the problem and the measures of adaptation to climate change, according to the area of vulnerability.
- Promotion of workshops with community organizations, professionals, technical groups, producers and beneficiaries, in order to exchange knowledge, experiences, lessons learned and best practices.
- Dissemination of information through variety of communication channels.

3. Strengthening the institutional capacities for systematic monitoring of climate change in order to prevent and report effects of the climate.

Activities:

- Modernization and expansion of the country's different hydro-meteorological networks through automated technological equipment and instrumentation.

- Development and adaptation of the information systems from satellite images, disaster risk information, geographic information and digital mapping to analyse current threats and reduce the impact of hydro-meteorological system.
- Creation of risk maps using models for future climate scenarios.
- Systematization of information on climate variability throughout the territory and influence on farming, water or the coasts.

The Adaptation Fund has selected six projects that aim to reduce the vulnerability of critical agricultural sectors, water resources and coast. The approved projects are:

1. Technical capacity building in the Central Region producers, to implement a practical tool for agro-ecological zoning and scenarios for climate change adaptation (Executing Unit: INTA; Partners: CNP, INTA, INDER, MAG, municipalities, ICE and UCR). This entails the implementation of the zoning mandate according to Section 1.5.5 and specific application in adaptation.
2. Incorporation of agricultural practices in farms of dairy products for adaptation to climate change, (Executing Unit: COOPEPURISCAL; Partners: MAG, Municipality, UPAP, UCR and CACP).
3. Commercialization of sustainable seafood products and protected area development in order to reduce the socio-ecological vulnerability of artisanal fisher associations, (Executing Unit: PRETOMA-CEMA; Partners: ASOBEJUCO, ASPEPUCO and ASPECOY).
4. Improving water resources and strengthening the resilience of vulnerable communities to climate change in Aranjuez river basin, Puntarenas (Executing Unit: ACEPESA; Partners: CNFL, ASADA of Bajo Caliente, ASADA of Corazon of Jesus and ASADA of Ojo de Agua).
5. Internalization of environmental costs of adaptation to climate change in water operators in vulnerable areas (Executing Unit: CEDARENA; Partners: AyA; ARESEP).
6. Watchers water and promoters of community adaptation to climate change (Executing Unit: ALIARSE; Partners: Municipality of Parrita, National Emergency Commission, Integral Development Assoc, La Guaira, Municipality of Hojancha and Integrated Development Assoc, Matambú).

3.5.2 Elaboration of the National Plan of Adaptation

Alongside the projects within the Adaptation Fund, the Directorate of Climate Chance, with the support of the Spain Cooperation, is elaborating the *National Plan of Adaptation*, which expects the final elaboration by the end of 2016 (DCC. 2014 b).

The DCC is undertaking a process for the preparation of National Plan of Adaptation based on consultation and consensus with stakeholders on activities that include the following adaptation sectors: water, energy, agriculture, fisheries and coastal zones, health, infrastructure, biodiversity and tourism. The expected result for the design of the National Plan of Adaptation are as follows:

1. Having a validated updated of the risk and vulnerability diagnostic, considering the local and regional levels, in relation to climate change and adaptation, and developing sector reference scenario or baseline and setting recommendations.

2. Proposing lines of action to local regional levels in adaptation and specific strategic areas of work validated for each of the sectors involved, including:

a) Identification and mapping of keys stakeholders for each of the sectors identified in the ENCC on adaptation, considering the municipality's actors.

b) Identification and proposal of strategic actions in the short, medium and long terms.

3. Estimating costs of adaptation action lines in the short, medium and long terms.

4. Having performance indicators for each of the actions and products, including the concepts of monitoring, reporting and verification (MRV).

5. Having action plans in adaptation considering the particularities of the sectors.

6. Integrating action plans in a proposed national plan, starting from the local level.

7. Designing and facilitating consultation workshops necessary to fulfill the objective of participation, consultation and consensus.

3.5.3 Program Promoting Sustainable Agricultural Production

MAG created the Program Promoting Sustainable Agricultural Production (PFPAS) in 2004 through Law 8408 for loan agreement between Costa Rica and the Inter-American Development Bank (IDB). The program stemmed from an initiative of the Extension Service, which raised some changes required in the management of production systems by the producers, to improve their situation and to achieve sustainability and competitiveness of their activities. (MAG-PFPAS. 2010)

The general objective of PFPAS is to increase income and improve the quality of life of families of small and medium agricultural producers, by promoting the competitiveness of agricultural production systems on an economically and environmentally sustainable basis. The objectives of the program are: a) to increase competitiveness through technology; b) to generate sustainable economic opportunities by increasing productivity and market access, and c) to improve environmental management for small and medium agricultural producers through technical assistance and recognition of external environmental benefits.

The program is a pilot and innovative experience in the field of sustainable agricultural production, based on the agricultural extension service, which encourages the use of technical options for production in harmony with the environment, through a series of mechanisms as:

- The recognition of environmental benefits generated by investments with positive environmental effect, under previously established standards and ex-post pay to producers who qualify to the incentive (pay between 20-30% of the cost of investment).

- Pay of 50% of technical assistance required for the development of sustainable agricultural production projects.

- The cost of plans for sustainable production in Didactic Integrated Farms, selected by the Agricultural Services Agencies, which allow farms as training sites for dissemination of technical options among producers.

- Training of relevant professionals and technicians in the competitiveness and sustainability of agricultural production practices.

- Conducting studies for the support of ministerial decisions on promoting sustainability and competitiveness of agricultural production.

As part of efforts to promote sustainable practices in agricultural production, MAG developed a list of 81 eligible sustainable production techniques. The practices presented below are those that can contribute to adaptation to climate change or risk management. This is part of the capacity building provided to farmers, they are accompanied by MAG official in the identification the techniques applicable in each case.

Practices that can contribute to adaptation or risk management:

- Fodder banks for sustainable livestock systems.
- Forage equipment for sustainable livestock systems.
- Equipment and materials for soil solarisation, which is an environmentally friendly method of using solar power for controlling pests.
- Establishment of improved sustainable livestock grazing systems.
- Infrastructure and equipment for the supplementary feeding of livestock in summer.
- Irrigation systems that optimize water use.
- Inert substrates for production in hydroponic systems.
- Individual compost heap.
- Green fertilizers.
- Salting troughs and livestock conservation systems.
- Analysis of water quality for irrigation, processing, agribusiness and other uses in agricultural production.
- Individual species seed banks to cover and green manure,
- Green barriers and hedges.
- Boxes for retention.
- Fences for sustainable livestock for systems.
- Mulch.
- Cover crop.
- Equipment and supplies for managing land cover.
- Equipment for the application of bio-fertilizers and bio-controllers.
- Drawers for infiltration.
- Infrastructure for proper storage of seed for individual benefit.
- Storage Infrastructure as silage or forage bales for individual use.
- Infrastructure and equipment for individual use for the manufacture of bio-controllers and bio-fertilizers.
- Infrastructure and equipment for the treatment, processing and utilization of waste from production processes.
- Practices to prevent laundering of internal roads on the estate.

- Terraces.
- Trees for reforestation purposes for protective use, windbreaks, shade coffee and apparatus in pastures.
- Development of brands that reflect characteristics of product produced in harmony with the environment.
- Seed dedicated to the spread profit of promising species for agricultural production.
- Certification systems of production.
- Watercourses in hillsides.
- Works of protection to prevent erosion on farm roads and watersheds.
- Banks group seed species for cover and green manures.
- Diversion channel.
- Channel guard.
- Channel infiltration.
- Control of landslides.
- Flood control.
- Cortina wind breaks.
- Design and slope protection.
- Drainage of agricultural land.
- Equipment and tools for conservation planning watersheds and farms.
- Equipment and tools for group use conservation tillage.
- Equipment and tools for group use in conservation tillage.
- Equipment and tools for Integrated Pest Management.
- Infrastructure for proper storage of seed to group profit.
- Storage Infrastructure as silage or forage bales for collective use.
- Infrastructure to prevent pollution and improve the use of water sources.
- Infrastructure and equipment group use for the manufacture of bio-controllers and bio-fertilizers.
- Infrastructure and equipment for the decontamination of wastewater in production processes and post-harvest of agricultural products.
- Infrastructure and equipment for the decontamination of wastewater in production processes, butchering, processing and packaging of livestock products.
- Infrastructure and equipment for the treatment and / or reuse of sewage.
- Stone walls to prevent runoff on farms.
- Tools and equipment for the agro-farm conservation planning and / or micro.
- Group Programs soil test.
- Protection of banks of areas of streams, creeks and rivers.
- Recovery and gully control.
- Planting trees to restore degraded areas for purposes of natural resources in the area of the farm.
- Via grassed water.
- Community tree nurseries in order to improve ongoing coverage watersheds.
- Communal tree nurseries for reforestation purposes of protection, windbreaks, shade and hedges.
- Communal tree nurseries for the preservation of native genetic materials; hedgerows materials; materials for green manure; materials for windbreaks and hedges.

After the pilot phase of the PFPAS finished in 2011, MAG allocated funds from its regular budget in the amount equivalent of $ 400 thousand, and launched the program as Recognition of Environmental Benefits of Sustainable Production, for environmental projects approved by the Ministry, to give continuity to the Program Promoting Sustainable Agricultural Production.

In cattle, the recognition of the environmental benefits intends to contribute to progress towards practices systems that allow:

a. To provide food to improve the diet or digestion of animals (e.g. establishment of fodder banks, establishment of improved pastures, forage grass, grass harvesting, construction of silos, silage and hay equipment, buildings for beef cattle feedlot associated to release grazing areas).

b. To increase biomass in farms (e.g. establishment of improved pastures, establishing hedges, establishment of fodder banks, tree planting, fencing grazing areas to release them and leave them in regeneration, infrastructure for seed or forage species of trees).

c. To reduce GHG emissions and suitably used organic waste (e.g. digesters, composting).

In agriculture, the program provides incentives for the development of projects submitted by organizations of small and medium farmers to solve simultaneously the interrelated problems of competitiveness and sustainable management of natural resources. The projects eligible for the incentive program are those aimed at application of the sustainable practices listed above and directed to:

- Solving problems of productivity resulting from failures in the technology applied in production systems.

- Promoting the adoption of new production systems to meet changing preferences of local or international markets.

- Introducing production systems that more efficient in the use the soil, and the protection and conservation of natural resources.

- Reducing the use of agrochemicals and improve agricultural production with environmentally friendly technologies and systems quality and safety.

- Generating benefits to primary production, through product certification for quality, according to market preferences.

In recognition of the positive environmental effects generated by the project, the program provides an economic incentive that varies between 20 and 30% of the equivalent of the value of investments that generate environmental benefits.

It is important to mention that under the program, investments with positive environmental effect are those required to develop or adapt production systems so that the land degradation and environmental pollution and the production is reduced, in harmony with the environment and producing healthy products. Such investments may be at different stages of the production chain: in pre-production; primary production; processing, packaging, processing and marketing

of the product. The environmental benefits are all elements that support life, such as water, air, biodiversity, landscape and fertile soil.

The table 10 shows the result of the PFPAS with 18,619 producers participating in the program in 114 projects. (EPYPSA. 2010)

Table 10. Result of the PFPAS

Region	Projects	Producers	Area
East Central	30	5.027	12.474
South Central	11	616	5.878
West Central	20	9.031	1.423
Chorotega	12	656	6.196
North Huetar	5	338	1.423
Huetar Atlantic	6	202	1.514
Central Pacific	12	449	992
Brunca	18	2.378	6.959
Total	114	18.697	36.859

Source: MAG

The amount of funding of the program was for $21 million with a national counterpart of $3.4 million and the rest as a loan of the IDB (see table below).

Table 11. Amount of the PFPAS Program

Concept	Amount ($)
Administration	2.100.000
Investment and technical assistance	8.800.000
Training	2.350.000
Studies	1.600.000
Financial expenses	1.787.000
Others	963.000
National counterpart	3.487.598
Total	21.087.598

Source: EPYPSA. 2010

3.5.4 Voluntary Certification in Good Agricultural Practices

In 2009, the country established an agreement with the European Union to improve the safety of food exported to that destination, as well as to the consumption for the country. This came to structure the State Phytosanitary Service (SFE) in professional, technological, and scientifically levels. The SFE strengthens the control, monitoring and education tasks with producers and exporters in the topic of Good Agricultural Practices (GAP). Because of the agreement, MAG currently is conducting a pilot program expected to be a long-term program, which is the recognition of producers fully complying GAP. The program is contributing to the health of

consumers, the exports, the environment and the occupational health of workers. (SFE, MAG. 2015)

The requirements for farms to receive this certification are:

- Be a legally constituted organization.
- Having implemented a quality system.
- Having qualified staff for its activities.
- Possess an infrastructure with the functions they perform.

Comply with requirements, and being an organization selected by MAG, enables farms enrolled in the project a comprehensive training in GAP, and strong support in the implementation of the necessary practices on their farms. MAG monitors and even audits at least once a year the farm to check that sustain the agreed conditions. The certification is valid for one year, after which the farm must perform an assessment to ensure that conditions continue to comply with the requirements.

Officials of the SFE give part of the training and coordinate the training from other entities, such as MAG, the Ministry of Labor and the National Training Institute (INA), among others. The agricultural extension staff of MAG in every region provides the evaluation and monitoring of GAP.

The program focuses its initial work on the most consumed products in the country, such as tomatoes, sweet peppers, lettuce, sprouts products, spinach and mango, among others. During this pilot phase, the certification has no cost, but to meet the required conditions for the certification implies some investment on farms.

The relevancy of this GAP, as seen in Section 3.10, is some banks use this certification as requisite to grant some incentives in the financial conditions on loans. However, this seems to be a system suitable for medium and large farmers, with capacity to have a better organization as company legally constituted and with practices of quality systems.

The companies with voluntary certification valid until 2016 area listed in table 12, and the list shows a limited enrolment:

Table 12. Companies with Voluntary Certification

Company	Product	Location
Compañía Agricola Campo Verde	Mini-vegetables and sweet corn	Cipreses, Cartago
Adapex	Mini-vegetables and sweet corn	Cipreses, Cartago
Hacienda San Joaquín	Lemon mesino	Abangares, Guanacaste
Papayas Doradas	Papaya	Parrita, Puntarenas
Inv, Agroind la Esperanza	Potato	Oreamuno, Cartago

Company	Product	Location
Hierbas Frescas de la Pradera	Spices	Paraiso, Cartago
Frutimangas S, A,	Mango	Orotina, Alajuela
Jose Rafael Ulloa Rojas,	Mini-vegetables	Oreamuno, Cartago
Asociacion Nacional Organizaciones Agropecuarias (Agropec)	Tomato	Santa Barbara, Heredia
Compañía Agrícola Feriola S, A,	Broccoli	Agua caliente, Cartago
Empacadora La Trinidad	Tomato	Cervantes, Cartago
Wilberth Navarro Monestel	Lettuce	Tobosi, Cartago
Legumbres Brenes	Lettuce	Oreamuno, Cartago
Agroalfalfa S, A,	Sprouts	Cervantes, Cartago
Mario Leitón	Onion	Tierra Blanca, Cartago

Source: SFE

3.5.5 Assistance for Farmers after Extreme Events

The high vulnerability of Costa Rica to extreme weather events and other threats, prompting the Ministry of National Planning and Economic Policy (MIDEPLAN) made in 2010 the *Study on the economic impact of extreme natural events and anthropogenic* (Flores, Roberto et al. 2010). The study estimated that in the period between 1988 and 2013, 34 out of 41 events (64%) relate to weather. The direct losses accumulated in this period reached $ 2.124 million, where 35% of the losses are concentrated in roads, and 22% relate to the agricultural sector as losses in crops, equipment and infrastructure inside farms. In this way, the conclusion is 57% of the losses directly or directly affect agricultural production.

This study identified the financing of these actions facing extreme events in the sector from sources as the National Commission of Risk Prevention and Emergency Response (CNE), Ministry of Public Works and Transport (MOPT), MAG and some producer organizations.

However, even though the country register assistance for farmer after these extreme events, there is not disaster assistant policy programme set for farmers. The attention of farmers after a disaster is within the framework of the *National Risk Management Policy 2016-2030* lead by the CNE. The *Law 8484 Emergency and Risk* Prevention gives powers to the State by the CNE to declare state of emergency and act under a state of emergency to deal with emergencies and operating under the National Risk Management System, which cuts across all state institutions. Each institution has a commitment to risk management that coordinates with the CNE. Likewise, the CNE has the National Emergency Fund, financed by the central government budget, but each institution must have a budgetary allocation to develop prevention and emergency response.

3.5.6 Regulation on agrochemicals

The regulation on the use of agrochemicals in Costa Rica does not consider adaptation to climate change as one of the objectives of regulating pest control. The environmental protection of this regulation is oriented toward controlling pollutants that may affect any dimension of the environment or the human health. The *Phytosanitary Protection Law No. 7664* of 1997 gives the obligation to MAG, through the State Phytosanitary Service (SFE), to promote integrated pest

management in the framework of sustainable farming to control pests without harming the environment.

The Program to Promote Sustainable Agricultural Production (PFPAS) proposes the basis of this integrated pest management. The PFPAS recognized that "regarding the use of pesticides and agrochemicals, the regulation exists; however, the country should go towards eliminating the use of banned agrochemicals and a more agile registration system. The state must also establish maximum residue limits in products and promote the use of codes of good agricultural practices. The state must establish public policy to control the use of cleaner products and a log system of chemicals used, with support from producer organizations and private companies. "(MAG. 2010 b)

However, this regulatory framework does not give the phytosanitary system an explicit role in reducing phytosanitary problems related to climate change, aspect that should be part of the integrated agricultural pest management in a sustainable development context. This role in adaptation is not implicit in the regulation, so the sector policy needs to incorporate it explicitly, to match the long-term perspective of the phytosanitary control with the process of adaptation to climate change.

Although existing regulations and public policies on phytosanitary control do not have this orientation to adaptation, provides the basis for the country to incorporate the perspective of phytosanitary threats originated in the climate change.

On registration for the control of agrochemicals, the *Law for the Promotion of Organic Farming* of 1987 established that individuals and companies engaged in the import, manufacture and sale of chemicals must register with the Association of Agronomists and a qualified professional should have supervision of the accomplishment of the regulation. The Phytosanitary Protection Law transferred the management of this registry to the SFE. In addition, this law extends the supervisory role of professional associations related to chemistry and microbiology.

The Phytosanitary Protection Law states among its objectives the protection of agricultural products from damage caused by pests and the combat by using, recording and importing of chemical, biological or related substances to use in agriculture. To fulfil this objective, the SFE must implement programs of recognition and detection of pests as well as establish a national system of information on crops health. Based on this detection and information systems, the SFE should promote and monitor the integrated pest management and the use of appropriate methodologies.

Once the SFE checks for a major pest, the MAG will have to adopt the necessary measures to combat plagues and prevent its spread technical measures. In this context, this concept applies for plagues originated in the climate chance.

As a policy of encouraging alternatives to the use of agrochemicals, the SFE is responsible for the promotion of organic agriculture through a system of certification of organic agriculture, according to the *Organic Law on the Environment*.

In 2007, MAG issued the Decree No. 33495 for Regulation on Registration, Use and Control of Synthetic Pesticides, Technical Grade Active Ingredient and Related Substances of Agricultural Use. This decree stands the environmental criteria that "chemical or related substances to agricultural use represents a potential risk to human health, the environment and

competitiveness of the agricultural sector", therefore, this use requires procedures for registration and control of chemical, biological or related substances for agriculture.

The decree aims to establish regulations and procedures governing the registration, use and control of synthetic pesticides, based on the assessment that the product is effective for the purpose intended and does not pose unacceptable risks to human health and the environment.

This decree also establishes the procedures for the SFE to monitor crops for human and animal consumption, in order to determine the presence or absence of pesticide residues.

The issuing of this decree in 2007 represents not only a strengthening of the regulatory framework, the institutional arrangement for the control of agrochemicals provided by this decree allowed the SFE to improve the procedure for the registration of agrochemicals. The improvement is specially in the debugging of statistics on imports and exports, by standardizing the procedures in customs agencies on the criteria of active ingredients registered. In addition, the SFE has improved the monitoring of crops of chemical residues, not only among producers but also in supermarkets, promoting these establishments manage a extended corporate responsibility by demanding good agriculture practices of farmer providers. The regionalization of the SFE services has allowed more training to farmers about the mandates of the phytosanitary regulation, promoting the good agriculture practices (Jorge Araya. SFE. Personal interview). The result of the strengthening of the institutional framework is the decrease of the use registered of agrochemicals as shown in table 13.

Table 13. Pesticide Use in Agriculture

Year	Pesticides (Kg of active ingredient per Ha)
2008	20.06
2009	15.56
2010	15.47
2011	10.77
2012	11.42
2013	9.15
2014	10.16

Source: SFE

This strengthening of the institutional framework gives the SFE an enabling environment to incorporate the monitoring of phytosanitary threats related to climate change. However, this monitoring of the SFE requires a complementary effort in research about the biology of pests and their natural control in the context of future climate scenarios, as well as about the techniques to control pests in the new environmental conditions. The SFE needs the support of a system for monitoring the environmental conditions and the behaviour of plagues. In addition, the research should advance in the identification of crops more resistant to potential new plagues and the agriculture zoning considering the threats of pests.

3.6 Sector and Rural Development Policies

Conductive questions:
Is physical infrastructure (irrigation systems, roads, harbours) climate-proof? What are the regulations in relation to climate-proofing of infrastructure?
Do infrastructure development priorities focus on agriculture and climate change challenges and needs? If yes, explain.

- Is electricity (or the use of fossil fuels) subsidised in Costa Rica?
- Is water (access) subsidised in Costa Rica?

3.6.1 Natural Hazards Reduction for Public Investment Projects

The background in terms of public investment shown in section 3.5.4 reflects heavy losses in physical infrastructure such as bridges, roads and buildings. Excess precipitation events are the source of most of the damage. These data suggest the project design do not consider or fails to apply an instrument to identify and reduce the risks associated with existing threats. In addition, the reconstruction of damaged or lost infrastructure is under the same conditions of vulnerability and risk, without a redesign looking a climate-prof infrastructure (Flores, Roberto et al. 2009).

For this reason, in 2014 MIDEPLAN presents the *Analysis Methodology for Natural Hazards in Public Investment Projects*, developed under the inter-ministerial agreement between MAG and MIDEPLAN. This methodology seeks to identify and analyse the implicit threats in places of public investment projects, and MIDEPLAN proposes technical criteria for making decisions about the relevance of carrying out certain projects. (MIDEPLAN, 2014 b)

It is important to note this methodology even though is guiding, is official by MIDEPLAN and mandatory according to the Executive Decree No. 35374-PLAN *Standards Guidelines and Procedures for Public Investment*, published in 2009. All public institutions must report their investment projects registered in the National Investment System (SNIP) of MIDEPLAN. This ministry evaluates the application of the methodology. This decree mandates the disaster risk assessment in public investment and establishes that each "project in the pre-investment phase should perform the disaster risk assessment as part of the technical study to prevent and mitigate the impact of natural and man-made hazards. The analysis and assessment of disaster risk project involves the study of mitigation measures to the different events (hydro-meteorological phenomena, geo-tectonic, etc.), according to the provisions of the methodological guide. "(MIDEPLAN, 2009).

The objectives of this methodology are:

- Having a simple instrument and objective manner to guide, qualify and estimate an index based on the country's main natural threats, before deciding the execution of a public investment project.

- Provide guidance on the type and depth of the analysis of risk to natural hazards in projects.

- Incorporate into project design measures to reduce their exposure and fragility or improve their resilience.

- Promote maintenance actions that reduce the likelihood of impacts by natural hazards.

The methodology consists of the following components:

a. Index of Environmental Fragility (IFA): The legislation for the development of Regulating Plans in each canton in the country establishes this index, with quality indicators of the level of incidence of threats.

b. General Criteria: allow a first analysis of exposure to each threat, the level of incidence and specific characteristics of the place where the project locates.

c. Matrices for the combination or association of parameters: This type of matrices adjust criteria to estimate the effect of variables associated as a threat index value.

The methodology developed assessment scale shown in the table 14.

Table 14. Rating Scale of Threat Index

Threat Level	Threat Index	
Very high	4,01	5
High	3,01	4
Half	2,01	3
Low	1,01	2
Very low	Equals to 1	

Source: MIDEPLAN, 2014.

After obtaining the corresponding results, there are criteria for additional technical studies to confirm the preliminary results and ensure that decisions keep as much certainty as possible. These criteria are:

Very high threat level: For the execution of a project of physical infrastructure, performed the analysis and obtained a rating of threat equal to five, the recommendations are:

- Choose to dispense with the chosen area and select another location.

- Only if done strategic location of the project on the site analyzed, make first a deepening of the geotechnical, hydrological, climatic, etc., and then a comparison of costs and benefits of the project with those associated with alternative sites, taking into the need, cost and scale of the works necessary risk reduction.

High threat level: The project should take into account the implementation of the necessary work to reduce the risks associated with threats.

Medium level threat: The comparison between alternatives in relation to the location of your site determines the technical, financial and operational viability of the projects. This considering that:

- Threats analyzed did not represent a major constraint
- Forecasts associated with risk reduction mean significant cost increases.

Low threat level: With a minimum of additional investments, aimed at reducing the risks of existing threats, give the project the technical, financial and operational viability.

Very low threat level: The project has technical, financial and operational viability, from the perspective of natural hazards, without additional investment.

Finally, the analysis identifies the actions or measures to reduce exposure of the project or reduce the physical vulnerability of its infrastructure. In both cases, the measures must allow a project to withstand additional stresses generated by the occurrence of a phenomenon. To do this, you should consider the following:

i. Identify possible measures to reduce exposure or enhance their physical protection.

ii. Determine the level of impact that measures have in solving the problem.

iii. Check the interdependence of the measures and consider complementary grouping.

iv. Identify the costs of the measures.

v. Check the technical feasibility of the implementation of the measures.

In addition, in those cases where it is not possible to reduce the risk in the project area, the analysis should consider change the location of project.

With the *Analysis Methodology for Natural Hazards in Public Investment Projects*, the recovery, building and maintenance of infrastructure financed by public investment has now a protocol to consider climate threats and vulnerability. However, the consideration of climate risk in new infrastructure should not be only an obligation for public investments. The risk management requires of protocols for climate-prof infrastructure available for producers in their own projects, as a way to reduce their vulnerability to the climate extreme events. The existing of the protocol climate-prof infrastructure is not oriented to farmers, and most of the damage coming from extreme events has to be finance directly by the producers.

3.6.2 SENARA and the Program for Integrated Water Resources Management

The Law 8685 of 2008 originates the Program for Integrated Water Resources Management (PROGIRH) as an agreement between Costa Rica and the Central American Bank for Economic Integration (CABEI) for US $ 35 million for a program of SENARA. The PROGIRH aims to "contribute to sustainable human development through integrated water resources management and strategic services for its conservation and production, ensuring economic efficiency, social development with equity and environmental sustainability." The program has

three components: (1) Groundwater Management, (2) Irrigated Agricultural Production and (3) Improvement of Farmland with Drainage.

Program Components

The component of Groundwater Management aims to "develop research, management and conservation of groundwater to ensure the sustainability of the quantity and quality of hydrogeological resources at local and regional levels." This component has involved work of sustainable use projects in six aquifers: (i) Virilla right bank; (ii) Rio Grande; (iii) coastal aquifers in basins that discharge into the Potrero, Brasilito and Tamarindo Bay; (iv) Rivers Ario and Manzanillo; (v) right bank of the River Tempisque; and (vi) coastal aquifers in basins that discharge between Herradura Bay and Punta Uvita. These aquifers include cities of the Grand Metropolitan Area (GAM) like San Ramon, Palmares, Grecia, Naranjo, Sarchi, Atenas, Alajuela, and populations of the southern part of the Nicoya Peninsula and Central Pacific.

The Irrigated Agricultural Production component aims to "develop an integrated strategy to address the deficit of water in farming, aimed at increasing competitiveness, supporting national food security and improve the socioeconomic conditions of the families." The component aims 11,000 new hectares in the Pacific Coast and Central Region of the country, for the benefit of more than 2,600 families, projects in Tempisque Irrigation District for 8,806 hectares and 193 families and 76 projects of the Small Area Program on Irrigation.

The component of Improvement of Farmland with Drainage aims to "contribute to solving the problems of the main areas affected by poor drainage and flooding, according to the current land use, the general state of the existing infrastructure, the physical characteristics of the territory and potential use of the land. This component aims 60 infrastructure projects to cover 10,000 ha and 1,500 families of farmers in North Huetar and Atlantic Regions (Sarapiqui and cantons of Limon), and 1,000 ha of farm drainage, plus the rehabilitation of 10,000 ha with poor drainage which directly benefits more than 3,000 families in the Caribbean and South Coast area. Additionally, the drainage projects aims cover of 2,000 hectares and 1,769 families in the Northeast Zone of Cartago.

The total investment of the PROGIRH is US $ 56.62 million, of which $ 18.6 million (47%) corresponds to the component of Irrigated Agricultural Production, $ 27.7 million (32%) to Groundwater Management, and $ 10.1 million (17%) to the Improvement of Farmland with Drainage. The CABEI funding sources are for US $ 33.68 million (59%) and the country counterpart is US $ 22.95 million (41%). The program includes various investment categories, such as civil works, equipment and materials, engineering costs, supervision, consulting, and training. Tables 15 and 16 show the sources and breakdown of the financing of the program.

Table 15. PROGIRH: Financing of the Program by Component

Component	Investments	Percentage
Groundwater Management	18,681,969	32%
Irrigated Agricultural Production	27,757,505	47%
Improvement of farmland with drainage	10,184,686	17%

Source: SENARA

Table 16. PROGIRH: Financing of the Program by Component, Sub Component and Source

Concept	US$	BCIE (US$)	%	Government (US$)	%	Partners
Component 1, Groundwater Management	18,681,969	4,871,473	26%	13,810,496	74%	SENARA, AyA, MINAE, FONAFIFO, INA,UP/CI, Municipalities
Research aquifer systems	3,471,856	1,851,717	53%	1,620,139	47%	
Hydrogeological Integrated Management Resources	10,056,896	3,019,757	30%	7,037,139	70%	
Monitoring and control of water systems	5,153,218	0	0%	5,153,218	100%	
Component 2, Irrigated Agricultural Production	27,757,505	23,166,666	83%	4,590,839	17%	SENARA, INA
Surface expansion of Program of Small Area on Irrigation and Drainage	12,307,967	9,072,163	74%	3,235,804	26%	
Surface expansion of Tempisque Irrigation District	15,449,538	14,094,503	91%	1,355,035	9%	
Component 3, Improvement of farmland with drainage	10,184,686	5,640,223	55%	4,544,463	45%	SENARA, INA, IDA
Extension area drained	5,594,638	3,322,407	59%	2,272,231	41%	
Rehabilitation and improvement of drains	4,590,048	2,317,817	50%	2,272,231	50%	
Total	56,624,160	33,678,362	59%	22,945,798	41%	

Source: SENARA

Table 17 presents the incorporation of PROGIRH in the NDP 2015-2018 as part of the government goals for this period. The financing in the NDP is a mix of the sources from CABEI and the government counterpart.

Table 17. PROGIRH: Financing of the Program in NDP 2015-2018 by Sub Component

Concept	Millions US$
Component 1, Groundwater Management	13,73
Component 2, Irrigated Agricultural Production	10,76
Component 3, Improvement of farmland with drainage	8,68
Total	33,17

Source. NDP 2015-2018

Tables 18 and 19 show the level of implementation of the PROGIRH by 2015, with 142 project of irrigation, 3,450 farms and 3,847 ha throughout the country. The total of drainage projects is 93 with 7,771 farms and an area of 34.432 ha.

Table 18. Irrigation Projects Built by Region until 2015

Region	Number of projects	Area (Ha)	Farms	Cost ($)
Chorotega	30	286	465	379,374
Central West	38	1,472	1273	2,198,992
Huetar North	7	477	280	765,859
Central Pacific	35	670	479	2,299,932
Central East	28	741	851	2,159.197
Brunca	4	201	102	279,322
Total	142	3,847	3,450	8,082,675

Source: SENARA

Table 19. Drainage Projects Built by Region until 2015

Region	Number of projects	Area (Ha)	Farms	Cost ($)
Chorotega	1	200	30	41,964
Central West	1	230	100	13,458
Huetar North	10	2,596	407	2,546,048
Central Pacific	3	519	76	94,660
Central East	3	644	113	486,028
Brunca	8	8,288	2,050	1,694,473
Huetar Atlantic	67	21,956	4,995	3,436,134
Total	93	34,432	7,771	8,312,765

Source: SENARA

Cost of water

SENARA offers irrigation water with two modes:

- Service water for irrigation by gravity
- Service water pumping for irrigation

SENARA provides the service water for irrigation by gravity to producers whose farms can receive gravity irrigation. The rate is per irrigable area and charged regardless of service usage. It also has two components: a share of operation and maintenance of 43,500 colones / ha / year (around $ 80 ha / year) and an amortization rate of investment of 17,800 colones / ha / year (around $ 33 ha / year).

Producer who have farms at a height that requires water for pumping irrigation receive the service of irrigation by pumping. The fee for this service is per volume with a share of operation

and maintenance of 2.56 colones / m3 (around $ 0.004 m3) and a recovery rate of investment of 1.05 colones / m3 (around $ 0.0019 m3).

SENARA establishes rates according to the cost of the service, without any kind of subsidy for the service. The problem that exists regarding the proper allocation of water pricing is, as discussed in section 1.5.2, 50% of water use is illegal under estimates of the Water Board of MINAE, and the lack of control and cost of water incentive some farmers to keep this illegal status. Section 1.5.3 shows the subsidy related to the canon for use of water.

Coverage of SENARA Services

The Agriculture Census of 2014 shows the influence of the Project of SENARA services is still limited in the agriculture sector. The table 20 shows only 4% of the 93 thousand farms in the country do not use water in their agriculture activities. Most of the farms (37%) receive a public service of water provision and 55% of the farms obtain water from rivers, springs or wells. SENARA is only providing water in the 1% of the farms (INEC. 2014). The main difference between SENARA solution and the public water system is SENARA focus in projects channeling water for farming from considering a sustainable provision. The public water system is design for the regular consumption of water not only for agriculture, but also for industry, commerce and residential use. The sustainability of this public system sometimes is not enough, because municipalities and rural aqueduct have no capacity for investment to channel water from far sources.

Table 20. Proportion of farms by source of water used for agricultural activities

Source	Percentage of farms
Public water system	37%
River	20%
Spring	22%
Water well	13%
SENARA	1%
Water harvesting	2%
Other	2%
No water use defined	4%

Source, SENARA

3.6.3 Cost of electricity

The subject of the cost of electricity is not relevant in agriculture, because the country does not have any subsidy policy benefiting farmers. The dates of electricity are define for residential users, and two modalities for commercial and industrial users. The definition of rates in electricity is under the competence of the Regulatory Authority for Public Services (ARESEP), which is an independent and autonomous technical agency not affected by political interest for any special sector.

3.7 Research and development

Conductive questions:

Is climate change adaptation set as a R&D priority area? Are the R&D expenditures for adaptation research?

Have public funds been allocated to areas such as:

Development of climate change and disaster risk reduction practices, assessment methodologies and other relevant aspects of risk management approaches.

Tools to map multiple-risk and vulnerability (climate, pest, disease) scenarios at different spatial scales.

Development and implementation of weather forecasting, hydrological monitoring and early warning systems linked to the agricultural sector.

Development of new technologies (biotechnology, nanotechnology, others) and assessment of their effectiveness for adaptation (or increasing resilience).

What policies and infrastructure are in place in order to facilitate knowledge flows for farmers?

Do government agencies make information and R&D results available for free for farmers?

The National Development Plan 2015-2018 establishes adaptation to climate change as an implicit target for agricultural research and technological innovation. The strategy of research and innovation seeks the establishment of strategic alliances that allow the sector to have technology research and transfer in agriculture as a comprehensive national plan with all the efforts made by INTA, the academia, the private sector and the producer associations.

In addition, the NDP 2015-2018 redirects research towards the real needs of farmers and producers, especially in terms of agriculture designated for domestic consumption, in areas such as research for the adaptation to the effects of climate change; efficient water use; soil and biodiversity protection, and the development of technologies to improve production processes, among other aspects related to adaptation.

On coordination of scientific and technological research and transfer, one of the most important infrastructure is the renew and strengthened National System of Agricultural Research and Technology Transfer (SNITTA), which seeks a coordinated and articulated work between public, private and academic sectors, with the participation of the Ministry of Science and Technology (MICIT) (MAG. 2011). The Executive Decree No. 24901-MAG created SNITTA in 1996, as a system for the articulation of institutions in the field of research and technology transfer in agriculture. SNITTA confirmation is by 20 organizations working in the following activities and products: organic farming, avocado, bioenergy, cocoa, meat, onions, citrus fruits, beans, rural youth, corn, banana, palmito-pejibaye, potato, papaya, pineapple, pork, cattle, small ruminants and Tomato. However, although SNITTA is not fully operating in terms of all its objectives (Chaves, Marco. 2011); hence the MAG works by strengthening the formulation and implementation of specific programs and projects in this field. (MAG. 2011).

The organizations that make up the SNITTA are:

- The Ministry of Agriculture and Livestock,
- Ministry of Science and Technology,
- The National University,
- The University of Costa Rica,
- The Costa Rica Institute of Technology,
- The State Distance University,
- The National Institute of Learning,
- The National Council of Production,
- The National Institute of Rural Development,
- The National Irrigation and Drainage,
- The Coffee Institute,
- The National Banana Corporation,
- The Industrial Agricultural League Sugarcane
- The Central American School of Livestock,
- The National Seed Office,
- The National Chamber of Agriculture and Agribusiness,
- A representative of the Peasant,
- The Livestock Development Corporation,
- The Foundation for the Promotion of Research, and
- Transfer of Agricultural Technology, FITTACORI.

The study *Integration of Activities and Vulnerability and Adaptation to Climate Change*" by CATIE (Raffaele Vignola et al. 2014), made an analysis of the research in the area of adaptation directed for agriculture. This study found some specific research aimed to "evaluate the perception of actors of the sector in relation to climate change; identify mechanisms to adapt production systems; generate of inputs for the construction of policies for the sector adaptation in harmony with other sectors such as water; asses vulnerability, and project climate under different scenarios." In certain regions, the information used is about climate risk of the region like Talamanca in the province of Limon and Nicoya en Guanacaste, both historically associated with extreme weather events deficit or excess rainfall. Other areas use information not associated directly to climate risk in the region. CATIE and IICA conducts greater amount of this research.

The research in CASCADE project by CATIE aims to identify agricultural practices (based on ecosystems) to reduce the effects of extreme events deficit and excess rainfall in the country, in systems of production of basic grains and coffee. INTA is investigating cultivation of corn, beans and tomato resistant to water shortages and above the required temperature, silvo-pastoral systems and adaptation strategies, management of diseases caused by temperature variation, evaluation of ecosystem services on cattle farms, livestock production, and low emissions in cattle.

Next is the research projects for adaptation identified by CATIE: (Raffaele Vignola et al. 2014)

- Financing and development of research programs and technological development, del Fondo para la Investigación Científica y Tecnológica (FONCYT-Ministerio de Ciencia y Tecnología).

- CASCADE project for Cartago and San José (Ecosystem-based Adaptation for Smallholder Subsistence and Coffee Farming Communities in Central America by Conservation International (CI) and CATIE).
- Evaluation of ecosystem services in livestock breeding farms (CATIE).
- Adaptation of maize and beans to climate change: A tool for poverty alleviation (IICA),
- Technological innovations in the integrated management of "cuero de sapo" incassava: strategy to reduce the impact of disease due to climate change (Fondo Regional de Tecnología Agropecuaria, FONTAGRO).
- Silvo-pastoral systems design as a strategy for adaptation and mitigation of climate change livestock systems change (Fondo Regional de Tecnología Agropecuaria, FONTAGRO).
- Developing competitive livestock production systems with low emissions of greenhouse gases in Central America (GAMMA-CATIE).

3.7.1 Allocation of public funds

The agriculture sector do not count on any specific program of climate change and disaster risk reduction practices. These activities and those related to mapping of multiple-risk and vulnerability and weather forecasting, hydrological monitoring and early warning systems have a general approach in the country and not specifically oriented to agriculture (see section 1.5.7). Only for 2015, the CNE had a budget of $12.3 million.

INTA is managing the program of research related to practices influencing the adaptation practices by famers, but as section 3.3 explained, there is not a clear identification of the amount of resources dedicated directly to topic related to adaptation. In 2014, the budget of INTA in research and innovation was $2.5 million, in experimental stations $2.4 million and in technology transference and information $330 thousand.

3.8 Capacity Building

Conductive questions:

Are there specific programmes to promote the uptake of adaptation practices?

Are extension services integrating local farmer's knowledge on resilience increasing practices?

Are the weather forecasting, hydrological monitoring and early warning systems available for farmers? If yes, explain how they work.

How farmers obtain market information such as price? Are the market monitoring and forecasting system available for farmers? If yes, explain how they work.

What are the on-farm strategies adopted by farmers to manage the extreme weather events (e.g., crop diversification)?

Do advisory and extension services provide information on public and private risk information (e,g,, weather) and on-farm risk management strategies?

3.8.1 Extension and Advisory Services

INTA leads the central program to promote adaptation practices by MAG. Currently INTA has a staff of four people working in this area, two researchers work in coordination with the IMN and support the elaboration of the national communication of climate change. All the staff work in the transference of knowledge through the extension services of the ministry.

The extension services by MAG have been an important activity supporting farmers over several years. This activity is perform by the Directorate of Regional Operations and Agricultural Extension, which aims "to be the executing agency of integrated services to producers and companies, accurately responding to their demands on sustainable production and organizational advice; this articulated in production chains targeting different markets"[12].

Among the purposes of this directorate are to "strengthen the entrepreneurial capacity of producers in order to stimulate sustainable competitiveness and generation of added value" and to "promote sustainable development of agricultural production and rural areas." With these competencies, this agency has the capability to manage extension services to support activities oriented to adapt farmers to the climate change effects.

The directorate has the Office of Agricultural Extension with the role of supporting and advising in policies, standards, methodologies, strategies, tools and programs to support production in the agricultural chains, and establishing a methodology for strengthening teamwork within the institution and partnerships with the public sector, academia and the private sector to develop extension services (MAG, 2015).

As the backbone of the Office of Agricultural Extension, the Sustainable Production Department has been working on the Program Promoting Sustainable Agricultural Production (PFPAS). The Sustainable Production Department has the objective of "promoting domestic production through technology and methodology oriented social, economic and environmental sustainability of production systems and welfare of the population". Some of the functions of this department allow extension activities with the potential to disseminate adaptation policies for agriculture, these functions are:

- Tracking and monitoring results of innovations in the field of farm at basin and regional level.
- Documenting the state of the development of sustainable production, advising on policies to promote this area and coordinating efforts with other institutions and organizations.
- Coordinating actions to determine needs and applied research development of innovative technologies.
- Promoting technologies that reduce land degradation and water pollution, increase infiltration, prevent environmental pollution, obtain safety and increase production yields.
- Developing programs for generation and recognition of environmental services in agricultural production.
- Promoting agriculture in protected environments and controlled environments and organic farming systems.
- Developing programs for planning land use at local, regional and national levels.

[12] http://www,mag,go,cr/acerca_del_mag/estructura/oficinas/dsorea,html

However, there is no evidence any extension services is working directly and exclusively in adaptation to climate chance, and most of the activities are focus in sustainable development in agriculture.

According to current data of the Sustainable Production Department, for 2015 the extension services count on a staff of 236 people, with 190 advisors and 46 assistants, supporting 32,902 producers. This gives an average ratio of 173 producer per advisor (see table 21). However, the Agriculture Census of 2014 indicates from 93,013 farms in the country, 70,608 are not receiving extension services, resulting in only around 20 thousand farms receiving advisory services in the country, meaning a scope on only a fifth of the farms.

Table 21. Personnel and Scope of Extension Services

Region	Area (Km^2)	Producers	Personnel		Producers per Advisor
			Advisors	Support staff	
Central Region	7,584	11,945	73	23	487
North Huetar	6,379	5,689	27	3	211
Huetar Atlantic	10,251	3,832	16	5	240
Central Pacific	311	2,499	20	5	125
Brunca Region	9,528	1,339	23	5	58
Chorotega Region	7,930	6,368	26	5	245
Sarapiqui Region	2,141	1,230	5	-	246
Total	44,124	32,902	190	46	173

Source: MAG

3.8.2 Other Advisory Initiatives

In term of forecasting and early warning systems, even though the IMN provides forecast of weather conditions for different regions of the country, there is no an official program to support farmers in the decision making process to incorporate the weather information in the crop cycle. According to officials of MAG, only a program in Guanacaste has these characteristics, but a NGO lead the program with direct coordination with producers, based on an informal collaborative activity.

The producer associations are organization with programs designed to advise their members about the weather information and the implication in crops. According the information provided by experts of these associations in rise, sugar cane, pineapple, banana and livestock, these organizations are aware about the importance of dissemination and application of this information, but the focus have been on information of weather affecting the crop cycle, and low emphasis on long-term climate information.

The limitation of the efforts of the producer associations is only 10% of the producer belong to these organizations. Other 17% of the producers belong to cooperative organization which some of them have an approach similar to the producer associations. However, 70% of the producers do not participate in any organization (INEC. 2014).

Other interesting experience of the producer association, based on the information of experts in sugar cane, banana, rise and livestock, is these organizations has been working on adaptation of products to the soil and climate conditions of the different regions, among other factors, of the country. This adaptation purpose is based on competitiveness and not on the climate change effects, but this is an experience of adaptation has created an important infrastructure for the main products of the country. Even though these organizations affirm they are working in adaptation, the mentioned actions address to risk management efforts facing the extreme events of droughts and floods. In the case of coffee and livestock, the actions refer to the NAMAS for these products, but the plans and monitoring of these initiatives relate mostly to mitigation.

3.8.3 Intelligence of Markets

The main support for farmers about price information and commercialization comes from the National Production Council (CNP), which has an Agriculture Market Information System (SIMA), providing information of export products and crop oriented to domestic markets, as those commercialized in the farmer fairs in almost each town and city along the country. This information system is coordinated with the Comprehensive Program of Agriculture Marketing (PIMA) of MAG, unit in charge of the capacity building to strengthen the participation of farmers in the commercialization chain.

Almost every producer association has a program of information of prices for international and domestic markets, and are the provider of information for SIMA and PIMA.

3.9 International Cooperation and other initiatives

3.9.1 Cancun Adaptation Framework

The most relevant agreements ratified by Costa Rica related to international policies for adaptation to climate change are within the Framework Convention on Climate Change United Nations (UNFCCC). In the Conference of the Parties (COP) in Cancun, parties adopted the Cancun Adaptation Framework (CAF) and stated that adaptation must have the same level of priority as mitigation. The aim of the CAF is to improve adaptation actions through international cooperation, reduce vulnerability and build resilience in developing countries, taking into account needs of particularly vulnerable countries (Raffaele Vignola et al. 2014).

At COP 17 (Durban) the COP achieved the following resolutions:

- Rules, procedures and composition of the Adaptation Committee.
- Activities under the work program on loss and damage.
- Procedures and guidelines for national adaptation plans.

At COP 18 (Doha) the COP achieved the following resolutions:

- Technical guidelines for the development of national adaptation plans.
- The continuity of the work program on loss and damage.
- A work plan three years to the Adaptation Committee.

With the ratification of the UNFCCC Costa Rica has the obligation to take all these agreements and those that occur in the future in this regard.

3.9.2 Fund of Adaptation

The involvement of MINAE in the Fund of Adaptation in 2014 is possibly the main measure the country has taken to promote specifically adaptation actions to the effect of climate change in some highly vulnerable sectors (DCC, 2014).

This initiative is part of the Adaptation Fund of the United Nations Framework Convention on Climate Change (UNFCCC), which assists developing countries particularly vulnerable to the adverse effects of climate change, by financing specific projects and adaptation programs.

Section 3.5.1 gives some details of the objectives and activities this fund plan to execute in next years.

3.9.3 Central American Program

Until 2015, Costa Rica has been involved in the adaptation program under the Central American Integration System (SICA), through the Technical Committee on Climate Change. However, the government recently announced its intention to withdraw Costa Rica from SICA, so the future of their participation in their activities in adaptation is uncertain. Within the SICA, Costa Rica participates in the Regional Climate Change Strategy (ERCC), formulated in 2008 by the Central American Commission on Environment and Development (CCAD).

The ERCC has the strategic area related to Agriculture and Food Security, whose aim is to achieve "Reducing vulnerability of agriculture to climate variability and change by incorporating adaptation into relevant regional policies" (CCAD, 2010).

This strategy has as one of its proposals the creation of a Regional Adaptation Fund as a complementary financial mechanism to the resources of the countries and can contribute and channel funds on issues and areas of common regional interest and benefit to the adaptive management of the SICA countries. SICA has not implemented yet this fund.

Another area of action is the implementation of the Central American Policy for Integrated Risk Management (PCGIR), through the Regional Centre for the Prevention and Attention to Disasters (CEPREDENAC), which is the instance of the Environmental subsystem of SICA, with five program areas:

1. Institutional Strengthening.
2. Land Management.
3. Training and Education.
4. Preparedness and Response.
5. Scientific-Technical Development

Other regional strategy in which Costa Rica is involved is the Regional Environmental and Health Strategy (ERAS), a consensus-led initiative of the councils of ministers of agriculture through the Agricultural Council (CAC), environment ministers through CCAD and health ministers gathered

in the Council of Ministers of Health (COMISCA), all organs of SICA. The ERAS seeks to incorporate the Central American Agricultural Policy in five areas:

1. Sustainable Land Management.
2. Change and climate variability.
3. Biodiversity.
4. Green business.
5. Spaces and healthy lifestyles.

3.9.4 Inter-American Institute for Cooperation on Agriculture

The Inter-American Institute for Cooperation on Agriculture (IICA) has in its 2010-2020 Strategic Plan an objective directly related to climate change and the subject of adaptation. It reads, "Improve the capacity of agriculture to mitigate and adapt to climate change and better use of natural resources" (IICA, 2010). One of the objectives of the technical cooperation of IICA is to "work together with institutions of the countries, especially the ministries of agriculture, in the development of public policies, implementation of sector strategies and the provision of timely policy instruments. So all this can contribute to reducing levels of uncertainty of producers in agriculture and help them to improve productivity and competitiveness".

IICA-EUROCLIMA project, launched in 2014, has 1.5 million and covers 18 Latin American countries, including Costa Rica. This initiative involves public agencies as of INTA of MAG, the National System of Conservation Areas (SINAC) of MINAE and the Advisory Commission on Land Degradation (CADETI).

3.10 Finance Instruments and Insurance

Conductive questions:
Are there government programmes to improve farmer's access to finance (grants, interest concessions and guarantees) aimed at encouraging the adoption of risk reducing and resilience improving agricultural practices? If yes, explain,
Are there climate change adaptation and mitigation funds specifically for the agricultural sector? If yes, explain,
Are there any financial- climate risk management mechanism such as insurance instruments?
Are there one or various funding institutions for the implementation of adaptation policies?

In general, the finance of agriculture in the country is not design to promote the adoption of adaptation practices to climate chance. Even programs as the credit program in the Banco Nacional de Costa Rica states is working on the basis of the adoption of good agricultural practices, but the revision of the certification of GAP by MAG (see section 3.5.4) shows the adoption of this certification is low in the country and has low relationship with adaptation or risk management.

Banks like Banco de Costa Rica and Banco Popular do not have a credit policy towards agriculture involving incentives to measures against climate change. In these banks, actions to support climate change initiatives focus on financing of sustainable transport with the Program for Acquisition of Efficient Vehicle (PAVE).

The National Rural Development Institute (INDER) has a financing program "Rural Credit" to finance productive activities for farmers in higher social lag. The activities funded are:

- Agriculture.
- Trade.
- Crafts.
- Industry and Agribusiness.
- Machinery-commercial vehicles and equipment.
- Agro-eco-tourism.
- Work capital.
- Services.
- Aquaculture.
- Forestry.
- Artisanal fisheries.

Loans in INDER do not have any conditioning based on climate risk vulnerability or even environmental requirements.

Even though more banks do not have any requisite of adaptation practices in loan assignation, an import practice of banks is the allocation of credit in agriculture considering the cultivation regions, and short-terms climate effects in some products, and defining the loan availability for some crops based on these conditions. This practice is the common rule for banks as Nacional de Costa Rica, Banco de Costa Rica, Banco Popular y Bancredito, but there is not assessment of the real application of this credit policies. Even though the rational of credit allocation by banks are not considering adaptation of climate change, the conditioning to short-term climate threats makes credit a potential instrument to incentivize producers to incorporate practices as zoning according to land use potential and vulnerability or practices to adapt products to the effects of climate change.

However, data from the Agriculture Census of 2014 show 80 thousand farms form 93 thousand in the country do not use credit to finance their activities, in this way, the promotion of adaptation practices promoted by loan program will have a limited scope in term the totality of farmer. However, always the amount of producer susceptible to reached by credit incentives is an important group to consider.

3.10.1 Integral Crop Insurance Program[13]

Respect to the insurance system, the National Insurance Institute (INS) has the Integral Crop Insurance Program, and reviews it for each agricultural cycle, according to every crop. Currently, this insurance provides coverage for the following products presented in table 22. This list of crops can be extended prior feasibility studies by the INS. The insurance rates correspond to the

[13] http://portal,ins-cr,com/portal,ins-cr,com/General/Noticias/SegCosechas2015,htm

modality of equity in losses of 0% by the farmer; other modalities with equity in losses by farmers have slightly lower rates[14].

The insurance born with Law 4461 in 1969 for basic grains and were subsequently incorporated new crops. Rice was a first crop covered by this insurance because of the policy in agriculture giving protection of this product considered base of the Costa Rican alimentary diet (IICA, 2007).

Table 22. Integral Crop Insurance Program Coverage

Crop	Insurance rates			
	Coverage A		Coverage B	
	Land owner	Land rent	Land owner	Land rent
Dry land rice (Low Risk)	10,16%	11,68%	1,52%	1,75%
Dry land rice (Medium Risk)	12,69%	14,60%	1,90%	2,19%
Dry land rice (High Risk)	15,23%	17,52%	2,29%	2,63%
Rice with supplemental irrigation	5,23%	6,02%	0,78%	0,90%
Wet rice	3,14%	3,62%	0,47%	0,54%
Squash	7,62%	8,76%	N.A.	N.A.
Organic banana	8,89%	10,22%	N.A.	N.A.
Organic banana (by plant)	8,89%	10,22%	N.A.	N.A.
Traditional banana	8,89%	10,22%	N.A.	N.A.
Banana dátil	5,78%	9,49%	N.A.	N.A.
Coffee	4,44%	5,11%	N.A.	N.A.
Coffee (by plant)	1,90%	2,19%	N.A.	N.A.
Sugarcane (without irrigation)	3,81%	4,38%	N.A.	N.A.
Sugarcane (irrigated)	2,54%	2,92%	N.A.	N.A.
Onion (greenhouse)	7,62%	8,76%	N.A.	N.A.
Irrigated onion	5,08%	5,84%	N.A.	N.A.
India cane (by plant)	1,27%	1,46%	N.A.	N.A.
Spicy pepper for export	12,70%	14,60%	N.A.	N.A.
Sweet pepper (field)	8,89%	10,22%	N.A.	N.A.
Sweet pepper (greenhouse)	3,81%	4,38%	N.A.	N.A.
Hydroponics	1,27%	1,46%	N.A.	N.A.
Bulb flowers	2,54%	2,92%	N.A.	N.A.
Beans	11,38%	13,09%	1,71%	1,96%
Leather fern Leaf	2,54%	2,92%	N.A.	N.A.
Corn	10,16%	11,68%	1,52%	1,75%
Melina	1,59%	1,82%	N.A.	N.A.
Export melon (irrigated)	2,54%	2,92%	N.A.	N.A.
Yam	6,98%	8,03%	N.A.	N.A.
Export ñampí	6,98%	8,03%	N.A.	N.A.
Oil palm	1,27%	1,46%	N.A.	N.A.
Oil palm (by plant)	1,27%	1,46%	N.A.	N.A.
Potato	3,17%	3,65%	0,48%	0,55%
Papaya (by plant)	6,98%	8,03%	N.A.	N.A.
Pepper	6,35%	7,30%	N.A.	N.A.
Pineapple for export	2,54%	2,92%	N.A.	N.A.
Plantain for Export (by plant, Pococí)	23,07%	34,49%	N.A	N.A
Plantain for Export (by plant, other areas)	16,15%	26,53%	N.A	N.A.
Watermelon for export (irrigated Central Pacific Region)	6,35%	7,30%	N.A.	N.A.
Watermelon for export (irrigated Chorotega	2,54%	2,92%	N.A.	N.A.

[14] This equity Works like a deductible rate of losses assumed by farmers.

Crop	Insurance rates			
	Coverage A		Coverage B	
	Land owner	Land rent	Land owner	Land rent
Region)				
Tobacco burley	10,16%	11,68%	N.A.	N.A.
Tobacco habano	10,16%	11,68%	N.A.	N.A.
Teak	1,27%	1,46%	N.A.	N.A.
Tiquisque for export	12,70%	14,60%	N.A.	N.A.
Yampi for export	6,98%	8,03%	N.A.	N.A.
Cassava for export	6,35%	7,30%	N.A.	N.A.
Carrot	5,08%	5,84%	N.A.	N.A.
Other crops	6,67%	7,67%	N.A.	N.A.

Source: INS

Crop insurance is one of the main mechanisms for the management of climatic and biological risks affecting crops; these risks have intensified in recent years with climate change and other phenomena that alter weather patterns. The insurance compensates part of the economic losses faced by farmers in their crop by climate risks and facilitates, especially producers of limited resources, to face losses and stay within the activity. (IICA, 2007)

Due to its geographical location, small size and influence of the two oceans, Costa Rica has a wide climatic variability, which causes many crops are frequently at risk of drought, high rainfall and other weather-related. Hence the importance that the country has strategies to prevent, control and mitigate losses in agriculture that affect not only the economic situation at the level of producers but also the country in general. Crop insurance constitutes part of the risk mitigation strategies.

The insurance has a form of collective contracting, with discounts on commercial rate for each farmer, depending on the number of hectares secured together and the ranges provide for the different crops. This form of collective contracting is available to financial entities, cooperatives and farmer association. Rates with the option of collective insurance rates can decrease up to 35%.

Relevant aspects of this insurance program are:

- Planting dates are set by region for each crop type and variety. They are subject to modification depending on weather conditions and forecasts currently issued by the National Meteorological Institute.
- Rates of the different crops hedging A (Basic) and B (No germination) to farmers according to classification of the different production areas in three levels of risk (low, medium, high), according to the loss experience in the application of this insurance.
- The program provides for the possibility of equity in losses of 10% and 20% in all crops, allowing the insured the option of reducing rates in equal percentages.
- The practice of discounts or surcharges on rates of coverage, based on the loss experience of the insured remains. This applies based on the loss information of the last three consecutive years by the farmer, and the possibility of discounts based on technical and management criteria.

The insurance do not have differentiate rates depending the regions of the country, but the policies of INS define those regions where the insurance apply and those others where the insurance has not coverage due the weather risk.

According to the data from the Agriculture Census of 2014, only 2% of the farms have crop insurance. Of these farms, 44% have less than 10 hectares, 25% between 11 and 50 ha and 31% are large farms with over 50 ha.

3.10.2 Other funding Institutions

In terms of funding institutions, CATIE (Raffaele Vignola et al., 2014) found the agreement of institutions of the agricultural sector with national and international organizations to generate knowledge in the areas of agriculture and climate change and develop infrastructure to reduce vulnerability. For example, MAG and the Republic of China agreed on a research program on farming technology.

Other example is the MAG, ICAFE, FONAFIFO and CATIE partnership to develop a program for recognition of the environmental benefits on coffee cultivation in combination with forest plantations.

In other hand, the cooperation agency CIRAD of France and the cooperation of Norway established an agreement with the MAG to work on issues of ecosystem services in coffee plantations and rust disease, being this related to climate change[15]. This agreement is part of a regional project called “Control of Coffee Rust in Mesoamerica”, executed by CATIE.

Other agreement is between MAG and SENARA to improve irrigation and drainage infrastructure. The Institute of Rural Development (INDER) and INTA have a research agreement for the production of rice varieties resistant to climate change. Finally, CONARROZ and UNA have an alliance to generate studies on adaptation of rice to climate change.

The DCC has registered the implementation of seven projects working directly or indirectly on adaptation to climate change in agriculture (see table 23). The Adaptation Fund is the unique project working specifically in adaptation of climate change. The other projects have an overall purpose on climate change in agriculture and work as well in mitigation as in adaptation, but the evidence shows they work mostly on mitigation activities and their expected actions in adaptation are results of the mitigation efforts. An example of this last situation is the low carbon strategy in cattle, and the improvement of pastures influence the enteric fermentation and the production of methane from the cattle, but improve pastures also increase the resilience of the activity with grass better adapted a new climate conditions in the future. Even though this double role of some measures on mitigation and adaptation is true, most of the projects have planning, design and monitoring in terms of mitigation goals and metrics, and do not show a clear effect on adaptation.

[15] http://www.catie.ac.cr/es/en-que-trabajamos/agroforesteria/agro-cafe/proyectos-agroforesteria/proyecto-roya-catie-cirad-promecafe-noruega

Table 23. Cooperation Project with Influence in Adaptation of Climate Chance in Agriculture

• Adaptation Fund General Objective: Reduce vulnerability in critical areas to reduce the negative impacts of climate change and improving the resilience of communities and small producers. Period of Execution and status: 2015-2019. Cooperation Source: UNFCCC. Cooperating contribution amount (US $): Up to US $ 10 million. National Counterpart: $ 2 million. Notes: This is the project of CC directly related to adaptation (see Section 3.5.1)
• Low Emission Development Strategies (EC-LEDS) General Purpose: Work with selected developing countries and strengthen their capacity to create and implement strategies to develop low emissions. Period of Execution and state: It starts in 2011 and is ongoing. Cooperation Source: State Department of the USA. Amount of Funding: Not determined by the source. Notes: This strategy focus on improvement of pastures, planting of trees on farms and strategies of management of techniques for better feeding of cattle due to the weather variations. The main purpose in to reduce enteric fermentation and increase carbon sequestration, but these actions look for adaptation of feeding to face the new weather conditions coming from climate change and protection of sols with forest cover.
• Action Plan for the Implementation of the National Climate Change Strategy General Objective: Supporting the development and implementation of the National Action Plan for Climate Change under an inter-sector approach as an instrument for the implementation of the National Climate Change Strategy (ENCC). Period of Execution and state: 2010-2015 Cooperation Source: Debt Exchange Spain-Costa Rica (AECID) Cooperating contribution amount (US $): $ 260 thousand Notes: This project define the action lines of the ENCC for adaptation to climate change (see Section 3.5.2).
• Low Emission Capacity Building Program General Objective: Strengthening the National Climate Change Strategy with emphasis on Livestock

Period of Execution and state: February 2013-June 2015 Source of Cooperation: EU, Germany and Australia. Cooperating contribution amount (US $): $ 642 thousand. Notes: This strategy focus on improvement of pastures, planting of trees on farms and strategies of management of techniques for better feeding of cattle due to the weather variations. The main purpose in to reduce enteric fermentation and increase carbon sequestration, but these actions look for adaptation of feeding to face the new weather conditions coming from climate change and protection of sols with forest cover.
• Partnership for Market Readiness (PMR) General Objective: Assist in the development and implementation of domestic carbon market Period of Execution and status: 2016-2019. Cooperation Source: World Bank. Cooperating contribution amount (US $): $ 3 million. Notes: The actions in agriculture must to focus in those actions in mitigation having a additional contribution in adaptation.
• Facilitating implementation and readiness for mitigation (FIRM) General Objective: Support the country to reduce the emission of greenhouse gases. Period of Execution and state: 2012-October 2014. Source of Cooperation: Funds DANIDA (Danish Cooperation). Cooperating contribution amount (US $): $ 300 thousand. National Counterpart: US $ 45 thousand. Notes: This strategy focus on improvement of pastures, planting of trees on farms and strategies of management of techniques for better feeding of cattle due to the weather variations. The main purpose in to reduce enteric fermentation and increase carbon sequestration, but these actions look for adaptation of feeding to face the new weather conditions coming from climate change and protection of sols with forest cover.

Source: DCC

4 Recommendation of Policies on Adaptation in Agriculture

4.1 Reduce the gap between the policy declaration and the implementation and articulation of specific actions.

The revision of the agriculture policy of climate change in Costa Rica show a gap between the policy declaration and the implementation of specific actions. The set of policies show a clear exposition of the objectives in mitigation and those related to adaptation and risk management. However, there is a low implementation of the activities stated in the policies.

The policy requires an incorporation in the planning of entities involved in the agricultural sector with a better articulation from MAG for the following up of the effective incorporation, and the monitoring and tracking of the execution with an appropriate monitoring, report and verification (MRV) system to ensure the following up of the policies.

Many of the actions from units of MAG, entities of the agriculture sector, farmer associations, universities, NGOs and MINAE do not coordinate into the adaptation and risk management policies, and by the sector councils related to the coordination of these policies. Part of the limitation with this unarticulated implementation activities is there is not and extend and effective dissemination and extension of the results of the actions benefiting farmers.

4.2 Emphasis of the Policy in Adaptation

Implementation of activities in climate change presents an emphasis on mitigation activities and initiatives as NAMAS and low carbon strategies are the framework for some adaptation measures resulting from mitigation purposes.

Examples of this symbiotic relationship between mitigation and adaptation are the improvement of pastures to reduce the enteric fermentation in cattle, the introduction of trees in cultivation fields, the protection of soil or the irrigation projects. These measures seek essentially reduce methane or increase carbon sequestration of forest patches or permanent crops. Even though these measure also have effect in adaptation or risk management practices, the emphasis in measures with both effects, imitation and adaptation, distract efforts directed to those measures only with effect in adaptation.

In addition, most of the actions express planning and monitoring in terms of the mitigation scope, giving to the climate change policy in agriculture a feature of mitigation policy, and making unclear the expected results in terms of adaptation.

The future climate scenarios and the identified impacts in the related studies address to the conclusion that climate change will affect the performance of crops and the adaptation policy should have a greater emphasis in the agriculture policy.

The climate change policy on agriculture should establish a new paradigm in the country: adaptation is "what matters". This concept suggests that climate change policy must depart from the situation already observed in some crops, and from what is shaping up future climate scenarios. Climate change is already affecting and will increase its impact in the agricultural sector. Currently, the policy focus on the implementation of mitigation projects and programs, influenced especially by the availability of funds to implement mitigation projects toward its goal of carbon neutrality by 2021. However, a better evaluation of cost-

benefit of the mitigation and adaptation measures could show the country will have a better return redirecting the focus of its climate chance in agriculture more effectively in adaptation.

4.3 Long-term policies

An important limitation of the scope of policies in Costa Rica is the change of government administrations every four year and the definition of new policies and priorities by the new authorities.

Adaptation requires binding long-term policies. The actions to adapt to climate change requires a long-term approach. The design of policies every four years with the election of a new government administration makes short-term focus of some adaptation measures.

This analysis identified a long-term policy that is referential in the country and that goes from 2010 to 2021. However, there is no obligation of a new government following the aspects outlined in the long-term policy, and future administration can change the focus or emphasis of adaptation actions that require many year of sustainability to produce their effect.

4.4 Clear separation of adaptation from climate risk management

The importance of extreme weather events, especially their economic cost and demand for logistic resources caused the country develop a platform for emergency attention backed by a specific law issued since 2006 and specific budget in the central government and institution to work in risk preparedness and emergency attention. Moreover, every institution leading sector policies should have a plan for the attention of emergency and prevention measures.

This have given to the risk management a higher priority than actions on adaptation to climate change, and even in some levels of public administration and farmers confuse both concepts, and set their actions in risk management as adaptation measures, resting focus to important activities in this area. Actions mentioned by experts in producer associations referred mostly to risk management activities, confirming this confusion.

The policy must separate adaptation from the climate risk management, and the importance of the agenda of every one must have the same level of importance. Adaptation actions cannot wait to start implementation in the future, and the ongoing risk management activities generally distract the immediate attention of the adaptation measures.

4.5 More Research Activities

The research in new variety of crops, zoning of cultivation and other knowledge generation about strategies to adapt to climate chance is low in the country. The efforts in INTA and in producer associations have a low scope. Possibly the main reason is the low political support, but this lack of political vision comes from the low perception of the importance of adaptation or the perception this a future issue. This lack of political support means low funding in research and prioritization in mitigation and risk management.

The effect of climate change on crops and agricultural activities in general should guide major research activities. The future conditions of climatic factors on projected climate scenarios must become into productivity scenarios for crops, as input for farmers and their adaptation process.

4.6 Outreach of experiences from academia, NGOs and producer organizations

The research and application of technology development from the academia, NGOs and the producer associations have a very limited outreach, and their scope is limited to academic purposes, terms of reference of the projects or members of the producer associations.

The transference and dissemination of climate information and scientific knowledge about the expected effects of climate on agriculture should have more coordination with academia, NGOs and producer organizations, MAG, extension services and farmers.

Infrastructure as the National System of Agricultural Research and Technology Transfer (SNITTA) is a concept that can contribute with a higher coordination of research and dissemination of technology in adaptation. The level of operation of SNITTA is among the work lines of institutions that have developed areas of coordination outside SNITTA, making the objectives of MAG to revamp the initiative an important policy measure.

4.7 Zoning Policy

The zoning has a regulation and policy framework suitable for a policy supporting the allocation of crops according to the future conditions imposed by the climate change.

The execution of actions promoting the zoning is low by MAG and banks are the institution promoting the major advances is these practices by conditioning some loan lines to the allocation of crops in zones with low level of risk. However, only few farmers depends on credits to finance their crops.

The zoning of regions suitable for cultivation should be set considering the scenarios of future climate. Zoning must count on a policy of incentives and disincentives to guide the allocation of agricultural activities.

The legislation in Costa Rica do not give to MAG the competence to promote the zoning by command measures or bans, demanding major complementary policies of incentives, knowledge dissemination, capacity building and research.

4.8 Finance and Insurance based on adaptation incentives

The consideration of weather in the assignation of loans or insurance coverage is only in terms of the short-terms effects of the climate in the crop cycle, but adaptation in not related to this assignation.

Banks and insurance companies require more information and capacity building to identify the importance of the long-term effects of the climate change in the sustainability of their business.

The finance and insurance instruments should include adaptation as part of the criteria to define products and pricing. Currently, these institutions include climate information in their commercial policies, but relate especially to extreme events and short-term effects.

4.9 Climate-prof Infrastructure

The recovery of infrastructure finance by public investment has now a protocol to consider climate threats and vulnerability. This is an important advance in line to finance investments need under the requirement of a protocol for climate-prof infrastructure.

The consideration of climate risk in new infrastructure should not be only an obligation for public investments. The risk management requires of protocols for climate-prof infrastructure available for producers in their own projects, as a way to reduce their vulnerability to the climate extreme events. The existing of the protocol climate-prof infrastructure is not oriented to farmers, and most of the damage coming from extreme events has to be finance directly by the producers.

4.10 A Comprehensive Policy on Water

The Agriculture Census of 2014 shows the influence of the Project of SENARA services is still limited in the agriculture sector. SENARA is only providing water in the 1% of the farms and most farmers obtain water from public services, rivers, springs or wells (INEC. 2014). The low coverage of SENARA is because the design of the policy this institution limited to some regions, which are the more sensible areas of droughts and floods. However, the scope of adaptation practices through SENARA will be still limited in scope.

Other important issue related to the water policy is the specific interests in some influential groups whose have prevent a new and modern water legislation.

The canon in Costa Rica for water exploitation is a pricing instrument promoting rational use, but the statistics from the Directorate of Water show a half of users of the water have an illegal source, and the pricing is not operating for this users.

The country requires a more comprehensive policy of water use in agriculture backed by a modern legislation. This policy should promote not only a rational use of the resource, but also the uptake of measures to adapt the use and provision to the effects of climate change.

4.11 A Phytosanitary Policy oriented to Adaptation

The regulatory framework does not give the phytosanitary system an explicit role in reducing phytosanitary problems related to climate change. This role in adaptation is not implicit in the regulation, so the sector policy needs to incorporate it explicitly, to match the long-term perspective of the phytosanitary control with the process of adaptation to climate change.

Although existing regulations and public policies on phytosanitary control do not have this orientation to adaptation, provides the basis for the country to incorporate the perspective of phytosanitary threats originated in the climate change.

The issue in 2007 of the regulation on registration and use of synthetic pesticides represents a strengthening of the regulatory framework and the institutional arrangement for the control of agrochemicals. This strengthening of the institutional framework gives the SFE an enabling environment to incorporate the monitoring of phytosanitary threats related to climate change. However, this monitoring of the SFE requires a complementary effort in research about the biology of pests and their natural control in the context of future climate scenarios, as well as about the techniques to control pests in the new environmental conditions. The SFE needs the

support of a system for monitoring the environmental conditions and the behavior of plagues. In addition, the research should advance in the identification of crops more resistant to potential new plagues and the agriculture zoning considering the threats of pests.

5 References

Alvarez, Luis et al. 2012. Regionalized Climate Change Scenarios for Costa Rica. San Jose: IMN.

Arauz, Felipe. 2011. Eighteenth State of the Nation Report: Agriculture, practices and environmental challenges. San Jose: State of the Nation Program.

Astorga, Yamileth. 2013. Nineteenth State of the Nation: Water Resource Management. San Jose: State of the Nation Program.

CCAD. 2010. Regional Strategy on Climate Change. San Salvador: SICA

Chavez, March. 2011. National System for Research and Transfer of Agricultural Technology (SNITTA): Important and necessary institutional tool for improving Costa Rican competitiveness. San Jose: LAICA.

CINPE. 2012. Cost-effectiveness Scenarios of Mitigation Measures: Sugar Cane, Coffee and Livestock. San Jose: CINPE.

CORFOGA. 2000. Livestock Census. San Jose: National Livestock Corporation.

CNE. 2015. National Policy on Risk Management 2016-2030. San Jose: National Commission for Risk Prevention and Emergency Response (CNE).

DCC. 2012. Plan of Action of the National Climate Change Strategy. San Jose: MINAE.

DCC. 2014. Call for Proposals for the Adaptation Fund: Program "Reducing the vulnerability focusing on critical areas in order to reduce the negative impacts of climate change and improve the resilience of these populations") http://cambioclimaticocr,com/biblioteca-virtual/cat_view/3-publicaciones-de-adaptacion.

DCC. 2015. Operating Institutional Plan. San Jose, Directorate of Climate Change.

DCC. 2014 b. Terms of reference for recruitment consultancy design, development and socialization of the National Adaptation Plan. MINAE: DCC.

EPYPSA. 2010. Final Report of the Consultancy Evaluation Program Promoting Sustainable Agricultural Production (PFPAS). San José: EPYPSA.

Flores, R. et al. 2014. Database Impacts of Meteorological Events in the Agricultural Sector in Costa Rica. San Jose: MAG-MIDEPLAN.

Flores, Roberto et al. 2010. Study on Economic Impact of Extreme Natural and Anthropic Events. San Jose: MIDEPLAN.

Fundecooperacion. 2014. Adaptation Fund Report.http://fundecooperacion,org/fondo-de-adaptacion-2

IICA. 2007. Seguros Agropecuarios y Gestión de Riegos. San José, IICA.

IICA. 2010. Strategic Plan 2010-2020. San José: IICA

IMN. 2008. Second National Communication. Climate Variability and Climate Change in Costa Rica. San Jose: IMN, 2008.

INEC. 2014. Agriculture Census. San Jose: INEC.

MAG. 2010. State Policy for the Agro-food Sector and Rural Development 2010-2021. San Jose: MAG.

MAG. 2010 b. Study of the State of Sustainable Production and Proposed Mechanisms for Permanent Promotion of Sustainable Production: Final Report. San Jose, MAG.

MAG. 2011. Agro-Environment, Climate Change and Carbon Neutrality Agenda in the Agro-food Sector of Costa Rica. San Jose: MAG.

MAG. 2011 a. Plan of Action for Climate Change and Agro-Environmental Management 2011-2014. San Jose: MAG.

MAG. 2011 b. Sector Plan for Agricultural and Rural Development 2015-2018. San Jose: MAG.

MAG. 2013. Study on the national environment of organic agriculture in Costa Rica. San Jose: MAG.

MAG. 2015. Methodological guidelines for Agricultural Extension. San Jose: MAG.

MAG-PFPAS. 2010. Program Promoting Sustainable Agricultural Production (PFPAS): Final Report. San Jose: MAG.

MEIC. 2011. Agrochemical Trading in Costa Rica. San Jose: MEIC.

MIDEPLAN. 2007. National Development Plan 2016-2010 “Jorge Manuel Dengo Obregon”. San Jose: MIDEPLAN.

MIDEPLAN. 2009. Executive Decree No. 35374-PLAN Standards Guidelines and Procedures for Public Investment. San Jose: MIDEPLAN, 2009.

MIDEPLAN. 2010. National Development Plan 2011-2014 “María Teresa Obregón Zamora”. San Jose: MIDEPLAN.

MIDEPLAN. 2014. National Development Plan 2015-2018 "Alberto Cañas Escalante" (NDP 2015-2018). San Jose: MIDEPLAN.

MIDEPLAN. 2014 b. Methodology for analyzing natural hazards to public investment projects in profile stage. San Jose: MIDEPLAN.

MINAE et IMN. 2012. Improving National Capacities for the assessment of vulnerability and adaptation of the water system to climate change in Costa Rica, as a mechanism to reduce the risk of climate change and increase the Human Development Index. San Jose: IMN.

MINAE. 2009. National climate Change Strategy. San Jose: MINAE.

MINAE. 2013. Agenda of Water in Costa Rica. San Jose: MINAE.

Ordaz, J. et al. 2010. Costa Rica: Effects of Climate Change on Agriculture. Mexico, DF, CEPAL.

PRODUS-UCR. 2010. Project improving national capacities for the assessment of vulnerability and adaptation to climate change of the water system in Costa Rica. San Jose: IMN.

Raffaele Vignola et al. 2014. Integration of Activities and Studies on Vulnerability and Adaptation to Climate Change. Turrialba, CATIE.

Retana, Alberto et al. 2014. Third National Communication. Food Security and Climate Change in Costa Rica: Basic Grains. San Jose: IMN.

SENARA. 2009. Program for Integrated Water Resources Management (PROGIRH). San Jose: SENARA.

SENARA. 2015. National Policy on Risk Management 2016-2030. San Jose: SENARA.

SFE. MAG. 2015. Voluntary Certification System in Good Agricultural Practice for Fresh Produce domestic consumption, https://www.sfe.go.cr/agroquimicos/certific_bpa.html

SIDE. 2015. Livestock Strategy for Low Carbon in Costa Rica: Strategy and Action Plan 2015-2034. San Jose: MAG.

Villalobos, Roberto y Retana, Jose. 1999. Assessment of the Impact of Climate Variability on Agricultural Production in Costa Rica: Case Studies in Coffee, Potato and Bean. San Jose: IMN.